MELD-XI score predicts in-hospital mortality independent of simplified pulmonary embolism severity index among patients with intermediate-to-high risk acute pulmonary thromboembolism

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ABSTRACT

MELD-XI score predicts in-hospital mortality independent of simplified pulmonary embolism severity index among patients with intermediate-to-high risk acute pulmonary thromboembolism

Introduction: *Acute pulmonary thromboembolism (PTE) is a highly morbid and fatal condition. Although several risk stratification models exist for prediction of mortality risk in PTE, no study has yet focused on the effect of impaired vital organ function, such as renal or hepatic impairment, on mortality in PTE. MELD-XI (Model for end-stage liver disease excluding INR) score predicts mortality among patients with end-stage hepatic and cardiovascular disorders. Herein, we aimed to test MELD-XI score for predicting in-hospital prognosis of patients with intermediate-to-high risk acute PTE.*

Materials and Methods: *We reviewed the medical records patients older than 18 years hospitalized with intermediate-to-high risk PTE between 01.06.2011 and 01.01.2019. Simplified pulmonary embolism severity index (sPESI) score and MELD-XI score were calculated, and in-hospital mortality determined. MELD-XI score was compared between patients with and without in-hospital mortality and was correlated to sPESI score. The predictive power of MELD-XI score for in-hospital mortality was sought and an in-hospital survival analysis with Kaplan Meier curve and log-rank test was done for MELD-XI score.*

Results: *A total of 104 patients [mean age of 70.8 ± 15.9 years; 68 (65.4%) females]. Fourteen (13.5%) patients died at hospital. MELD-XI and sPESI*

scores were significantly correlated to each other and were higher in deceased patients than the survivors [17.3 (IQR 14.3) vs. 10.12 (IQR 2.99); p< 0.05 and 2 (IQR 1) vs. 1 (IQR 1); p< 0.05, respectively]. MELD-XI score and sPESI score were significant predictor of in-hospital mortality in multivariate analysis. A MELD-XI score ≥ 10.25 had a sensitivity of 78.6% and a specificity of 70.0% for in-hospital mortality. A survival analysis revealed that a high MELD-XI category (MELD-XI score ≥ 10.2) significantly worsened in-hospital survival (p< 0.01; log rank test).

Conclusion: *MELD-XI score performs well for mortality prediction among patients with intermediate-to-high risk PTE. This subject needs to be further studied by large, randomized controlled studies.*

Key words: *Acute pulmonary thromboembolism; MELD-XI score; mortality; intermediate-to-high risk*

ÖZ

MELD-XI skoru orta-yüksek riskli pulmoner tromboemboli hastalarında basitleştirilmiş pulmoner emboli ciddiyet indeksinden bağımsız olarak hastane içi mortaliteyi öngörmektedir

Giriş: *Akut pulmoner tromboemboli (PTE) yüksek oranda morbid ve fatal bir durumdur. PTE'de mortalite riskinin öngörülmesi için çeşitli risk sınıflama modelleri olsa da, henüz hiçbir çalışma PTE'de karaciğer ve böbrek fonksiyon bozukluğu gibi vital organların bozulmuş fonksiyonunun mortalite üzerine etkisine yoğunlaşmamıştır. MELD-XI (INR çıkarılmış son dönem karaciğer hastalığı modeli), son dönem karaciğer ve kardiyovasküler hastalıklarda mortaliteyi öngörmektedir. Bu çalışmada MELD-XI skorunun orta-yüksek riskli PTE hastalarında hastane içi ölümü öngörücü rolünü belirlemeyi amaçladık.*

Materyal ve Metod: *01.06.2011 ve 01.01.2019 tarihleri arasında orta-yüksek PTE ile yatırılan hastaların tıbbi kayıtları tarandı. Basitleştirilmiş pulmoner emboli ciddiyet indeksi (sPESI) skoru ve MELD-XI skoru hesaplandı ve hastane içi mortalite belirlendi. MELD-XI skoru hastane içinde ölen ve ölmeyen hastalar arasında karşılaştırıldı ve sPESI skoru ile korele edildi. MELD-XI skorunun hastane içi ölüm içi öngördürücü değeri test edildi ve Kaplan Meier eğrisi ve log rank testi kullanılarak MELD-XI skoru için sağkalım analizi yapıldı.*

Bulgular: *Çalışmaya toplam 104 hasta [ortalama yaş 70.8 ± 15.9 yıl; 68 (%65.4) kadın] alındı. On dört (%13.5) hasta hastanede öldü. MELD-XI ve sPESI skorları anlamlı şekilde birbirleriyle koreleydi ve ölenlerde yaşayanlara göre anlamlı şekilde daha yüksekti [17.3 (sırasıyla ÇAA 14.3)'e karşılık 10.12 (ÇAA 2.99); p< 0.05 ve 2 (ÇAA 1)'ye karşılık 1 (ÇAA 1); p< 0.05]. MELD-XI skoru ve sPESI skoru anlamlı şekilde korele idiler (r= 0.232; p< 0.05). MELD-XI skoru ve sPESI skoru çok değişkenli analizde hastane içi ölümün anlamlı öngördürücüsüydüler. MELD-XI skorunun ≥ 10.25 olması hastane içi mortaliteyi %78.6 duyarlılık ve %70.0 özgüllükle öngörebiliyordu. Sağkalım analizinde yüksek MELD-XI kategorisi (MELD-XI skoru ≥ 10.2) hastane içi sağkalımı anlamlı şekilde kötüleştirmekteydi (p< 0.01; log rank testi).*

Sonuç: *MELD-XI skoru orta-yüksek riskli PTE hastalarında mortalitenin öngörülmesinde iyi performansı göstermektedir. Bu konunun geniş, randomize kontrollü çalışmalarla ileri araştırılması gerekir.*

Anahtar kelimeler: *Akut pulmoner tromboembolizm; MELD-XI skoru; mortalite; orta-yüksek risk*

INTRODUCTION

Acute pulmonary thromboembolism (PTE) is a highly morbid and fatal condition, being responsible for most vascular deaths after myocardial infarction and stroke (1,2). There are several risk stratification systems and scores are available for risk and mortality prediction in PTE. The most commonly used risk stratification scheme is the ESC risk stratification system, which mostly concentrates on cardiac involvement by the increased right ventricular afterload imposed by pulmonary embolus, and thus requires cardiac evaluaiton via electrocardiography, echocardiography, and cardiac biomarker evaluation (1). Other risk stratification systems are also available, such as pulmonary embolism severity index (PESI) and its simplified form, simplified PESI (SPESI), which mostly concentrate on demographic, clinical and

vital sign characteristics (3,4). However, no study has yet focused on the effect of impaired vital organ function, such as of the kidneys and the liver, on mortality in PTE, which may occur due to the hemodynamic burden of PTE and the underlying comorbidities.

MELD-XI (Model for end-stage liver disease excluding INR) score is a modification of the original MELD (Model for end-stage liver disease) score, which is a novel score derived for mortality prediction among patients with end-stage liver disorders and incorporates the logarithmic conversions of serum total bilirubin, creatinine concentrations, and INR level (5,6). MELD-XI score was primarily developed for patients with end-stage liver disease using anticoagulants and does not use INR level (7). Recently, MELD-XI score has also been shown to be able to predict prognosis in critically ill patients (7). Likewise, it could predict

patient outcomes in a number of cardiac disorders, namely heart failure, left ventricular assist device implanted patients, heart transplantation, infective endocarditis, mitral valve repair surgery, among others (8-12). The suggested mechanism underlying the ability of MELD-XI score to predict mortality among cardiac, along with other critically ill, patients is renal and/or hepatic hypoperfusion and/or congestion resulting from forward and/or backward heart failure, resulting in deranged end-organ function (13-15). Although it has been shown to predict outcomes in various cardiovascular disorders, MELD-XI score has never been studied among patients with PTE. Hence, in this study we aimed to determine the role of MELD-XI score for predicting in-hospital prognosis of outpatients presenting with intermediate-to-high risk acute PTE and compare it with the sPESI score, a score with already proven role in predicting mortality in PTE. We used MELD-XI score instead of the original MELD score as the patients with PTE are almost always treated with anticoagulants.

MATERIALS and METHODS

This study was approved by the Local Ethics Committee and supported by the Institutional Research Fund (No: KA19/172). The medical records of patients aged older than 18 years who presented to our hospital's emergency department as outpatients with acute PTE and were admitted to hospital for intermediate-to-high risk PTE between 01.01.2013 and 01.01.2019 were retrospectively reviewed and recorded from written medical reports and hospital's data automation system. We recorded and analyzed demographic variables including age, gender; clinical variables including presenting symptom (chest pain, dyspnea, syncope, or altered consciousness and poor overall condition), comorbidities (cardiac, pulmonary, or systemic), presumed, definable cause of PTE such as cancer or recent trauma or surgery, administered anticoagulant and/or fibrinolytic therapy; vital signs including body temperature, respiratory rate, heart rate, and admission systolic blood pressure; echocardiographic variables including right ventricular apical four chamber basal size, right ventricular tricuspid annular plane systolic excursion (TAPSE), systolic pulmonary artery pressure (sPAP), grade of tricuspid insufficiency (1-4), and left ventricular ejection fraction (LVEF); electrocardiographic variables including sinus tachycardia, S1Q3T3 pattern, pathological Q waves in inferior leads, right axis deviation, right ventricular hypertrophy, incom-

plete or complete right bundle branch block, anteroseptal T inversion, anteroseptal ST depression, and profound bradycardia (< 40/min); biochemical variables including blood urea nitrogne (BUN), creatinine, total bilirubin, INR level, white blood cell count (WBC), hemoglobin concentration, serum C-reactive protein (CRP) level, maximal cardiac troponin I level at the time of emergency department admission, D-dimer level; and arterial blood gas variables including pH, PaO_2, SO_2, PCO_2, lactate level, and HCO_3 level.

This study only included intermediate and high risk PTE patients determined according to the ESC 2014 Pulmonary Embolism Guidelines. As such, high-risk PTE was defined as acute PTE with persistent hypotension [systolic blood pressure < 90 mmHg or > 40 mmHg drop for at least 15 minutes or needing inotropic support, not due to a cause other than PE, such as arrhythmia, hypovolemia, sepsis, or left ventricular (LV) dysfunction], pulselessness, or persistent profound bradycardia (heart rate < 40 bpm with signs or symptoms of shock). Intermediate-risk PTE was defined as acute PTE without systemic hypotension (systolic blood pressure > 90 mmHg) but with either RV dysfunction or myocardial necrosis. RV dysfunction was considered positive when end-diastolic right ventricular (RV) to left ventricular (LV) diameter ratio was greater than 0.9 in apical four chamber view and/or there occurred RV systolic dysfunction evidenced by reduced tricuspid annular plane excursion (TAPSE) on echocardiography; or when there were newly developed electrocardiographic changes (new complete or incomplete right bundle-branch block, anteroseptal ST elevation or depression, or anteroseptal T-wave inversion). Myocardial necrosis was defined by elevated admission or follow-up troponin I level (> 0.4 ng/mL) (1).

Simplified PESI (pulmonary embolism severity index) (sPESI) score was calculated for all patients. In this score, 1 point is given to each of the following characteristics: age > 80 years; male gender; chronic obstructive pulmonary disease or chronic heart failure; pulse rate ≥ 110 bpm; systolic blood pressure < 100 mmHg; and arterial SO_2 < 90% (4,16).

MELD-XI score was calculated by the following formula: $5.11 \times \ln$ (serum bilirubin in mg/dL) + $11.76 \times \ln$ (serum creatinine in mg/dL) + 9.44. Serum creatinine and bilirubin values below 1.0 mg/dL were rounded

up to 1.0 and serum creatinine values above 4 were rounded to 4.0. Serum creatinine was rounded to 4 in patients on hemodialysis therapy (17).

The exclusion criteria included patients younger than 18 years, patients with low-risk thromboembolism, patients with missing medical records, and patients that were treated as outpatients. In-hospital all-cause mortality was defined as death by any cause during the time of hospital stay.

Statistical Analysis

All statistical analyses were performed using SPSS v 20 software package (IBM SPSS statistics). The normality of the distribution of continuous variables was tested using the Kolmogorov-Smirnov test. The normally distributed continuous variables were expressed as mean ± standard deviation; the non-normally distributed ones as median and interquartile range-(IQR); and categoric variables as number and percentage. Normally distributed continuous variables were compared with the independent samples t-test; non-normally distributed continuous variables with the Mann-Whitney U test; and the categoric variables with the Chi-square test or Fisher's exact test. MELD-XI score was compared between patients with and without in-hospital mortality. Correlation between the scoring systems was tested using Spearman bivariate correlation analysis. The significant predictors of in-hospital mortality were initially tested with a univariate analysis using all available variables. All univariate predictors of mortality with p value ≤ 0.2 were then used in a binary logistic regression model to determine the independent predictors of in-hospital mortality. The predictive power of MELD-XI score for in-hospital mortality was sought using ROC (Receiver operating characteristics) analysis to determine the area under the curve, sensitivity, specificity, and positive and negative predictive values. A survival analysis with Kaplan Meier curve and log-rank test was used to determine the effect high vs low MELD-XI score category on in-hospital survival. A p value of less than 0.05 was considered statistically significant for all statistical tests.

RESULTS

A total of 104 patients with a mean age of 70.8 ± 15.9 (range 24-96 years) were included, of which 68 (65.4%) were female. General clinical and demographic characteristics of the study population were

shown on Table 1. Based on the ESC 2014 PTE gideline, a total of 9 (8.7%) patients had high-risk PTE and 95 (91.3%) had intermediate-risk PTE. The mean sPESI score of the patients was 1.31 ± 1.02 and the mean MELD-XI score was 11.44 ± 3.78. A total of 14 (13.5%) of the patients died at hospital. The comparison between the deceased and surviving patients with respect to clinical, echocardiographic, electrocardiographic, and biochemical parameters were shown on Table 2. MELD-XI score was significantly higher in deceased patients than the survivors [17.3 (IQR 14.3) vs. 10.12 (IQR 2.99); p< 0.05] as was the median SPESI score [2 (1) vs. 1 (1); p< 0.05] and serum CRP level [110.0 (IQR 68.0) vs 27.2 (IQR 49.2); p< 0.05] whereas the deceased ones had a significantly lower hemoglobin count than the survivors [9.7 (IQR 2.1) vs. 13.4 (IQR 2.3); p< 0.05]. Other parameters were similar between the two groups.

In correlation analysis MELD-XI score and sPESI score were significantly correlated (r= 0.232; p< 0.05). Univariate predictors of death were MELD-XI score, sPESI score, pulmonary artery systolic pressure, serum CRP, and hemoglobin count, whereas clinical PTE severity was not predictive of mortality in univariate analysis. A multivariate analysis using binary logistic regresion analysis with forward Wald method showed that MELD-XI score was an independent predictor of in-hospital death along with sPESI, systolic pulmonary artery pressure, and hemoglobin count (Table 3). ROC analyses showed that sPESI score (AUC = 0.744 95%CI 0.631-0.856; p= 0.001) and MELD-XI score (AUC = 0.765 95%CI 0.618-0.912; p= 0.001) were significantly predictive of in-hospital death (Figure 1, 2). A MELD-XI score of ≥ 10.25 had a sensitivity of 78.6% and a specificity of 70.0%, while a sPESI score of ≥ 1.5 had a sensitivity of 78.6%, a specificity of 64.6%. A survival analysis based on a MELD-XI cut-off point of 10.2 revealed that patients in the high MELD-XI category (MELD-XI score ≥ 10.2) had a significantly worse in-hospital survival than those in the low MELD-XI category (MELD-XI score < 10.2) (p< 0.01; log rank test), so that 95.5% of patients with a MELD-XI score of < 10.2 survived by 60 days after hospitalization whereas only 71.1% of those with a MELD-XI score of ≥ 10.2 survived. (Figure 3).

Table 1. General clinical and demographic characteristics of the study population

Characteristics	Study population (n= 104)
Age (years) (median-IQR)	75 (23)
Gender (male) (n, %)	36 (34.6%)
Presenting symptom	
Chest pain (n, %)	45 (43.3%)
Dyspnea (n, %)	47 (45.2%)
Syncope (n, %)	8 (7.7%)
Altered consciousness and poor overall condition (n, %)	4 (3.8%)
ESC PTE severity	
High-risk (n, %)	9 (8.7%)
Intermediate-risk (n, %)	95 (91.3%)
sPESI score (mean ± SD)	1.31 ± 1.02
MELD-XI score (mean ± SD)	11.44 ± 3.78
Cancer (all types) (n, %)	27 (26.0%)
Recent posttraumatic or postoperative PTE (n, %)	14 (13.5%)
COPD (any type) (n, %)	4 (3.8%)
Bronchial asthma (n, %)	3 (2.9%)
Active smoking (n, %)	20 (19.2%)
Diabetes mellitus (any type) (n, %)	26 (25%)
Hypertension (n, %)	58 (55.8%)
Hyperlipidemia (n, %)	24 (23.1%)
History of cerebrovascular accident (n, %)	24 (23.1%)
CVA (n, %)	17 (16.3%)
History or current atrial fibrillation (any type) (n, %)	19 (18.3%)
Heart failure (any type) (n, %)	17 (16.3%)
Chronic renal disease (n, %)	11 (10.6%)
Not on dialysis (n, %)	6 (5.8%)
On dialysis (n, %)	5 (4.8%)
Administered anticoagulant/thrombolytic therapy	
Unfractioned heparin (n, %)	11
Low-molecular weight heparin (n, %)	89
Thrombolytic therapy (n, %)	4

IQR: Interquartile range, ESC: European Society of Cardiology, PTE: Pulmonary thromboembolism, sPESI: Simplified pulmonary embolism severity index, COPD: Chronic obstructive pulmonary disease.

Table 2. Comparison deceased and surviving patients with respect to clinical, echocardiographic, electrocardiographic, and biochemical parameters

Parameter	Deceased patients (n= 14)	Surviving patients (n= 90)	p
Age (years) (median-IQR)	59 (45)	74(16)	NS*
Male gender (n, %)	3 (21.4%)	33 (36.7%)	NS†
Chronic obstructive pulmonary disease (n, %)	1 (7.1%)	3 (3.3%)	NS‡
Bronchial asthma (n, %)	0 (0%)	3 (3.3%)	NS‡
Active smoking (n, %)	2 (14.3%)	18 (20.0%)	NS‡
Diabetes mellitus (n, %)	3 (21.4%)	23 (25.6%)	NS‡
Hypertension (n, %)	9 (64.3%)	49 (54.4%)	NS†
Coronary artery disease (n, %)	3 (21.4%)	21 (23.3%)	NS‡
History of cerebrovascular accident (n, %)	4 (28.6%)	13 (14.4%)	NS‡
Heart failure (n, %)	3 (21.4%)	14 (15.6%)	NS‡
Chronic renal disease (n, %)	1 (7.1%)	10 (11.1%)	NS‡
Cancer (n, %)	11 (78.6%)	16 (17.8%)	< 0.001†
Recent posttraumatic or postoperative PTE (n, %)	0 (0%)	14 (15.6%)	NS‡
ESC PTE severity			
High-risk (n, %)	2 (14.3%)	10 (11.1%)	NS‡
Intermediate risk (n, %)	12 (85.7%)	80 (88.9%)	NS†
MELD-XI score (median-IQR)	17.3 (14.3)	10.12 (2.99)	< 0.05*
sPESI score (median-IQR)	2 (1)	1 (1)	< 0.05*
RV diastolic diameter/LV diastolic diameter ratio (median-IQR)	0.9 (0.6)	0.8 (1.0)	NS*
RA diameter (mm) (median-IQR)	33 (12)	39 (9)	NS*
TAPSE (mm) (median-IQR)	17 (2)	18 (8)	NS*
LVEF (%) (median-IQR)	52 (11)	55 (8)	NS*
sPAP (mmHg) (median-IQR)	65 (42)	43 (28)	< 0.05*
Tricuspid insufficiency (median-IQR)	2 (1-3)	2 (1-3)	NS*
Troponin I (ng/mL) (median-IQR)	0.06 (0.41)	0.05 (1.15)	NS*
ECG changes (any) (n, %)	9 (64.3%)	48 (52.2%)	NS†
BUN (mg/dL) (median-IQR)	20 (27)	18 (13)	NS*
Creatinine (mg/dL) (median-IQR)	1.22 (4.16)	0.88 (0.42)	NS*
eGFR (ml/min/1.73 m^2) (median-IQR)	44 (117)	67 (37)	NS*
Total bilirubin (mg/dL) (median-IQR)	0.45 (0.80)	0.45 (0.16)	NS*
WBC (10^3/µL)(median-IQR)	9.71 (1.28)	12.4 (2.95)	< 0.05*
Hb (g/dL) (median-IQR)	9.7 (2.1)	13.4 (2.3)	< 0.05*
CRP (mg/dL) (median-IQR)	110.0 (68.0)	27.2 (49.2)	< 0.01*
D-dimer (µg/mL) (median-IQR)	9.6 (13.7)	7.2 (19.4)	NS*
Heart rate (beats/min) (median-IQR)	93 (18)	93 (41)	NS*
Respiratory rate (breaths/min) (median-IQR)	22 (5)	20 (7)	NS*
Lactate (mmol/L) (median-IQR)	2.1 (0.6)	2.2 (4.6)	NS*
pH (median-IQR)	7.40 (0.15)	7.41 (0.13)	NS*
PaO_2 (mmHg) (median-IQR)	46.8 (41.2)	54.0 (36.7)	NS*
Arterial blood gas SO_2 (%) (median-IQR)	80.4 (17.4)	88.0 (5.1)	NS*
HCO_3 (mmol /L) (median-IQR)	23.0 (6.4)	22.9 (8.2)	NS*
$PaCO_2$ (mmHg) (median-IQR)	35.7 (3.5)	29.6 (10.4)	NS*
Admission systolic BP (mmHg) (median-IQR)	120 (18)	136 (46)	NS*

* Mann-Whitney U test; † Chi-square test; ‡ Fisher's exact test.
ESC: European Society of Cardiology, PTE: Pulmonary thromboembolism, RV: Right ventricle, RA: Right atrium, TAPSE: Tricuspid annular plane systolic excursion, sPAP: Systolic pulmonary artery disease, BUN: Blood urea nitrogen, eGFR: Estimated glomerular filtration rate, WBC: White blood cell count, Hb: Hemoglobin, CRP: C-reactive protein, PaO_2: Partial oxygen pressure, SO_2: Oxygen saturation, $PaCO_2$: Partial carbondioxide pressure, BP: Blood pressure.

Table 3. Independent predictors of in-hospital death in binary logistic regression analysis

Variable	Hazard ratio (95% CI)	p
sPESI score	5.3 (1.14-25.09)	< 0.05
MELD-XI score	1.40 (1.04-1.89)	< 0.05
Systolic pulmonary artery pressure	1.08 (1.02-1.15)	< 0.05
Hemoglobin count	0.481 (0.29-0.79)	< 0.05
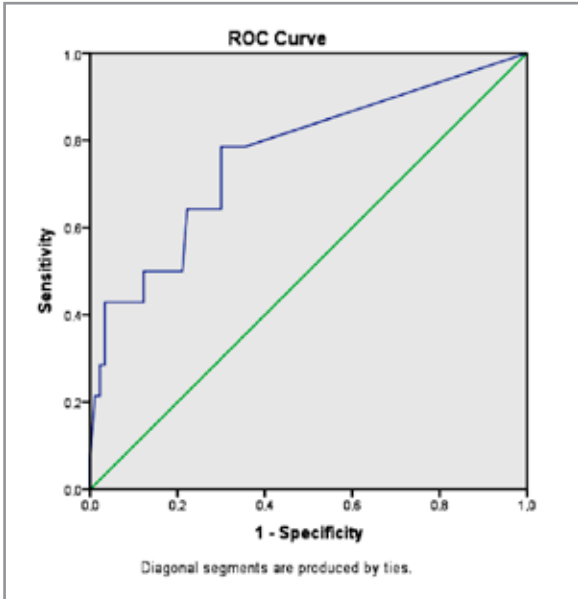
Figure 1. ROC curve for MELD-X score.
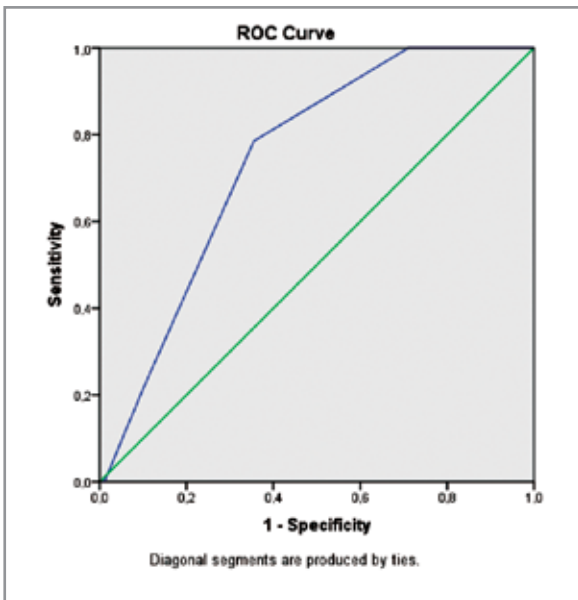
Figure 2. ROC curve for sPESI score.
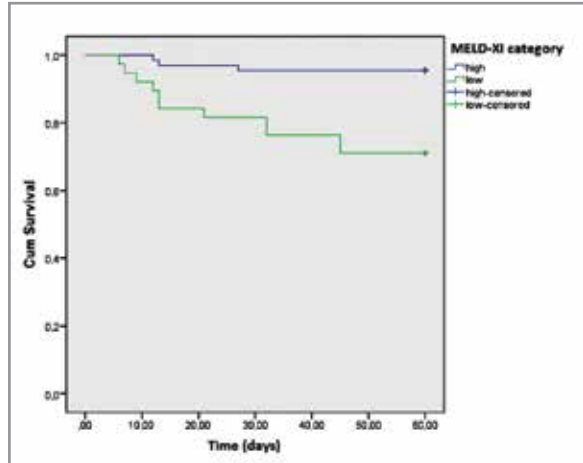
Figure 3. Kaplan Meier in-hospital survival curve for MELD-XI score.

DISCUSSION

The results of the present study revealed that, among hospital admitted intermediate-to-high risk PTE patients, MELD-XI score was significantly higher in deceased versus survivors. Furthermore, MELD-XI score was an independent predictor of in-hospital mortality and had an identical sensitivity and a better specificity than sPESI score for the same outcome. Finally, a higher MELD-XI score category (MELD-XI≥ 10.2) was associated with a significantly lower survival after hospitalization. These results collectively indicate that MELD-XI score is a useful tool for mortality prediction among hospitalized intermediate-to-high risk PTE patients.

PTE is a condition associated with a fairly high morbidity and mortality risk, being the third most common vascular disease, only after myocardial infarction and stroke and having an increasing incidence in parallel to cancer, immobility, and obesity (1,18-22). There are some risk stratification schemes and scores for mortality prediction among PTE patients, the most commonly used of which is the ESC risk stratification

model with a proved role for mortality prediction (1,23). According to that model, pulmonary embolism severity is classified as high-risk, intermediate-risk, and low-risk, and is based on cardiovascular hemodynamics (syncope, persistent hypotension, profound bradycardia), right ventricular dilatation (increased right-to-left ventricular diameter ratio), systolic dysfunction (reduced right ventricular systolic function and/or wall hypo/akinesis), or myocardial injury (increased cardiac enzymes or B-natriuretic peptide level). There are other risk stratification models and scores, of which the most commonly utilized ones are PESI score and its simplified form, sPESI score, which are mainly based on demographic and clinical variables such as demographic factors (age, sex) comorbidities [cancer, heart failure (HF) or chronic obstructive pulmonary disease (COPD)] and vital signs (heart rate, systolic blood pressure, body temperature, respiratory rate, and consciousness level). Both scores have been linked to increase mortality risk in PTE (24-29). However, the afore-mentioned scores primarily incorporate cardiopulmonary variables but not other systems, and it is unclear how impaired end-organ function, such as renal and hepatic functions, affects mortality. Herein we aimed to use MELD-XI to predict mortality in PTE. MELD-XI score was significantly higher in deceased patients and was an independent predictor of mortality apart from sPESI score. Furthermore, its predictive power for mortality was fairly good. Our positive results for MELD-XI score may indicate three possibilities about its ability to predict mortality in PTE. First, MELD-XI score may reflect a mortality increase as a result of impaired end-organ function and multiorgan failure secondary to cardiovascular derangement and resulting low-output/congestive state due to PTE (30,31). Second, although being statistically non-significant, our results showed that PaO_2 and SO_2 levels in arterial blood gas analysis were lower in the deceased patients than the survivors. This may reflect that tissue hypoxia may also have increased mortality by impairing renal and/or hepatic function and thus increasing MELD-XI score. So, far studies have shown that tissue hypoxia may impair renal and hepatic function and/or cause reversible or irreversible injury (32,33). As PTE may create severe hypoxia and depress tissue oxygenization, this mechanism may be a link between mortality from PTE and an increased MELD-XI score. As the third and the last possibility, MELD-XI score may in fact predit mortal-

ity increase due to underlying disorders impairing renal and hepatic function, such as poor overall status, comorbidities or underlying disorders like cancer, COPD, HF, CAD, and recent surgery, among others. However, irrespective of which possibility is more important, these both of the two possibilities ultimately lead to the same conclusion that sicker patients with impaired renal and/or hepatic function of any reason are more likely to die. Therefore, MELD-XI score may be in fact may be assessing a common final pathway during the events culminating into death in PTE. Hence, although it is a relatively simpler score incorporating serum levels of only two serum levels, it may be one, if not the only one, of the ultimate risk stratifiers in PTE, as in other criticall ilnesses. Besides, as it is an easy score requiring only two parameters readily available in serum biochemistry, it may readily calculated and give an immediate idea about the outlook of a patient. Therefore, our results seem very relevant with the goal of predicting mortality among these patients, perhaps not in the form of guiding decisions regarding thrombolytic therapy, but being aware of the more grave prognosis to prompt administering more aggressive treatments to correct end-organ perfusion and/or congestion and to address causative or comorbid conditions.

LIMITATIONS

This study had some limitations. First of all, this was a retrosepctive study with a relatively small sample size and a low number of deceased patients. Second, we did not use B-type natriuretic peptide level for determining cardiac injury and based the latter solely on troponin I measurement. Third, we assessed only in-hospital mortality but not long-term mortality. Lastly, we only included hospitalized patients and we did not evaluate the role of MELD-XI for mortality prediction for PTE patients managed on an outpatient basis.

CONCLUSION

The present study implies that MELD-XI score performs well and independently of sPESI score for mortality prediction among in-patients with intermediate-to-high risk PTE. This subject must be further studied by large, randomized controlled studies.

CONFLICT of INTEREST

No conflict of interest declared by the authors.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: OÇ, ÇOÇ

Analysis/Interpretation: OÇ, ÇOÇ, GU

Data Acquisition: OÇ, GU

Writting: OÇ

Critical Revision: OÇ, EK

Final Approval: OÇ, EK, İHM

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