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Mortality prediction in the emergency service intensive care patients with possible COVID-19: a retrospective cross-sectional study

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Abstract

INTRODUCTION: Despite the declining clinical importance of Coronavirus Disease 2019 (COVID-19), the virus is still causes mortality in the critically ill patients. This study aims to determine the impact COVID-19 on mortality, evaluate the performance of Acute Physiology and Chronic Health Evaluation-2 Scores (APACHE II), Sequential Organ Failure Assessment Scores (SOFA) and Pneumonia Severity Index (PSI) for mortality prediction in the COVID-19 suspected patients. **MATERIALS AND METHODS:** This study is a retrospective cross-sectional analysis of patients who were admitted to the pandemic intensive care unit with possible COVID-19. 28-day mortality difference between positive and negative groups was defined as the primary outcome. **RESULTS:** Of the 397 patients, 111 (28 %) patients had positive polymerase chain reaction (PCR). 75 (67.6 %) patients deceased in the PCR positive group while 163 (57.0 %) patients deceased in the negative group ($p > 0.05$). The median values of APACHE II, SOFA and PSI scores were significantly higher in the deceased group, for all patients. Cutoff points were determined for APACHE II score at 19 (AUC 0.96, PLR 14.16, NLR 0.12), SOFA score at 9 (AUC 0.96, PLR 20.23, NLR 0.11) and PSI score at 81 points (AUC 0.91, PLR 7.01, NLR 0.23). The AUCs of PSI was significantly lower from AUC of APACHE II and SOFA score (DeLong Test, $p < 0.001$). **CONCLUSION:** There was no statistically significant difference on mortality between positive and negative group.

Прогнозирование смертности у пациентов отделения интенсивной терапии неотложной помощи с возможным COVID-19: ретроспективное поперечное исследование

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Реферат

ВВЕДЕНИЕ: Несмотря на снижение клинической значимости коронавирусной болезни 2019 г. (COVID-19), вирус по-прежнему вызывает смертность у пациентов в критическом состоянии. **ЦЕЛЬ ИССЛЕДОВАНИЯ**: Определение влияния COVID-19 на смертность, оценка производительности шкалы Acute Physiology and Chronic Health Evaluation II (APACHE II), оценка шкалы Sequential Organ Failure Assessment (SOFA) и индекса тяжести пневмонии (PSI) для прогнозирования смертности у пациентов с подозрением на COVID-19. **МАТЕРИАЛЫ И МЕТОДЫ**: Проведен ретроспективный поперечный анализ пациентов, которые были госпитализированы в отделение интенсивной терапии пандемии с возможным диагнозом COVID-19. Как первичный результат была определена разница в 28-дневной летальности между группами с COVID «положительными» и «отрицательными» пациентами. **РЕЗУЛЬТАТЫ**: Из 397 пациентов у 111 (28 %) определялась положительная полимеразная цепная реакция (ПЦР). В группе с положительным результатом ПЦР умерли 75 (67,6 %) пациентов, тогда как 163 (57 %) пациента умерли в COVID «отрицательной» группе ($p > 0,05$). Медианные значения баллов APACHE II, SOFA и PSI были значительно выше в группе умерших для всех пациентов. Пороговые значения были определены для оценки APACHE II на уровне 19 (AUC — 0,96, PLR — 14,16, NLR — 0,12), оценки SOFA на уровне 9 (AUC — 0,96, PLR — 20,23, NLR — 0,11) и оценки PSI на уровне 81 балла (AUC — 0,91, PLR — 7,01, NLR — 0,23). AUC PSI была значительно ниже AUC APACHE II и оценки SOFA (тест Де Лонга, $p < 0,001$).

ВЫВОД: Не было никакой статистически значимой разницы в смертности между положительной и отрицательной группой.

KEYWORDS: comorbidities, Coronavirus-19, intensive care, mortality

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КЛЮЧЕВЫЕ СЛОВА: сопутствующие заболевания, коронавирус-19, интенсивная терапия, смертность

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Introduction

In December 2019, an unexpectedly high number of cases of atypical pneumonia with aggressive symptoms were observed in the Wuhan region of China. It was determined that the causative agent was a novel coronavirus not previously seen in humans and this virus was named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). SARS-CoV-2, primarily transmitted from person to person, especially through the respiratory tract. The virus rapidly continued to spread, and on March 11, 2020 it was officially recognized as a 'pandemic' by the World Health Organization [1]. The clinical condition caused by the virus is named Coronavirus Disease 2019 (COVID-19) and typically consists of respiratory system symptoms that vary in severity. Patients may present with symptoms such as sore throat, runny nose, fever, cough, myalgia, arthralgia, headache, diarrhea and in severe cases, acute respiratory distress syndrome (ARDS), septic shock, multiple organ failure and even death [1, 2].

Studies have shown that approximately 80 % of patients diagnosed with COVID-19 develop a mild to moderate form of the disease while around 20 % of patients develop a severe form and about 4–6 % of patients require intensive care [3]. Since the beginning of the pandemic, the high number of admissions to emergency departments has made it necessary to promptly identify the critical patient group requiring critical care and refer them to intensive care.

In this study, patients were admitted to the emergency services' intensive care unit with possible COVID-19 were evaluated with SARS-CoV-2 polymerase chain reaction (PCR) results, laboratory parameters, comorbidities, Acute Physiology and Chronic Health Evaluation-2 Scores (APACHE II), Sequential Organ Failure Assessment Scores (SOFA) and Pneumonia Severity Index Scores (PSI) to identify the similar characteristics of the critical patient group and determine the parameters that enable early detection.

Materials and methods

According to information obtained from the Hospital Information Management System, it was determined that 435 patients were admitted to the intensive care unit between January 1, 2021 and December 31, 2021. However, three of these patients were excluded due to under the age of 18 and 35 of them were excluded due to missing data. Total 397 patient data were retrospectively examined (fig. 1). Data of the included patients were accessed from both electronic records and intensive care patient files. Informed consent was obtained from all the patients, *their* families or legal representatives for their anonymized information to be published in this article.

The patients admitted to the intensive care unit were divided into two groups based on their PCR results, positive and negative. PCR negative group had at least 2 negative

PCR results and negative COVID-19 antigen tests to rule out COVID-19 and they mostly diagnosed bacterial or influenza pneumonia. 28-day mortality difference between negative and positive groups was defined as the primary outcome. The impact of age, gender, comorbidities, laboratory values, SOFA, APACHE II and PSI scores on mortality was set as the secondary outcome.

Information regarding the patients' medical history and comorbidities was obtained from the patient themselves, their relatives and by scanning the patient's history through the hospital information system. It was also obtained from the e-Nabız application of the Turkish Republic Ministry of Health. The PCR results of the patients were obtained from the Public Health Management System. Laboratory tests for the patients included complete blood count values, such as white blood cell count (WBC), neutrophils (Neu), lymphocytes (Lym), platelets (Plt), hemoglobin (Hgb), hematocrit (Hct), as well as kidney function tests [urea, blood urea nitrogen (BUN), creatinine], plasma electrolytes [sodium(Na), potassium(K)], glucose, liver enzymes [Aspartate Transaminase (AST), Alanine Transaminase (ALT)], total bilirubin, C-reactive Protein (CRP), D-dimer, and Ferritin. Blood gas analysis included pH, pO_2, pCO_2, HCO_3, and lactate measurements. Information about the need for mechanical ventilation, the fraction of inspired oxygen (FiO_2) being administered, patient vitals including systolic blood pressure, diastolic blood pressure, mean arterial pressure, oxygen saturation, heart rate, temperature and respiratory rate was obtained from the patients' intensive care follow-up file or the hospital information system.

In the study, the initial test results obtained from patients who underwent multiple laboratory tests in the intensive care unit, the latest PCR results obtained and the initial vital signs were included. The mechanical ventilation status and FiO_2 value were determined within the first hour of the patient's admission to the intensive care unit.

Data collected from patients were used to calculate the neutrophil/lymphocyte ratio, platelet/lymphocyte ratio and neutrophil/platelet ratio in Microsoft Excel.

When evaluating comorbid conditions of the patients, those with a history of ischemic and hemorrhagic cerebrovascular events (CVE) were categorized as the CVE group, patients with known malignancies receiving radiotherapy, chemotherapy or those not undergoing treatment by their choice were categorized as the malignancy group. Patients with chronic neurological diseases such as Alzheimer's, Parkinson's, epilepsy or psychiatric histories such as anxiety disorders, major or minor depression, bipolar mood disorders, obsessive-compulsive behavior disorders were categorized under neuropsychiatric disorders group.

Using the data collected from the patients, APACHE II, SOFA and PSI scores were calculated from June 24 to June 26, 2024 through https://www.uptodate.com/contents/search?search=calculators.

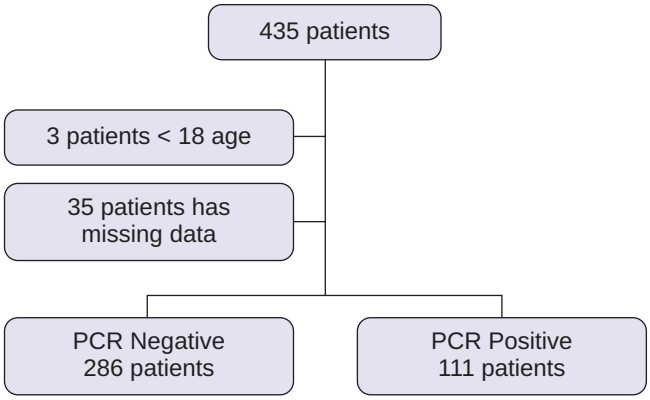

Fig. 1. Flow Chart

The outcomes of the patients were determined using information obtained from the hospital information system of patient. For patients transferred to another intensive care units or wards, the outcomes were tracked through the hospital information system.

For statistical analysis, Jamovi version 2.3 was used. The normality of the data was tested using the Shapiro-Wilk test. For descriptive statistics, quantitative variables with a normal distribution were expressed as mean ± standard deviation. Quantitative variables with a non-normal distribution were expressed as median (interquartile range 25–75) and categorical variables were expressed using counts and percentages. Normal distributed variables were compared using the Student's t-test, non-normally distributed quantitative variables were compared using the Mann-Whitney U test and categorical variables were compared using the chi-square test or Fisher's exact test. Sensitivity of numerical data in predicting mortality was assessed using Receiver-operating characteristic ROC analysis. Subsequently, Area Under The Receiver Operating Characteristic (AUC) values were calculated. Youden's index was used to determine optimal cutoff points. Positive likelihood ratio (PLR) and negative likelihood ratio (NLR) were calculated for each scoring system at this cutoff points. DeLong Test is performed to determine of difference between AUCs. Results with a p-value below 0.05 were considered statistically significant.

This study was deemed scientifically and ethically appropriate by the Kutahya Health Sciences University Non-Interventional Clinical Research Ethics Committee with decision number 37686 dated January 27, 2022 (Annex-1).

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Results

Among the 397 patients, 286 (72 %) had negative PCR results while 111 (28 %) had positive PCR results.

In the negative group the median age was 72.50 (65–82) while in the positive group the median age was 73.00 (64–82) ($p > 0,05$). Among the patients in the negative group, 163 (57.0 %) were male and in the positive group 60 (54.1 %) patients were male ($p > 0,05$). The distribution of demographic data of the patients is presented in table 1.

Cerebrovascular event (CVE) and malignancy comorbidities were significantly higher in the PCR negative group. There is no statistically significant difference between the PCR groups for other comorbidities included hypertension (HT), diabetes mellitus (DM), coronary artery disease (CAD), congestive heart failure (CHF), atrial fibrillation (AF), acute or chronic renal failure (ARF/CRF), asthma or chronic obstructive pulmonary disease (COPD) and neuropsychiatric disease. The distribution of patients' comorbidities in the PCR groups is provided in table 1.

Out of the 286 patients with a negative PCR result, 163 (57.0 %) deceased while 123 (43.0 %) survived. Among the 111 patients with a positive PCR result, 75 (67.6 %) deceased while 36 (32.4 %) survived. There was not significant difference in mortality between the PCR groups ($p > 0.054$). The distribution of patients' PCR results among outcome groups is presented in table 2.

In the PCR positive group, there was no significant difference in the median values of hematocrit, potassium, glucose and platelet/lymphocyte (Plt/lym) ratio between survivors and non-survivors ($p > 0.05$). Non-survivor group had higher median values of WBC, Neu, urea, BUN, creatinine, sodium, AST, ALT, CRP, D-Dimer, Neu/Lym ratio, and Neu/Plt ratio and lower median values of lymphocyte count, platelet count and hemoglobin level ($p < 0.05$). The examination of laboratory values and outcomes in the PCR-positive group is presented in table 3.

Table 1. The distribution of demographic data of the patients

Demographic data/Comorbidit		PCR– *n* = 286 (100 %)	PCR+ *n* = 111 (100 %)	*p*-value
Age Median (IQR 25–75)		72.50 (65–82)	73 (64–82)	$p = 0.99$
Gender *n*, (%)	Male	163 (57 %)	60 (54.1 %)	$p = 0.59$
	Female	123 (43 %)	51 (45.9 %)	
HT		140 (49 %)	56 (50.5 %)	$p = 0.78$
CAD		87 (30.4 %)	27 (24.3 %)	$p = 0.22$
AKF/CKF		108 (37.8 %)	45 (40.5 %)	$p = 0.61$
DM		106 (37.1 %)	36 (32.4 %)	$p = 0.38$
CVE		58 (20.3 %)	9 (8.1 %)	$p = 0.004$
Malignancy		57 (19.9 %)	9 (8.1 %)	$p = 0.005$
CHF		52 (18.2 %)	13 (11.7 %)	$p = 0.11$
AF		34 (11.9 %)	12 (10.8 %)	$p = 0.90$
Asthma/COPD		78 (27.3 %)	29 (26.1 %)	$p = 0.81$
Neuropsychiatric disease		34 (11.9 %)	14 (12.6 %)	$p = 0.84$
Pearson's Chi-Squared Test				

ARF/CRF — acute or chronic renal failure; AF — atrial fibrillation; CAD — coronary artery disease; CHF — congestive heart failure; COPD — chronic obstructive pulmonary disease; CVE — cerebrovascular event; DM — diabetes mellitus; HT — hypertension; PCR — polymerase chain reaction.

Table 2. The distribution of patients' PCR results among outcome groups

	Outcome			*p* value
PCR Results	Deceased	Survived	Total	
Negative	163 (57.0 %)	123 (43.0 %)	286 (100 %)	$p = 0.054$
Positive	75 (67.6 %)	36 (32.4 %)	111 (100 %)	
Total	238 (59.9 %)	159 (40.1 %)	397 (100 %)	
Pearson's Chi-Squared Test				

PCR — polymerase chain reaction

Table 3. The examination of laboratory values in the COVID-19 group

Parameters	Outcome	*n*	Median	IQR (25–75 %)	*p* value
WBC ($\times 10^3$/uL)	Deceased	75	15.7	(9.68–19.70)	< 0.001
	Survived	36	7.46	(6.09–10.25)	
Neu ($\times 10^9$/L)	Deceased	75	13.25	(7.87–17.70)	< 0.001
	Survived	36	5.94	(4.66–8.61)	
Len ($\times 10^9$/L)	Deceased	75	0.64	(0.36–1.06)	0.020
	Survived	36	0.8750	(0.64–1.16)	
Plt ($\times 10^3$/uL)	Deceased	75	164.00	(117.0–244.0)	0.003
	Survived	36	208.50	(188.75–303.50)	
Hgb (g/dL)	Deceased	75	10.40	(9.10–12.20)	0.023
	Survived	36	11.95	(10.05–13.67)	
Hct (%)	Deceased	75	34.00	(29.10–38.20)	0.104
	Survived	36	37.00	(32.07–42.50)	
Urea (mg/dL)	Deceased	75	113.0	(69.0–161.00)	< 0.001
	Survived	36	49.50	(34.50–76.75)	
BUN (mg/dL)	Deceased	75	53.0	(32.00–75.00)	< 0.001
	Survived	36	23.0	(16.25–36.00)	
Creatinin (mg/dL)	Deceased	75	1.73	(1.05–3.07)	< 0.001
	Survived	36	1.045	(0.77–1.26)	
Sodium (mmol/L)	Deceased	75	143.00	(138.0–140.75)	< 0.001
	Survived	36	138.00	(136.25–140.75)	
Potassium (mmol/L)	Deceased	75	4.39	(3.70–5.20)	0.163
	Survived	36	4.025	(3.65–4.58)	
Glucose (mg/dL)	Deceased	75	184.00	(120–244)	0.209
	Survived	36	145.00	(97.50–259.75)	
AST (IU/L)	Deceased	75	43.00	(26.00–88.00)	0.020
	Survived	36	29.50	(22.00–51.50)	
ALT (IU/L)	Deceased	75	33.00	(19.00–61.00)	0.023
	Survived	36	21.00	(15.25–34.50)	
CRP (mg/L)	Deceased	75	188.40	(84.00–241.20)	< 0.001
	Survived	36	46.09	(17.04–159.75)	
D-dimer (mcg/L)	Deceased	75	4140.00	(1848–4481)	< 0.001
	Survived	36	1417.50	(784.75–2898)	
Neu/lym	Deceased	75	19.49	(9.90–37.47)	< 0.001
	Survived	36	7.37	(3.70–12.88)	
Plt/lym	Deceased	75	284.44	(130.00–541.37)	0.701
	Survived	36	277.77	(180.02–367.75)	
Neu/Plt	Deceased	75	0.07	(0.04–0.12)	< 0.001
	Survived	36	0.02	(0.02–0.04)	
Mann-Whitney U Test					

ALT — alanine transaminase; AST — aspartate transaminase; BUN — blood urea nitrogen; CRP — C-reactive Protein; Hct — hematocrit; Hgb — hemoglobin; Lym — lymphocyte count; Neu — neutrophil count; Plt — platelet count; WBC — white blood cell count.

In the PCR positive group, the patients with ARF/CRF diagnosis had significantly higher mortality ($p < 0.001$). In patients with HT, CAD, CHF, AF, asthma/COPD, DM, CVE, malignancy and neuropsychiatric disease, there is no significant difference among outcome groups ($p > 0.05$). The relationship between comorbidities and outcomes in PCR-positive patients is presented in table 4.

Among PCR-negative patients, the medians of APACHE II, SOFA and PSI scores in the deceased group were significantly higher ($p < 0.001$). Similarly, among PCR-positive patients, the median values of the APACHE II, SOFA and PSI scores in the deceased group were significantly higher ($p < 0.001$).

ROC analysis was performed to determine the relationship with APACHE II, SOFA and PSI scores of all patients and outcome groups. Then AUCs calculated. According to the Youden's index, the optimal cutoff points were determined as 19 points for APACHE II (AUC = 0.96, $p = 0.0001$), 9 points for SOFA score (AUC = 0.96, $p = 0.0001$) and 81 points for PSI score (AUC = 0.91, $p = 0.0001$) (fig. 2). The cutoff points are significant based on sensitivity, specificity and the level of AUC. The optimal cutoff points for APACHE II, SOFA and PSI scores for all patients with sensitivity, specificity, positive likelihood ratio and negative likelihood ratio are presented in table 5. There were no significant difference between AUCs of APACHE II and SOFA score (DeLong Test, $p = 0.850$). The AUCs of PSI was significantly lower from AUC of APACHE II with AUC difference 0,050 ($p < 0,001$) and SOFA score with AUC difference 0,049 ($p < 0,001$).

Table 4. The relationship between comorbidities and outcomes in COVID-19 patients

Comorbidities	Outcome			
	Deceased *n* = 75 (100 %)	Survived *n* = 36 (100 %)	Total	*p*
HT	37 (49.3 %)	19 (52.8 %)	56 (100.0 %)	0.734
CAD	15 (20.0 %)	12 (33.3 %)	27 (100.0 %)	0.125
CHF	9 (12.0 %)	4 (11.1 %)	13 (100.0 %)	0.892
AF	9 (12.0 %)	3 (8.3 %)	12 (100.0 %)	0.560
Asthma/COPD	23 (30.7 %)	6 (16.7 %)	29 (100.0 %)	0.116
ARF/CRF	40 (53.3 %)	5 (13.9 %)	45 (100.0 %)	< 0.001
DM	22 (29.3 %)	14 (38.9 %)	36 (100.0 %)	0.314
CVE	6 (8.0 %)	3 (8.3 %)	9 (100.0 %)	0.952
Malignancy	7 (9.3 %)	2 (5.6 %)	9 (100.0 %)	0.715
Neuropsychiatric disease	11 (14.7 %)	3 (8.3 %)	14 (100.0 %)	0.543
Pearson's Chi-Squared Test and Fisher's Exact Test				

AF — atrial fibrillation; ARF/CRF — acute or chronic renal failure; CAD — coronary artery disease; CHF — congestive heart failure; COPD — chronic obstructive pulmonary disease; CVE — cerebrovascular event; DM — diabetes mellitus; HT — hypertension; PCR — polymerase chain reaction.

Table 5. The optimal cutoff points for APACHE II, SOFA and PSI scores

Scoring System	Cutoff Points	Sensitivity 95% CI	Specificity 95% CI	PLR 95% CI	NLR 95% CI	AUC 95% CI	*p*
APACHE II	19	0.89 (0.84–0.93)	0.94 (0.89–0.97)	14.16 (7.76–25.8)	0.12 (0.08–0.17)	0.96 (0.95–0.98)	0.0001
SOFA	9	0.89 (0.84–0.93)	0.96 (0.91–0.98)	20.23 (9.79–41.8)	0.11 (0.08–0.16)	0.96 (0.94–0.98)	0.0001
PSI	81	0.79 (0.74–0.83)	0.89 (0.83–0.93)	7.01 (4.52–10.9)	0.23 (0.18–0.30)	0.91 (0.88–0.94)	0.0001
ROC analysis performed.							

AUC — area under curve; APACHE II — acute physiology and chronic health evaluation-II scores; NLR — negative likelihood ratio; PLR — positive likelihood ratio; PSI — pneumonia severity index; SOFA — sequential organ failure assessment scores.

Discussion

According to the World Health Organization's data, as of June 2024, approximately 775 million people have been diagnosed with COVID-19 and around 7 million people have lost their lives [4]. New coronavirus variants continue to be identified as the days go by. While the mortality due to COVID-19 has significantly decreased since the introduction of vaccines, the risk of a new coronavirus variant emerging that is resistant to vaccines still exists. Despite advanced prophylaxis and treatment options, morbidity and mortality due to COVID-19 still persist and early diagnosis is particularly valuable for patients at high risk of developing critical illness. Initiating treatment early in this patient group is important for reducing mortality risk and preventing complications. Today, even if diagnosing COVID-19 in clinical practice is not as important as before, the virus is still continues to be a cause of mortality. Results of our study in a heterogeneous patient group including patients with positive and negative PCR results compatible with COVID-19 symptoms are valuable because they represent the patient population that clinicians directly encounter in clinical practice.

In PCR negative group 163 (57 %) of patients deceased while 123 (43 %) survived. In PCR positive group 75 (67.6 %) deceased and 36 (32.4 %) survived. There was no statistically significant difference in mortality among PCR groups (p = 0.054). Although the mortality rate is noticeably higher in the PCR-positive group, this difference is not statistically significant. There are some studies that report no significant difference in mortality between COVID-19 positive and negative patients who develop ARDS requiring mechanical ventilation [5]. Similarly, there were not significant difference between COVID-19 patients and other pneumonia etiologies [6]. However, some studies [7] showed that the mortality rate of COVID-19 patients is significantly higher from influenza group in the intensive care unit. There is no consensus in the literature. In our study, while the mortality rate is higher in COVID-19 diagnosed patients, this difference is not statistically significant. This may be explained by the relatively small number of patients.

In our study, the median values of hematocrit, potassium, glucose and Platelet-to-Lymphocyte (Plt/Lym) ratio were not significantly different between survivors and non-survivors in the COVID-19 group ($p > 0.05$). However, in the non-survivor group, the median values of WBC, Neu, urea, BUN, creatinine, sodium, AST, ALT, CRP, D-Dimer, Neu/Lym ratio and Neu/Plt ratio were significantly higher, while the median values of lymphocytes, platelets, and hemoglobin levels were lower. Similar to our study it was reported [8] that among COVID-19 positive patients, WBC, Neu, CRP values, D-Dimer, AST, ALT, and creatinine levels were significantly higher while lymphocyte and platelet levels were significantly lower in the deceased group. The relevant study mentioned that disseminated intravascular

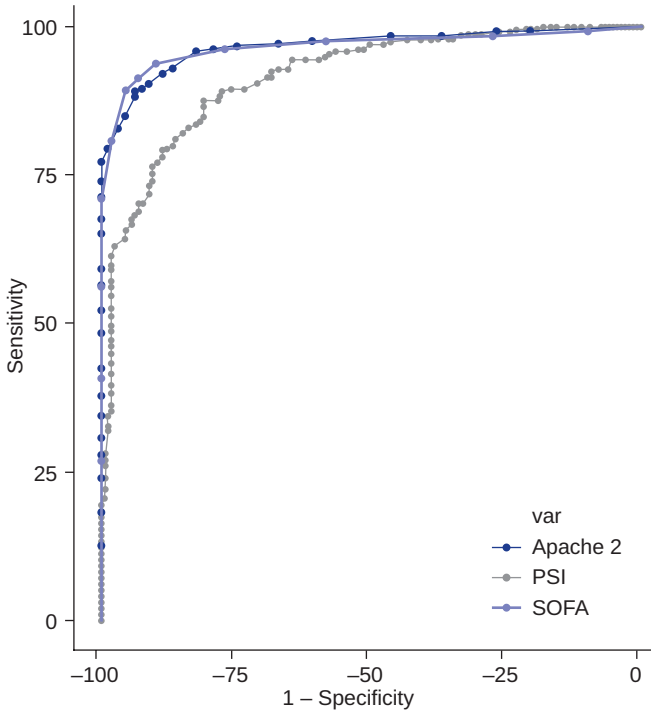

Fig. 2. Receiver operating characteristic curve for the predicted value of APACHE II, SOFA score, and PSI scores for the mortality

coagulation frequently developed in the deceased patient group and this condition was consistent with elevated D-Dimer levels and decreased platelet counts. Additionally, it was noted that Macrophage Activation Syndrome occurring in the critical patient group led to acute kidney injury and liver damage, causing elevated liver enzymes such as AST and ALT, as well as increased plasma levels of creatinine. CRP was associated with hyperinflammation state and patients with high CRP levels had high risk of respiratory failure [9]. In another study [10] it was reported that decreased lymphocyte and platelet count, elevated CRP, D-Dimer, AST and ALT and creatinine levels were associated with a poor prognosis. The relevant study highlights that Angiotensin-converting Enzyme-2 receptors on lymphocytes target lymphocytes against the virus, and this process results in lymphopenia. Lymphocytes are the primary cells responsible for generating an immune response against viral pathogens and lymphopenia is indicated to result in an inadequate immune response to the virus, hence being associated with a poor prognosis. Elevated D-Dimer levels are indicative of venous thromboembolism and lead to ventilation-perfusion mismatch, which in turn causes end-organ damage, poor prognosis and an increased risk of mortality [11]. Consistent with the results in our study, there are numerous studies [12, 13] that support the association of increased WBC, Neu, CRP, AST and ALT, creatinine and decreased platelet and lymphocyte counts with high risk of mortality. In some studies [14] Neu/Lym and Neu/Plt ratios were found to be significantly higher in the deceased group, similar to our study. However, in the same study, the

Plt/Lym ratio was found to be higher in the non-survivor group compared to survivors, unlike our study. There are numerous studies in the literature examining the relationship between laboratory values and mortality in COVID-19 patients. The results identified in our study are consistent with the literature [15–18].

In COVID-19 group mortality was found significantly higher in patients who had ARF/CRF, while no significant effect on mortality was observed for other comorbidities such as HT, DM, CAD, CVE, AF, CHF, malignancy, asthma/COPD and neuropsychiatric disease. Among the COVID-19 positive patients in the intensive care unit with hypertension, the duration of stay in the intensive care unit is longer and the risk of mortality is higher [19]. Additionally, DM, CAD and CVE are associated with increased mortality. Rehatta and colleagues [20] demonstrated that HT, DM, renal failure, CHF, CVE and chronic lung disease significantly increased the risk of mortality in COVID-19 patients. However, the same study did not find a significant difference on mortality for malignancy, CAD and neuropsychiatric disease. Renal failure, history of cerebrovascular events and malignancy were found as the risk factors for mortality in COVID-19 patients [21]. While mortality risk does not increase in patients with epilepsy and Alzheimer's Disease among neurologic disorders, there is an increase risk with Parkinson's disease [22]. Depression and other various psychiatric and neurological diseases was found to be associated with mortality [23]. There is no consensus in studies examining the relationship between comorbidities and COVID-19 patient mortality. In our study, patients with a history of AF, COPD or asthma, malignancy and neuropsychiatric diseases showed higher mortality rates; however, this difference was not statistically significant. This may be attributed to the relatively low number of patients in these subgroups. Patients with CAD had a lower mortality rate but the difference was not statistically significant. This result may be attributed to the impact of other comorbidities on mortality. Our findings are consistent with the literature.

Among patients with a negative PCR result, the deceased group had statistically higher APACHE II, SOFA and PSI scores ($p < 0.001$). There are numerous studies in the literature that examine intensive care scoring systems and patient outcomes. One study reported that APACHE II scores were significantly higher in the intensive care patients in the deceased group but unlike our study, SOFA scores did not show a significant difference between the deceased and survived patients [24]. In contrast some studies [25] showed that APACHE II and SOFA scores both were higher in the deceased group, similarly to our study. Alavi-Moghaddam and colleagues [26] reported that in community-acquired pneumonia cases, as the PSI and Confusion, Urea, Respiratory Rate, Blood Pressure and Age Above or Below 65 Years (also known as CURB-65) score increased, the risk of mortality also increased. The results obtained in our study are in line with the literature.

In our study, among patients with a positive PCR result, the deceased group had significantly higher APACHE II, SOFA and PSI scores. Beigmohammadi and colleagues [27] stated that an increase in APACHE II and SOFA scores increased the risk of mortality. Another study emphasized that APACHE II score more successful in predicting mortality compared to the SOFA score [28]. We found there was no significant difference between APACHE II and SOFA score AUCs (DeLong Test, $p > 0,05$) so both scoring systems successful in predicting mortality. The primary factor determining mortality in COVID-19 patients is respiratory system involvement, but mortality prediction can be successfully achieved using the SOFA score. An increase in the PSI score of patients with COVID-19 pneumonia proportionally increased the patient's risk of death [29]. Same study reports that mortality rate was 17.35 % in PSI class 4 patients and 74.78 % in PSI class 5. In our study, the median PSI score for the deceased group was 167 with the majority of them falling into PSI class 5. The median PSI score for the surviving group was 95 with most of them falling into class 3. PSI score is successful in predicting mortality in community-acquired pneumonias, as well as in COVID-19-related pneumonias, with a high predictive value [29]. Our results are in line with the literature.

ROC analysis is performed and Youden's Index is used to determine optimal cutoff points for APACHE II, SOFA and PSI scores. 19 points for APACHE II (AUC = 0.96, $p = 0.0001$), 9 points for SOFA score (AUC = 0.96, $p = 0.0001$) and 81 points for PSI score (AUC = 0.91, $p = 0.0001$) are determined as optimal cutoff points. An APACHE II score ≥ 19 points is 89 % sensitive and 94 % specific for mortality with PLR of 14,03 (%95 CI; 7,69–25,61) and NLR of 0,13 (0,09–0,18). A SOFA score ≥ 9 points is 89 % sensitive and 96 % specific for mortality with PLR of 20,23 (9,79–41,80) and NLR of 0,11 (0,08–0,16). A PSI score ≥ 81 points is 79 % sensitive and 89 % specific for mortality and has a PLR of 7,01 (4,52–10,9) and a NLR of 0,23 (0,18–0,30). In a study [30] it is found that a SOFA score of 2 or higher is 84 % sensitive and 63 % specific for 30-day mortality (AUC = 0.80, $p < 0.05$). Niaz and colleagues [31], in their published study, set the cutoff point for the SOFA score at 7 and found it to be 75 % sensitive and 95 % specific for mortality (AUC = 0.89). In a study examining the relationship between the PSI score and mortality [32], a 30-day mortality prediction was generated with 75 % sensitivity and 47 % specificity in patients with a PSI group 4 or higher (AUC = 0.69). Optimal cutoff point for the APACHE II score is determined as 15 (AUC = 0.88, $p < 0.001$) and used it to predict mortality with 85 % sensitivity and 77 % specificity [33]. Zou and colleagues (24) found that an APACHE II score equal or more than 17 had a sensitivity of 96 % and specificity of 86 % for mortality prediction (AUC = 0.96, $p < 0.05$). The optimal cutoff point for the SOFA score was determined as 3 (AUC = 0.86, $p < 0.05$). When compared to the literature, the cutoff points

in our study allow for more successful mortality prediction with higher sensitivity, specificity and AUC values.

Limitations

Some limitations of our study include its retrospective nature and being conducted at a single center. The absence of a dialysis unit has resulted in the inability to admit patients with urgent dialysis needs to our intensive care unit. Additionally, due to the COVID-19 pandemic, patients with a known diagnosis of COVID-19 were directly referred from the emergency department to pandemic intensive care units for isolation, and therefore, patients with a confirmed COVID-19 diagnosis were not admitted to our intensive care unit.

Conclusion

In our study, there was no statistically significant difference in mortality between patients with COVID-19 and those with respiratory distress due to different etiologies in the intensive care unit. Only renal failure significantly increased mortality, other comorbidities did not. Considering all patients, APACHE II, SOFA and PSI scores were significantly higher in the deceased patients and the cutoff points were determined as 19 points for APACHE II, 9 points for SOFA score and 81 points for PSI score. Multicenter studies with larger patient populations are needed in this regard.

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Author contribution. All authors according to the ICMJE criteria participated in the development of the concept of the article, obtaining and analyzing factual data, writing and editing the text of the article, checking and approving the text of the article.
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