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TANAFFOS

# The Impact of MELD, PESI, PSI, and DIC Scores on Predicting Pulmonary Thromboembolism and Mortality Rate in COVID-19 Pneumonia

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**Background:** Multiple studies have reported an increased incidence of thrombosis in patients with COVID-19 pneumonia, contributing to higher mortality rates. This study aimed to investigate the ability of disease severity scores, the Pneumonia Severity Index (PSI), Pulmonary Embolism Severity Index (PESI), Disseminated Intravascular Coagulation (DIC), and End-Stage Liver Disease Model (MELD), to predict embolism and embolism-related mortality in patients with COVID-19 pneumonia.

**Materials and Methods:** In this retrospective study, demographic data, comorbidities, hospitalization dates, length of stay in the intensive care unit, percentage of CT radiological involvement, presence of embolism, and biochemical and hematological test results of the patients were recorded. PSI, PESI, DIC, and MELD scores were calculated within the first 24 hours of hospitalization.

**Results:** A total of 158 patients (82 males, 76 females) with a mean age of 53.47± 12.49 years were included. Embolism was detected in 24 cases (15%), and the mortality rate was 11% (18 cases) across all cases. The optimal threshold values for predicting mortality were 63 for PESI and 76 for PSI (AUC values of 0.802 and 0.747). The optimal threshold value for detecting pulmonary embolism was 4 for DIC (AUC: 0.740). In the univariate analysis, variables with a p-value less than 0.1 included radiological score, age, DIC, troponin levels, and D-dimer levels. The subsequent multivariate analysis indicated that both the DIC score ($p = 0.047$) and the radiological score ($p = 0.043$) were independently associated with pulmonary embolism. In another univariate analysis, the variables with a p-value less than 0.1 included age, radiological score, the presence of comorbidities, procalcitonin, CRP, troponin, PSI, and PESI score. The follow-up multivariate analysis suggested that the PESI score ($p = 0.018$) and PSI ($p = 0.021$) were independently linked to hospital mortality.

**Conclusion:** The PESI score was found to be a significant predictor of mortality, while the DIC score was found to be a significant predictor of pulmonary embolism in patients with COVID-19 pneumonia.

**Keywords:** COVID-19; embolism; mortality; DIC; PESI

## INTRODUCTION

The COVID-19 virus primarily affects the respiratory system, and its clinical presentation can vary widely, ranging from asymptomatic to severe respiratory failure requiring intensive care. Studies have demonstrated an association between hospitalization needs and high mortality rates in COVID-19. Additionally, severe COVID-19 pneumonia patients have an increased risk of venous

thromboembolism (VTE) (1,2). In the cohort of COVID-19 pneumonia patients with more severe conditions receiving care within intensive care units (ICUs), the occurrence of VTE is documented to exhibit a prevalence at least twice that observed in patients with less critical presentations, accompanied by a corresponding mortality rate of 40% (3,4).

Given that timely and effective intervention can reduce morbidity and mortality in COVID-19 pneumonia patients, various scoring systems have been developed to predict these outcomes (5). One of those scoring systems, the Model for End-Stage Liver Disease (MELD) score, a predictor of survival in patients with end-stage liver disease, has been shown to significantly predict ICU admission and in-hospital mortality rates for COVID-19 pneumonia patients (6). Another scoring system, the Disseminated Intravascular Coagulation (DIC) score, which was developed for critically ill patients at high risk of DIC, has been reported to be useful in predicting prognosis in COVID-19 pneumonia (7).

The Pneumonia Severity Index (PSI) is another scoring system used to determine if community-acquired pneumonia (CAP) patients should be treated as outpatients or hospitalized, predicting the severity and mortality of the disease (8). Although limited in number, some studies have indicated the potential efficacy of the PSI in predicting mortality in instances of COVID-19 pneumonia (9).

The Pulmonary Embolism Severity Index (PESI) was originally developed to estimate mortality risk in patients with pulmonary thromboembolism (PTE) and to predict venous thromboembolism–related mortality. Recent evidence suggests that PESI exhibits high sensitivity and negative predictive value for predicting mortality and disease progression in patients with COVID-19 pneumonia (10).

We aimed to investigate the impact of these scores on predicting pulmonary embolism and mortality in COVID-19 pneumonia, considering that an accurate scoring system may facilitate the early detection of mortality and morbidity risks, such as embolism in COVID-19 patients, in addition to the lack of a comprehensive study encompassing all of these scores in COVID-19 pneumonia.

## MATERIALS AND METHODS

### Study design

The study was designed as a retrospective one at the Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital, Health Sciences University. Patients hospitalized for COVID-19 pneumonia in the COVID-19 wards between January 1, 2021, and September 1, 2021, were retrospectively reviewed. The study was conducted following the Declaration of Helsinki by the World Medical Association (1989) and was approved by our hospital's ethics committee (March 25, 2021, protocol no: 2021-106).

### Study population

Out of 989 patients admitted to COVID-19 wards within the specified date range, a total of 158 patients were included in the study, excluding patients a) outside the 18-80 age range, b) diagnosed with malignancy, and c) without pulmonary computed tomography (CT) angiography. During hospitalization, all patients' SARS-CoV-2 nucleic acid real-time polymerase chain reaction (RT-PCR) results were confirmed positive using oropharyngeal swab samples, and radiologists approved radiological findings of viral pneumonia.

### Data evaluation

Demographic data, body mass index (BMI), comorbidities, admission dates and days, duration of ICU stay, percentage of radiological involvement in chest CT, whether pulmonary CT angiography was performed, presence of embolism, biochemical and hematological tests [C-reactive protein (CRP), procalcitonin (PCT), D-dimer, fibrinogen, ferritin, troponin-T, complete blood count (CBC), lactate dehydrogenase (LDH)], treatments received,

and survival status were recorded for the patients. The PSI, DIC, MELD, and PESI scores indicating mortality and clinical severity within the first 24 hours of patient admission were calculated using the MDCalc (Ver 4.0.4) program.

### Biochemical and hematological tests

Hematological analysis was performed using the Mindray BC-6800 hematology analyzer (Beckman Coulter, Fullerton, California). RDW, ferritin, PCT, and CRP measurements were conducted using an automated analyzer (Hitachi cobas 6000-cobas e 601, Hitachi Ltd, Tokyo, Japan) with commercially available kits based on routine methods. Fibrinogen was measured using the Stago STA Compact Max. Troponin T was measured using the electrochemiluminescence method (Roche cobas 6000), and D-dimer was measured using the turbidimetric method (AU-480).

### Evaluation of chest CT involvement score

The patients were categorized based on their thoracic CT involvement of COVID-19 pneumonia (https://radiologyassistant.nl/chest/lk-JG-1/). The involvement percentage of each of the five lobes was calculated. (<5% involvement: 1 point; 5-25% involvement: 2 points; 26-49% involvement: 3 points; 50-75% involvement: 4 points; >75% involvement: 5 points).

### Statistical analysis

Statistical analysis was applied using the R Software version 3.5.1/2018-7-01 (Bell Laboratories, Lucent Technologies, New Jersey, USA). Normal distribution of all the variables was evaluated using the Kolmogorov-Smirnov test. Continuous variables with a normal distribution are expressed as mean ± standard deviation. Continuous variables with a non-normal distribution are summarized as median (interquartile range). Student's t-test was used to compare mean values, and the Mann-Whitney U test was used to compare median values. Chi-square and Fisher's exact tests were used to compare frequency distributions. Receiver Operating Characteristic (ROC) analysis was also used to develop threshold values for scoring systems to differentiate between COVID-19 pneumonia patients with and without embolism. Similar analyses and comparisons were conducted to classify COVID-19 pneumonia patients as mortal or non-mortal. Binary logistic regression analysis was performed to identify independent predictors for embolism and mortality in COVID-19 pneumonia patients. For this analysis, variables with a significance level of $p<0.10$ in univariate analysis were considered candidate variables for multiple analyses. A statistically significant value of $p<0.05$ was used.

## RESULTS

### General characteristics of the cases

A total of 158 patients, with an average age of 53.47±12.49 years (range, 18-80 years), were included in the study. Of these patients, 82(51.80%) were male, and 76(48.10%) were female. The average length of hospital stay was 9(7-12) days, the average radiological score was 6(4-9), and the average radiological percentage was 24(16-36). Comorbidities were present in 55% of the patients (Table 1).

### Laboratory findings and scoring (PSI, PESI, DIC, MELD)

Laboratory values within the first 24 hours of patient admission and PSI, PESI, DIC, and MELD scores were recorded. The median values for the DIC and MELD scores were 2.15 (1-3) and 7 (6-9), respectively, while the mean values for the PSI and PESI scores were 68.9±25 and 65.88±18.94, respectively (Table 2).

### Receiver operating characteristic (ROC) analyses

In the ROC analysis conducted to determine whether pulmonary embolism was present or not, the optimal

threshold values were calculated for PESI, DIC, MELD, and PSI as 78 (sensitivity 79%/specificity 45), 4 (sensitivity 85%/specificity 54), 7 (sensitivity 40%/specificity 70), and 82 (sensitivity 67%/specificity 54), respectively. The AUC areas were 0.587, 0.74, 0.54, and 0.565, respectively (Figure 1). It was shown that the DIC score was significantly superior to the other scores in predicting embolism (p-values; DIC vs. PESI: 0.049; DIC vs. PSI: 0.018; DIC vs. MELD: 0.001) (Figure 2).

In the analysis for mortality, the optimal threshold values were found to be 90 (sensitivity 77%/specificity 94) for PESI, 2 (sensitivity 44%/specificity 73) for DIC, 16 (sensitivity 100%/specificity 5) for MELD, and 76 (sensitivity 94%/specificity 68) for PSI. The corresponding AUC values were 0.917, 0.586, 0.474, and 0.898 (Figure 3). The superiority of the PESI score in predicting mortality over the other scores was demonstrated (PESI vs. MELD, p<0.001; PESI vs. DIC, p<0.001; PESI vs. PSI, p=0.691) (Figure 4).

**Table 1.** Demographic and radiological data

| Variables | Results |
|---|---|
| **Age; year**[a] | 53.47±12.49 |
| **Gender** | |
| **Female; n, (%)** | 76 (48.10) |
| **Male; n, (%)** | 82 (51.80) |
| **BMI (kg/m²)**[a] | 29.32±5.54 |
| **Average day of stay**[b] | 9 (7-12) |
| **Smoker; n (%)** | 78 (49,3) |
| **Comorbidities; n, (%)** | 87 (55) |
| **Diabetes; n, (%)** | 17 (10.75) |
| **Hypertension; n, (%)** | 21 (13.30) |
| **Heart failure; n, (%)** | 7 (4.43) |
| **COPD; n, (%)** | 12 (7.60) |
| **Neurological disorder; n, (%)** | 1 (0.6) |
| **Asthma; n, (%)** | 1 (0.6) |

[a]Results given as Mean± SD; [b]Results given as median (Interquartile range (IQR); n, number of cases; COPD, chronic obstructive pulmonary disease; BMI, body mass index

## Univariate and multivariate analyses

The PESI (107±13) and PSI (112±6) levels of deceased patients with embolism were found to be significantly higher than those of surviving patients (PESI: 69±22, PSI: 70±25) (p=0.031, p=0.01). Additionally, the PESI (80±16) and PSI (86±22) levels of deceased patients without embolism were also significantly higher than those of surviving patients (PESI: 63±18, PSI: 66±24) (p=0.001, P<0.001). In the univariate analysis conducted for pulmonary embolism (including radiological score, age, DIC, troponin, and D-dimer level), the multivariate analysis identified DIC score (p = 0.047) and radiological score (p = 0.043) as independent factors (Table 3). From the factors found to affect disease mortality (age, radiological score, presence of comorbidity, procalcitonin, CRP, troponin, PSI, and PESI), only PSI (p=0.021) and PESI score (p=0.018) were determined as independent factors in the multivariate analysis (Table 4).

**Table 2.** Laboratory findings and scores

| Variables | Results |
|---|---|
| **Procalcitonin (ng/mL)**[b] | 0.07 (0.05-0.13) |
| **CRP (mg/L)**[b] | 63.5 (22-123) |
| **Troponin-T(ng/mL)**[b] | 0.006 (0.004- 0.009) |
| **D-dimer (ng/mL)**[b] | 0.77 (0.49-1.42) |
| **Fibrinogen (mg/mL)**[a] | 591±154.58 |
| **Ferritin(ng/mL)**[b] | 357 (177-735) |
| **LDH (U/L)**[a] | 448.40±210.20 |
| **Platelets (10^3/mL)**[a] | 277.9±135.50 |
| **RDW (%)**[a] | 14±2.16 |
| **PDW (fL)**[a] | 16.13±0.68 |
| **MPV (fL)**[a] | 9.70±1,04 |
| **Radiological score**[b] | 7 (4-11) |
| **Radiological percentage**[b] | 28 (16-44) |
| **PSI**[a] | 68.9±25 |
| **DIC**[b] | 2.15(1-3) |
| **PESI**[a] | 65.88±18.94 |
| **MELD**[b] | 7 (6-9) |

[a]Results given as Mean± SD; [b]Results given as median (Interquartile range (IQR); PSI, Pneumonia Severity Index; PESI, Pulmonary Embolism Severity Index; MELD, The Model for End Stage Liver Disease; DIC, Disseminated Intravascular Coagulation; CRP, C-reactive protein; LDH, lactate dehydrogenase; RDW, Red blood cell distribution width; PDW, Platelet distribution width; MPV, mean platelet volume.

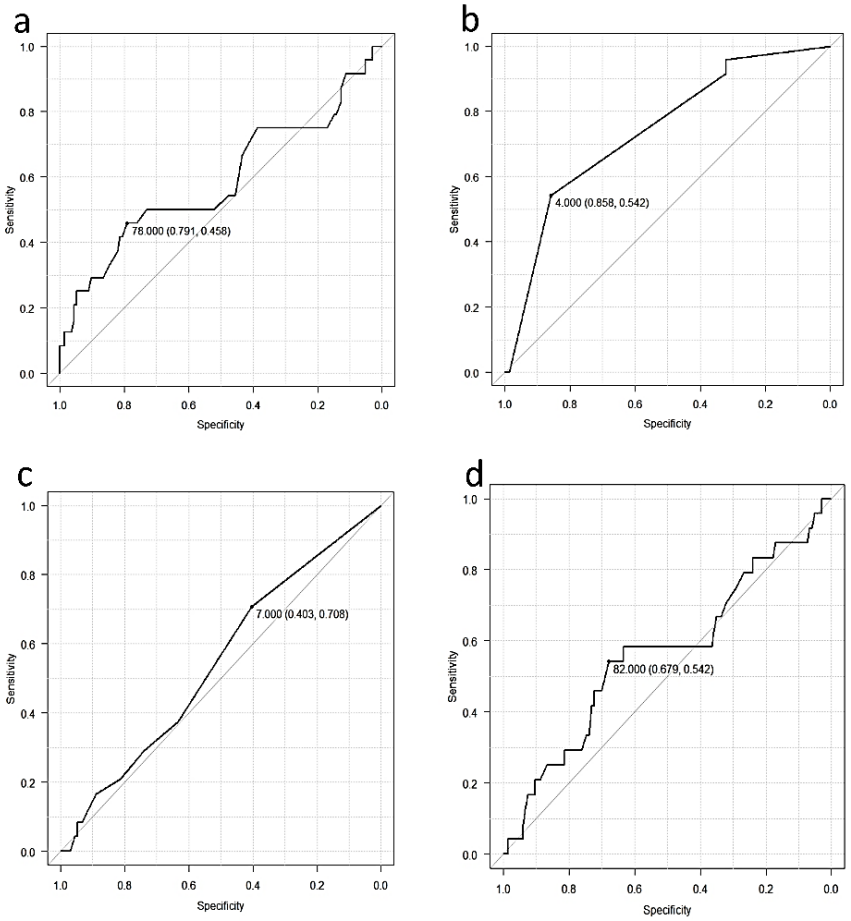


**Figure 1.** Optimal threshold values of PESI, DIC, MELD, and PSI scores, calculated for the detection of embolism in COVID-19 pneumonia. a) The optimal threshold for PESI score is 78 (79% sensitivity / 45% specificity), AUC: 0.587, b) The optimal threshold for DIC score is 4 (85% sensitivity / 54% specificity), AUC: 0.740, c) The optimal threshold for MELD score is 7 (40% sensitivity / 70% specificity), AUC: 0.544, d) The optimal threshold for PSI score is 82 (67% sensitivity / 54% specificity), AUC: 0.565

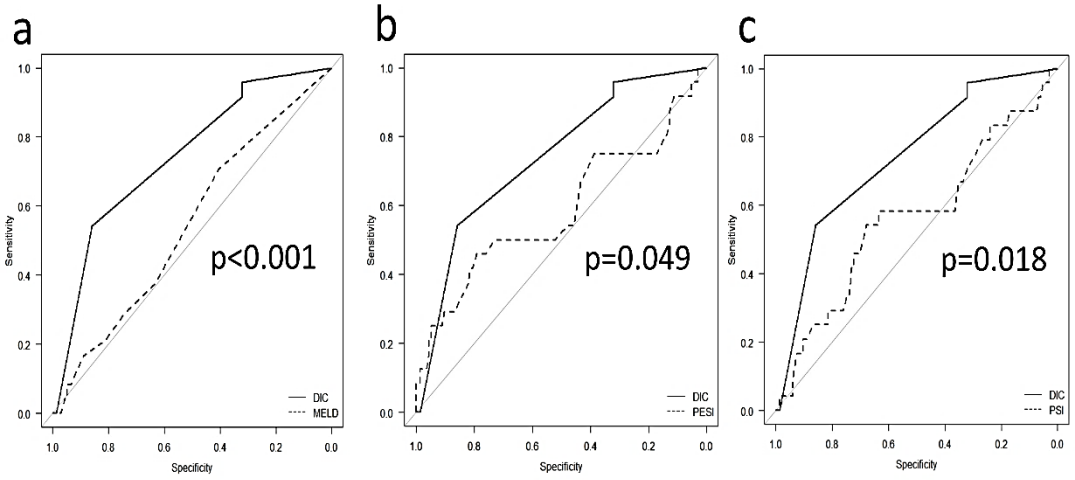


**Figure 2.** Comparison of efficacies of PESI, MELD, DIC, and PSI scores to predict embolism in patients with COVID-19 pneumonia (p values; a) DIC vs. MELD; p<0.001, b) DIC vs. PESI; p=0.049, c) DIC vs. PSI; p=0.018)

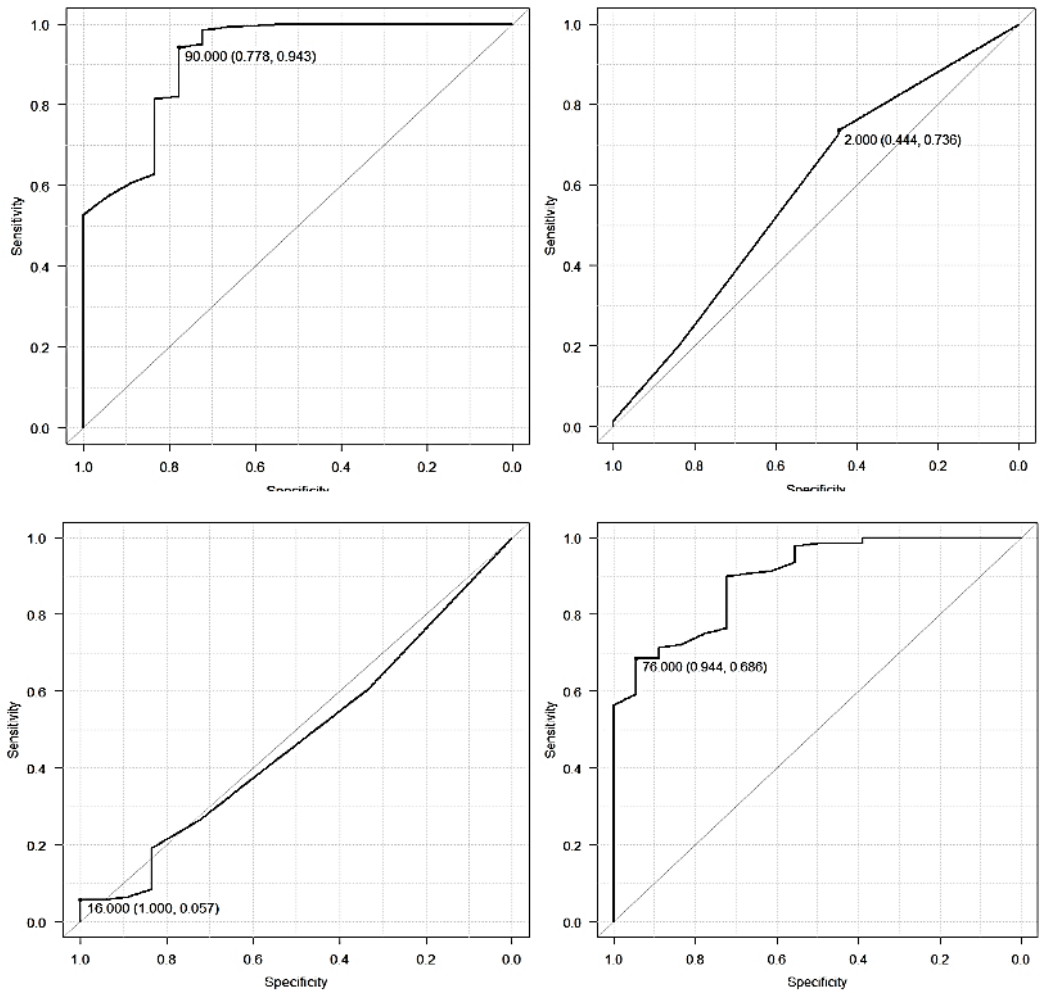


**Figure 3.** Optimal threshold values of PESI, DIC, MELD, and PSI scores calculated for mortality in COVID-19 pneumonia; a) The optimal threshold for PESI score is 90 (77% sensitivity/94% specificity), AUC: 0.917, b) Optimal threshold for DIC score 2 (44% sensitivity/73% specificity), AUC: 0.586, c) The optimal threshold for MELD score is 16 (100% sensitivity/5% specificity), AUC: 0.474, d) The optimal threshold for PSI score is 67 (94% sensitivity/68% specificity), AUC: 0.898

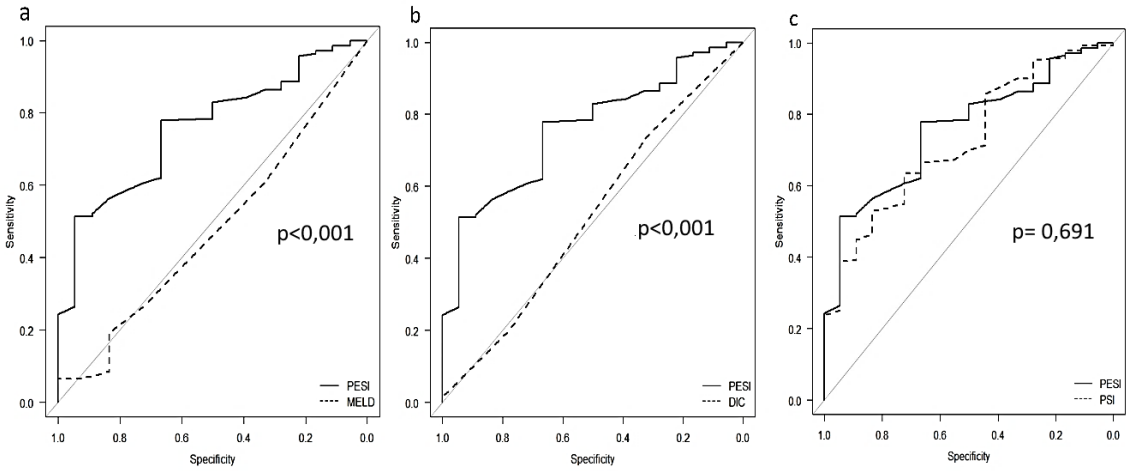


**Figure 4.** Comparison of the efficacies of PESI, MELD, DIC, and PSI scores ROC curves to predict mortality in patients with COVID-19 pneumonia (p values; PESI vs. MELD, p<0.001; PESI vs. DIC, p<0.001; PESI vs. PSI, p=0.69).

**Table 3.** Univariate and multivariate analysis between COVID-19 pneumonia patients with and without pulmonary embolism

| | Pulmonary embolism detected (n=24) | Pulmonary embolism not detected (n=134) | Univariate analysis *p value* | Multivariate analysis *p* value / OR (95% CI) |
|---|---|---|---|---|
| **Gender, male, n, (%)** | 12 (50) | 70 (52) | 0.507 | |
| **Age, years** [a] | 57.88±15.15 | 52.68±12.44 | **0.071** | 0.270 / 1 (0.98-1.06) |
| **BMI (kg/m²)** [a] | 30.15±5.83 | 29.15±5.50 | 0.452 | |
| **Radiological score**[b] | 5 (3-9.5) | 7 (4.75-11) | **0.042** | **0.043 / 0.86 (0.75-0.99)** |
| **Comorbidity, n, (%)** | 12 (50) | 75 (56) | 0.659 | |
| ***Laboratory values*** | | | | |
| **Pct (ng/mL)** [b] | 0.08 (0.06-0.14) | 0.07 (0.05-0.13) | 0.330 | |
| **CRP (mg/L)** [b] | 42 (20-148.50) | 65 (23-122.25) | 0.540 | |
| **Troponin-T (ng/mL)** [b] | 0.008 (0.005-0.016) | 0.006 (0.004-0.009) | **0.061** | 0.90 / 0.69 (0.02-281) |
| **D-dimer (ng/mL)** [b] | 2.66 (0.96-5.03) | 0.67 (0.46-1.10) | **0.011** | 0.16 / 1.12 (0.95-1.33) |
| **Fibrinogen (mg/mL)**[a] | 608±170.97 | 588.49±151.96 | 0.956 | |
| **Ferritin(ng/mL)** [b] | 260 (187-536.50) | 386 (171.25-742.50) | 0.586 | |
| **LDH (U/L)** [a] | 398.31±194 | 456±212.20 | 0.104 | |
| **Platelets (10^3/mL)**[a,b] | 293.33±131.32 | 231 (177.75-345.25) | 0.473 | |
| **RDW (%)** [a] | 13.61±1.34 | 14.10±2.27 | 0.314 | |
| **PDW (fL)**[a] | 15.84±1.46 | 16.18±0.40 | 0.269 | |
| **MPV (fL)**[a] | 9.61±1.37 | 9.72±1.10 | 0.670 | |
| ***Scorings*** | | | | |
| **PSI** [a] | 73.67±27 | 68±24.71 | 0.313 | |
| **DIC** [b] | 4 (3-5) | 2.51(1-3) | **<0.001** | **0.047 / 2.05 (1.09-4.17)** |
| **PESI** [a] | 74.75±23.26 | 64.96±17.76 | 0.148 | |
| **MELD** [b] | 7(6-9) | 7(6-9) | 0.471 | |

[a]Results given as Mean± SD; [b]Results given as median (Interquartile range (IQR); PSI, Pneumonia Severity Index; PESI, Pulmonary Embolism Severity Index; MELD, The Model for End Stage Liver Disease; DIC, Disseminated Intravascular Coagulation; CRP, C-reactive protein; LDH, lactate dehydrogenase; RDW, Red blood cell distribution width; PDW, Platelet distribution width; MPV, mean platelet volume; OR, odds ratio

**Table 4.** Univariate and multivariate analysis between surviving and non-surviving COVID-19 pneumonia patients

| | Non-surviving patients (n=18) | Surviving patients (n=140) | Univariate analysis *p value* | Multivariate analysis *p* value/ OR (95% CI) |
|---|---|---|---|---|
| **Gender, male, n, (%)** | 9 (50) | 73 (52) | 0.530 | |
| **Age, years** [a] | 60±8.35 | 52.5±13 | **0.009** | 0.069/ 0.97 (0.89-1.1) |
| **BMI (kg/m²)** [a] | 28.47±6.24 | 29.44±5.46 | 0.542 | |
| **Radiological score**[b] | 14.5 (5-18.5) | 6 (4-10) | **0.007** | 0.46/ 0.93 (0.76-1.12) |
| **Comorbidity, n, (%)** | 16 (88) | 71 (50) | **0.002** | 0.788/ 1.43 (0.10-19.96) |
| **PE detected, n, (%)** | 2 (11) | 22 (15) | 0.461 | |
| ***Laboratory values*** | | | | |
| **Pct (ng/mL)** [b] | 0.14 (0.09-0.23) | 0.07 (0.05-0.12) | **<0.001** | 0.33 / 0.86 (0.01-11.69) |
| **CRP (mg/L)** [b] | 130.5 (53-179) | 63 (22-112) | **0.018** | 0.98 /1 (0.98-1.01) |
| **Troponin-T (ng/mL)** [b] | 0.008 (0.006-0.023) | 0.006 (0.004-0.009) | **0.007** | 0.621/0.06 (0-2855) |
| **D-dimer (ng/mL)** [b] | 0.78 (0.34-2.47) | 0.77 (0.51-1.41) | 0.983 | |
| **Fibrinogen (mg/mL)**[a] | 622.44±174.33 | 587.62±152.10 | 0.490 | |
| **Ferritin(ng/mL)** [b] | 468 (117-1071) | 340 (180.25-688.75) | 0.504 | |
| **LDH (U/L)** [a] | 465 (308.75-669.5) | 437±198.40 | 0.073 | |
| **Platelets (10^3/mL)**[a,b] | 249±100.48 | 236.5 (184-352) | 0.515 | |
| **RDW (%)** [a] | 14.31±1.53 | 13.99±2.23 | 0.548 | |
| **PDW (fL)**[a] | 16.30±0.45 | 16.11±0.77 | 0.303 | |
| **MPV (fL)**[a] | 10±0.93 | 9.66±1.16 | 0.196 | |
| ***Scorings*** | | | | |
| **PSI** [a] | 103 ±12 | 64.30±22.32 | **<0.001** | **0.021 /0.90 (0.86-0.98)** |
| **DIC** [b] | 3(1-4) | 3(1-3) | 0.802 | |
| **PESI** [a] | 101.17±20.15 | 62.60±16.35 | **<0.001** | **0.018/0.93 (0.88-0.98)** |
| **MELD** [b] | 8.5(6-10.50) | 7(6-8) | 0.707 | |

[a]Results given as Mean± SD; [b]Results given as median (Interquartile range (IQR);), PSI, Pneumonia Severity Index; PESI, Pulmonary Embolism Severity Index; MELD, The Model for End Stage Liver Disease; DIC, Disseminated Intravascular Coagulation; CRP, C-reactive protein; LDH, lactate dehydrogenase; RDW, Red blood cell distribution width; PDW, Platelet distribution width; PE, pulmonary emboli, MPV, mean platelet volume; OR, odds ratio

## DISCUSSION

Since the emergence of COVID-19 pneumonia, it has caused significant mortality and morbidity worldwide. A notable portion of deaths in COVID-19 pneumonia has been reported to be attributed to thromboembolism (11,12). We evaluated the efficiency of PESI, MELD, DIC, and PSI scoring systems in predicting mortality and embolism in COVID-19 pneumonia, specifically whether thromboembolism and thromboembolism-related mortality can be accurately predicted. According to our findings, the PESI and PSI scores can be used to predict mortality in patients with COVID-19 pneumonia, whereas the DIC score can be used to predict pulmonary embolism.

The COVID-19 infection has given rise to an acute respiratory distress syndrome (ARDS) scenario, causing morbidity and mortality and posing a high risk of transmission, leading to a pandemic. The infection mainly exhibits a more severe course in individuals with comorbidities (such as hypertension, heart disease, diabetes, malignancy, COPD, etc.), males, and those aged 50 and above, often necessitating hospitalization (13). In a study, 50% of individuals with COVID-19 pneumonia had a history of at least one chronic disease (14). The research has demonstrated that COVID-19 pneumonia patients with cardiovascular disease and diabetes are commonly hospitalized (15,16). In our study, 55% had at least one comorbid condition, with hypertension being the most prevalent comorbidity (13.30%). The mean age was 53.47±12.49.

Various theories have been put forth to explain the increased tendency towards thrombosis in COVID-19 pneumonia. According to the first theory, the hypoxia observed in severe COVID-19 increases blood viscosity and induces thrombosis through a signal pathway mediated by a hypoxia-inducible transcription factor (17,18). Oudkerk et al. suggested that the elevated d-dimer levels in COVID-19 patients do not merely stem from systemic inflammation but likely reflect actual thrombotic disease induced by cellular activation triggered by the virus (19). Another perspective suggests that endothelial dysfunction, increased von Willebrand factor (vWF), Toll-like receptor activation, tissue factor pathway activation, complement activation, and cytokine release could lead to proinflammatory and procoagulant effects, causing disturbances in the coagulation cascade (17,19).

Another viewpoint proposes that the release of proinflammatory cytokines [IL-2, IL-6, IL-7, IL-8, granulocyte colony-stimulating factor, interferon-gamma-induced protein 10 (IP10), monocyte chemotactic protein-1 (MCP1), macrophage inflammatory protein 1A (MIP1A), and tumor necrosis factor (TNF)] at elevated plasma levels (cytokine storm) increases the risk of intravascular micro thrombosis through coagulation activation (17,19). Increased coagulability among hospitalized COVID-19 patients has been corroborated by various studies, with a reported pulmonary embolism (PE) incidence ranging from 1.9% to 8.9% (3,17,20). Our study revealed a detection rate of pulmonary embolism at 15%, in contrast to the reference studies, which is thought to be related to the low number of patients.

COVID-19 pneumonia is associated with high mortality; various studies have demonstrated that disease mortality rates range between 3% and 20% (21). A significant portion of the elevated mortality among COVID-19 patients has been linked to increased coagulopathy-associated pulmonary embolism and multi-organ failure following a cytokine storm (22). A study showed an incidence of venous thromboembolism (VTE) in intensive care COVID-19 pneumonia patients of 25%, with a mortality rate of 40% in this patient group (3). Another study demonstrated that VTE was identified in the majority of hospitalized COVID-19 pneumonia patients (50%) during the initial 24 hours of their admission (19). In another study involving COVID-19 pneumonia patients, 33% of deaths were directly attributed to VTE (12). Our study also found a mortality rate of 11.40%, which is consistent with the existing literature.

Furthermore, in line with the literature, 96% of the patients with detected emboli were identified within the first 24 hours of hospitalization. In our study, the

percentage of mortality in cases with detected emboli was lower (8.3%) than that mentioned in the study above, which might be due to the rapid initiation of treatment for patients with pulmonary embolism admitted directly to the ward, regardless of the severity of their condition. Both the reference study (19) and our study have shown that early detection and prompt treatment of pulmonary embolism in COVID-19 pneumonia patients help reduce mortality.

DIC score is primarily used to predict the risk of embolism. Viral infections can progress to sepsis, leading to dysfunction in the clotting system. The COVID-19 infection differs from known viral infections due to its potential to involve a cytokine storm, leading to a worse prognosis (23). Studies have shown a positive relationship between coagulopathy and cytokine storm in COVID-19 patients (22). While there is only one known study concerning the DIC score in COVID-19 pneumonia patients (24), it has been shown that an increased DIC value is associated with increased mortality and PE risk in COVID-19 pneumonia. In a recent study, the relationship between mortality and pulmonary embolism risk of COVID-19 patients and the DIC score was investigated, and it was found that a DIC score >1 threshold had 91% sensitivity for predicting mortality, and the same threshold had 76% sensitivity for predicting pulmonary embolism (24). Our study also demonstrated a significant relationship between the DIC score and emboli detection. We calculated an AUC value of 0.740 for a threshold of 4 (85% sensitivity / 54% specificity). The DIC score was statistically significant in predicting embolism in both univariate and multivariate analyses. We suggest performing a CT angiography for embolism detection for COVID-19 patients with a calculated DIC score >4 within the first 24 hours of admission. In our study, the low specificity (54%) of a DIC score of 4 and above in detecting embolism suggests that it may not be appropriate for predicting embolism. However, its high sensitivity (85%), along with the statistical significance observed in both univariate and multivariate analyses for detecting pulmonary embolism, indicates that it could still be considered as a useful screening tool.

PSI (Pneumonia Severity Index), practical for deciding whether community-acquired pneumonia (CAP) patients should be treated on an outpatient basis or hospitalized, is a score that predicts the severity and mortality risk in pneumonia patients (8, 25). In studies evaluating the prognostic utility of the PSI for predicting mortality in COVID-19 pneumonia, one investigation yielded an AUC value of 0.835 (with a sensitivity of 84% and specificity of 72%) (21), whereas another study reported an AUC value of 0.874 (9). Similarly, our study found that the predictive power of PSI for mortality in COVID-19 pneumonia was significant and similar to the literature (AUC 0.898; 94% sensitivity / 68% specificity). In our study, in line with the literature, the PSI score was found to be statistically significant in predicting mortality in both univariate and multivariate analyses. We suggest that this makes the PSI score a potentially valuable parameter for predicting mortality in COVID-19 pneumonia.

PESI (Pulmonary Embolism Severity Index) is a prognostic score for 30-day mortality in acute pulmonary embolism patients. A study calculated an AUC value of 0.820 (82% sensitivity/96% specificity) for predicting mortality using the PESI score in hospitalized COVID-19 patients (10). In another study involving COVID-19 pneumonia patients with acute pulmonary embolism, the calculated AUC value for predicting mortality for the PESI score was 0.638 (26). PESI had the highest AUC value (0.917) for detecting mortality among the scoring systems we investigated. Additionally, in both univariate and multivariate analyses, we found that the PESI score was significantly higher in mortal cases. Furthermore, we observed that PESI levels were significantly higher in both patients who died with detected embolism and those who died without embolism compared to surviving patients. Consistent with these studies, our study demonstrated the significance of the PESI score in predicting mortality.

MELD score is a scoring system used for liver transplant candidates and has also been studied in cases of

COVID-19 pneumonia. Apart from patients with liver disease, it's also utilized as a prognostic marker in heart failure patients. Studies on MELD have been conducted in various patient groups. In one study involving COVID-19 pneumonia patients in the ICU, the MELD score was found to be significant in predicting mortality. Patients with a MELD score higher than 18.5 showed higher rates of in-hospital mortality and ICU admission. The MELD score predicted ICU admission with 99% sensitivity and 100% specificity (AUC: 0.740) and in-hospital mortality with 99% sensitivity and 100% specificity (AUC: 0.797) (6). Our study calculated an AUC value of 0.474 (with an optimal threshold of 16) for predicting mortality using the MELD score (100% sensitivity / 5% specificity). MELD score was found to be insignificant in both univariate and multivariate analyses for mortality. Further studies should be conducted to explore the relationship between MELD score and COVID-19 pneumonia.

Our study had some limitations. Firstly, the study's retrospective design resulted in the inability to access specific tests and demographic data of the patients in the ward, which reduced the number of included patients. Prospectively, conducting this study with more patients might yield more accurate results.

## CONCLUSION

Our study demonstrated that the DIC score is significant in predicting the risk of pulmonary embolism in patients with COVID-19, whereas the PESI and PSI scores can be used to assess mortality risk in COVID-19 pneumonia. On the other hand, in pneumonia types associated with cytokine storms, such as COVID-19, the early assessment of the DIC score and the timely initiation of chest CT angiography (within 24 hours of admission) in high-risk patients have proven effective in the detection of embolism, thus potentially reducing mortality associated with pulmonary embolism.

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