Journal of Experimental and Clinical Medicine
https://dergipark.org.tr/omujecm

Research Article

J Exp Clin Med
2022; 39(4): 1175-1183
doi: 10.52142/omujecm.39.4.43

Values of intensive care scores in predicting morbidity and mortality in patients treated for COVID-19 pneumonia

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Received: 10.05.2022 • **Accepted/Published Online:** 8.06.2022 • **Final Version:** 29.10.2022

Abstract

Some of the patients with COVID-19 pneumonia are followed up in intensive care units (ICU). This study aimed to determine the success of intensive care scores used in patients followed up in the ICU with the diagnosis of COVID-19 pneumonia in predicting morbidity and mortality. This retrospective study included patients treated for COVID-19 pneumonia in the ICUs of Samsun Training and Research Hospital. We used the patients' demographic characteristics, vital signs, arterial blood gas values, radiological imaging, and laboratory data by using the hospital database and patient files. Group I was composed of alive patients, while Group II was of dead ones. A total of 75 patients were included in the study, of which 34 (45.3%) were female and 41 (54.7%) were male. The median length of intensive care stay was 8 (5-15) days in Group I patients and 5 (2-8) days in Group II patients, which was higher in alive patients (p=0.004). Radiological involvement was present in 93.3% (n=70) of the patients, and involvement was observed in both lungs in 77.3% (n=58). We observed complications in 54.7% (n=41) of the patients, whereas the incidence of complications was 20% in Group I and 72% in Group II, which was statistically significant (p<0.001). APACHE II, PSI, SOFA, qSOFA, SMART-COP, CURB65, A-DROP and NEWS2 scores were statistically significantly higher in patients who died, whereas APACHE II, SOFA, qSOFA, and SMART-COP scores were more successful in predicting morbidity. It is vital to predict the mortality risk early in patients with COVID-19 pneumonia followed up in intensive care units. Among the scoring systems, APACHE II, PSI, SOFA, qSOFA, SMART-COP, CURB65, A-DROP, and NEWS2 can be used safely to predict mortality.

Keywords: COVID-19, intensive care unit, mortality, pneumonia, score

1. Introduction

The novel coronavirus disease 19 (COVID-19), also known as novel coronavirus pneumonia, first appeared in Wuhan, China, at the beginning of December and spread almost worldwide within two months, leading to the pandemic. COVID-19 is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It can increase up to 50% in some populations even if the overall mortality rate of the disease is around 2%, and the most important reason for this is virus-induced pneumonia. 80% of COVID-19 patients have mild disease, 20% require hospitalization, and some need to be followed up in the intensive care unit (ICU). Patients with severe pneumonia require ICU follow-up and invasive or non-invasive respiratory support in an acute respiratory distress syndrome clinic (1,2).

Today, many scoring systems are used to estimate the mortality of patients followed up in ICUs. Recently, especially NEWS2 and SOFA are considered to be recommended scoring systems for predicting the prognosis of severe COVID-19 disease. Pneumonia severity index (PSI) is also reported as a scoring system that can be used in COVID-19 pneumonia as it questions additional diseases and radiological results (3,4). It is yet unclear which scoring system is more useful in patients with severe COVID-19 pneumonia, even though many scoring systems are used in ICUs (5). This study compared the existing intensive care scoring systems used to predict morbidity and mortality in patients who are followed up in the ICU due to COVID-19 pneumonia and determined which test is more sensitive and specific.

2. Material and Methods

2.1. Study design and patients

This retrospective study included patients treated for pneumonia between April 1, 2020, and November 1, 2020, in the ICUs of Samsun Training and Research Training and Research Hospital after obtaining the permission of the local ethics committee (GOKA/2021/1/10) following the approval of the Republic of Türkiye Ministry of Health on December 5, 2020. We used the patients' demographic characteristics, clinical and radiological characteristics, initial blood gas values, vital signs, and laboratory data at the time of admission to the intensive care unit by using the hospital

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database and patient files. We divided the patients into two groups, alive patients (Group I) and dead patients (Group II), and accordingly tried to determine the values of the scoring systems in predicting morbidity and mortality.

We used the Acute Physiology and Chronic Health Evaluation II (APACHE II), Pneumonia Severity Index (PSI), Sequential Organ Failure Assessment (SOFA), Quick Sequential Organ Failure Assessment (qSOFA), SMART-COP (acronym for Systolic blood pressure, Multilobar infiltrates, Albumin, Respiratory rate, Tachycardia, Confusion, Oxygen, and pH), MuLBSTA (Score for Viral Pneumonia Mortality), CURB65 (Confusion, Urea, Respiratory rate, Blood pressure, Age>65), A-DROP (Age, Dehydration, Respiratory failure, Orientation disturbance, blood Pressure), and National Early Warning Score (NEWS) 2 as the scoring systems.

We used the following internet address for APACHE II calculation; https://www.mdcalc.com/apache-ii-score, for PSI; https://www.mdcalc.com/psi-port-score-pneumonia-severity-index-cap, for SOFA; https://www.mdcalc.com/sequential-organ-failure-assessment-sofa-score, for qSOFA; https://www.mdcalc.com/qsofa-quick-sofa-score-sepsis, for SMART-COP; https://www.mdcalc.com/smart-cop-score-pneumonia-severity, for MuLBSTA; https://www.mdcalc.com/mulbsta-score-viral-pneumonia-mortality, for CURB65; https://www.mdcalc.com/curb-65-score-pneumonia-severity, and for NEWS2; https://www.mdcalc.com/national-early-warning-score-news-2.

APACHE II

The APACHE II score was first used in 1985. This score was developed to identify and classify the risk of critical patients in ICUs, including surgery and trauma patients. It is known to be useful in predicting mortality in critical trauma patients, transplant patients, and sepsis patients. The score includes 12 physiological variables, ranging from 0 to 71, based on age and underlying health status. APACHE II sections are a) 12 acute physiological parameters (acute physiological score), b) patient age, and c) chronic diseases and surgical interventions (6).

PSI

PSI was developed by the Pneumonia Patient Outcomes Research Team (PORT) in 1997 to estimate short-term mortality in patients with community-acquired pneumonia. It is a comprehensive scoring system calculated based on the patient's demographic information, accompanying comorbidities, physical examination results, laboratory values, and radiological results. It is successful in predicting mortality in cases of pneumonia requiring intensive care and is widely used (7).

SOFA

The SOFA scoring system was developed by an international group of experts in 1996. SOFA describes multiple organ dysfunction with the following parameters, oxygenation index (arterial oxygen tension [PaO2]/fraction of inspiration oxygen [FiO2]), mean blood pressure, Glasgow Coma Scale (GCS), BUN and creatine value, bilirubin, and platelet value. The function of each organ system is scored between 0 and 4, and then separate SOFA scores are summed up to a total score from 0 to 24 (8).

qSOFA

qSOFA score was defined in the Third International Consensus Definitions for Sepsis and Septic Shock and recommended to be used to evaluate organ dysfunction in patients with suspected sepsis. However, many recent studies have found its effectiveness in predicting mortality in patients with different diseases (9). Three clinical variables are each scored with a score of variable mental status, systolic blood pressure ≤100 mmHg, and respiratory rate ≥22/min. The clinician should direct the patient to investigate organ dysfunction, initiate or increase treatment, consider increased follow-up, or refer to an ICU if the qSOFA total score is two and above (10).

SMART-COP

SMART-COP is one of the latest models in pneumonia scoring and has been defined by Australian researchers. SMART-COP was created to find patients with pneumonia who needed intensive care unit or vasopressor support and included systolic blood pressure <90 mmHg-2 scores, multiple lobe involvement-1 score on chest X-ray, albumin value <3.5 g/dL-1 scores, respiratory rate >30 N/min-1 scores, heart rate >125 beats/min-1 score, confusion (acute)-1 score, low oxygen saturation (SpO2) <90%-2 scores, and pH value <7.35–2 scores. 0-2 points: low risk, 3-4 points: medium risk, 5-6 points: high risk and >7 points are defined as very high risk for the need for vasopressor support (11,12).

MuLBSTA

MuLBSTA is a scoring system developed to predict 90-day mortality in patients with viral pneumonia. This score uses the following data: multilobular infiltration, lymphopenia, bacterial co-infection, smoking history, hypertension, and age. Clinical access to all parameters defined in this score is easy and is used in the risk classification of hospitalized patients with viral pneumonia. Mortality rates for each class are classified as follows: MuLBSTA 0–11 (‘low-risk’, mortality=5.07%); MuLBSTA 12–22 (‘high-risk’, mortality=33.92%) (13,14).

CURB65

This classification system is fairly simple and can be easily applied in daily practice and was defined in 2003. The CURB65 score consists of confusion, urea >7 mmol/L,

respiratory rate ≥30 breaths/min, blood pressure (systolic <90 mmHg or diastolic ≤60 mmHg), and age ≥65 years. The risk of mortality in patients with a CURB65 score of 0-1 is <3%, and these patients can be monitored for outpatient care. The risk of mortality in patients with a score of 2 is around 9%, and short-term hospitalization is recommended for these patients. Those with a CURB65 score of 3-5 have a mortality risk of 15-40% and should be monitored at the hospital (15).

A-DROP

The A-DROP score is a modified version of the CURB65 score recommended by the Japanese Respiratory Society in 2006. Criteria are as follows: men aged ≥70 years or women aged ≥75 years, blood urea nitrogen ≥21 mg/dL or dehydration, oxyhemoglobin saturation measured with pulse oximetry <90% or PaO2 <60 mmHg, confusion and systolic blood pressure ≤90 mmHg (4).

NEWS2

The Royal College of Physicians of London released NEWS2, making a few changes to its NEWS score in December 2017. NEWS2 is a standard clinical scoring system developed to improve the detection of worsening in acute patients. It is based on the total scoring of six physiological parameters: respiratory rate, oxygen saturation, systolic blood pressure, pulse rate, level of consciousness, or consciousness and temperature. In addition, two points are added for patients in need of oxygen support. The NEWS2 score of 5 or 6 is considered a key threshold that may indicate clinical deterioration and should be evaluated urgently by a clinician or team competent in treating the patient (10).

Exclusion criteria:

- Patients diagnosed with pneumonia other than COVID-19 pneumonia

- Negative RT-PCR test from a throat swab sample

- Patients without blood gas and laboratory values in the patient file

- Patients without radiological images in the hospital database

- Patients not followed up in the ICU due to respiratory failure

2.2. Statistical analysis

The Kolmogorov-Smirnov test examined the suitability of the data for normal distribution. We used the student's t-test to compare normally distributed values in two independent groups and the Mann-Whitney U test to compare non-normally distributed values in two independent groups. We used the Exact and Pearson's Chi-square tests to analyze the relationship of categorical variables. We first analyzed age, gender, some clinical characteristics, and laboratory and treatment methods by the Univariate LR (Logistic Regression) method and then analyzed the variables found to be significant by the Stepwise Multivariate Enter LR method. We determined the cut-off value by ROC analysis over mortality and complication using variables such as APACHE II, PSI, SOFA, qSOFA, SMART-COP, MuLBSTA, CURB65, A-DROP, and NEWS2. We gave median and quarterly values for numerical variables and number (n) and % values for categorical variables as descriptive statistics. We used SPSS windows version 23.0 package software for statistical analysis and considered $p<0.05$ statistically significant.

3. Results

A total of 75 patients were included in the study, of which 34 (45.3%) were female and 41 (54.7%) were male. The median age was 75 (IQR 65-83) years, and there was no difference between the groups (p=0.706). There was no significant difference between the groups except for BUN, creatine, lactate and base excess values in arterial blood gas, total bilirubin, CK-MB, and troponin values. BUN (p=0.004) and creatine (p=0.002) values were statistically significantly higher in patients who died than in those who were alive. Similarly, lactate, base excess, total bilirubin, CK-MB, and troponin values were statistically significantly higher in patients who died ($p<0.05$) (Table 1).

The median length of ICU stay was 8 (IQR 5-15) days in Group I patients and 5 (IQR 2-8) days in Group II patients, which was statistically significantly longer in alive patients (p=0.004). The rate of consciousness was significantly higher in alive patients (p=0.006). Radiological involvement was present in 93.3% (n=70) of the patients, and this involvement was present in both lungs in 77.3% (n=58). The most common radiological feature was ground-glass opacity, with a rate of 80% (n=60), and the rate of parenchymal consolidation was 46.7% (n=35). The incidence of parenchymal consolidation in both lungs was 36% higher in patients who died, and this was statistically significant, whereas the incidence of parenchymal consolidation was 60% higher in patients experiencing parenchymal consolidation (p=0.024). Complications were observed in 54.7% (n=41) of the patients. The most common ones were acute renal failure (n=18), septic shock (n=9), ARDS (n=6), MODS (n=5), respectively. The incidence of complications was 20% in Group I and 72% in Group II, which was statistically significant ($p<0.001$) (Table 2).

APACHE II (p=0.004), SOFA (p=0.001), qSOFA (p=0.036), SMART-COP (p=0.032), and NEWS2 (p=0.010) scores were statistically significantly higher in patients with complications whereas there was no difference in PSI (p=0.492), MuLBSTA (p=0.374), CURB65 (p=0.119), and A-DROP (p=0.078) scores when the complication status was evaluated (Table 3).

APACHE II (p=0.001), PSI (p=0.006), SOFA (p=0.001), qSOFA (p=0.017), SMART-COP (p=0.001), CURB65 (p=0.001), A-DROP (p=0.001), and NEWS2 (p=0.001) scores

were statistically significantly higher in patients who died whereas there was no difference between the groups in MuLBSTA scoring when the mortality status was evaluated (p=0.896) (Table 4).

Table 1. Vital signs and laboratory findings

	Group I (n=25)			Group II (n=50)			Total (n=75)			
	Median	Min	Max	Median	Min	Max	Median	Min	Max	p
Age, years	77	68	81	74.5	65	84	75	65	84	0.706
SBP, mmHg	115	105	143	110.5	86	130	112	86	143	0.041
DBP, mmHg	66	63	78	64.5	50	79	65	50	79	0.231
Respiratory rate, min^{-1}	26	24	30	29.5	20	32	28	20	32	0.731
Heart rate, min^{-1}	100	88	122	108	92	128	105	88	128	0.532
Temperature, °C	36.6	36.5	36.8	36.6	36.5	36.7	36.6	36.5	36.8	0.102
Hemoglobin, g/l	12.1	11.1	12.9	11.9	10.3	13.3	11.9	10.3	13.3	0.870
Hematocrit, %	35	33.1	37.2	34.8	31.3	39.4	34.9	31.3	39.4	0.736
WBC count, 109/l	10.8	7.4	13.3	11.6	7.5	18.3	11.4	7.4	18.3	0.406
Lymphocyte count, 10^9/l	0.9	0.5	2	1.1	0.6	2.3	1.1	0.5	2.3	0.229
Lymphocyte, %	8	5.7	13.7	9.5	4.5	15.2	9	4.5	15.2	0.818
Neutrophil count, 10^9/l	9.9	7.8	12.7	9.9	6.4	15.6	9.9	6.4	15.6	0.549
Neutrophil, %	85.3	78.1	88.9	83.2	76.1	90.6	84	76.1	90.6	0.802
Patelet, 10^9/l	264	174	351	244	181	325	246	174	351	0.529
Glucose, mmol/l	154	124	213	158	106	244	157	106	244	0.897
Sodium, mmol/l	136	134	141	137	133	143	137	133	143	0.405
Potassium, mmol/l	4.3	3.8	4.8	4.3	3.8	4.9	4.3	3.8	4.9	0.477
Urea, mmol/l	47	36	69	89	50	137	71	36	137	0.004
Creatine, mmol/l	1.1	0.8	1.3	1.5	1	2.3	1.3	0.8	2.3	0.002
Arterial pH	7.4	7.4	7.4	7.4	7.2	7.4	7.4	7.2	7.4	0.200
Saturation, %	93	90	96	90	81.7	94	92	81.7	96	0.126
$PaCO_2$, mmHg	38.2	34.6	40.7	39.3	33.5	47.3	39	33.5	47.3	0.381
PaO_2, mmHg	69	50	90	66	46	78	67.6	46	90	0.34
Arterial HCO_3, mmol/l	24.3	21.8	26.1	21.3	18.6	24.2	22.1	18.6	26.1	0.064
Arterial lactate, mmol/l	1.6	1	2.7	2.3	1.7	4.1	2.2	1	4.1	0.006
BE	1.4	-3.1	4.2	-2.8	-6.7	1.6	-1.8	-6.7	4.2	0.026
CRP, mg/l	95.6	46.5	140	107	59.1	182.6	98.9	46.5	182.6	0.310
Procalcitonin, µg/l	0.2	0.1	3.4	1.4	0.3	5.7	1	0.1	5.7	0.068
D-Dimers, mg/dl	1.3	0.9	4	2.2	1	4.1	2.1	0.9	4.1	0.588
PT, sec	13.7	13.4	15.2	13.9	12.9	16.1	13.9	12.9	16.1	0.499
INR	1.2	1.1	1.4	1.2	1.1	1.4	1.2	1.1	1.4	0.771
AST, u/l	29	24	48	49	29	73	40	24	73	0.048
ALT, u/l	16	13	24	25	15	44	20	13	44	0.086
Albumin, g/l	3	2.7	3.3	2.9	2.5	3.1	2.9	2.5	3.3	0.212
Total bilirubin, µmol/l	0.5	0.4	0.7	0.6	0.5	1.3	0.6	0.4	1.3	0.030
CK-MB, u/l	1.6	1.2	3	4.4	1.9	9.3	3.2	1.2	9.3	0.001
Troponin, ng/l	0	0	0.1	0.4	0	1.9	0.1	0	1.9	0.001

ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, BE: base excess, CK-MB: creatine kinase-MB, CRP: C-reactive protein, DBP: diastolic blood pressure, HCO_3: bicarbonate, INR: International Normalized Ratio, GKS: Glasgow Coma Score, WBC: white blood cell, PT: Prothrombin time, PaO_2: arterial oxygen pressure, $PaCO_2$: arterial carbon dioxide pressure, SBP: systolic blood pressure

Table 2. Comparison of the patients' state of consciousness, radiological features and complications

	Group I (n=25)		Group II (n=50)		Total (n=75)		p
Sex (n,%)							0.189
Female	14	56	20	40	34	45.3	
Male	11	44	30	60	41	54.7	
Consciousness (n,%)							**0.006**
Awake	14	56	8	16	22	29.3	
Confusion	4	16	8	16	12	16.0	
Delirium	0	0	2	4	2	2.7	
Stupor	4	16	22	44	26	34.7	
Coma	3	12	10	20	13	17.3	
Thorax BT (n,%)							0.233
Unilateral involvement	5	20	7	14	12	16.0	
Bilateral involvement	20	80	38	76	58	77.3	
None	0	0	5	10	5	6.7	
Ground glass opacity (n,%)							0.540
Yes	21	84	39	78	60	80.0	
No	4	16	11	22	15	20.0	
GGO involvement (n,%)							0.575
Unilateral	3	12	5	10	8	10.7	
Bilateral	19	76	34	68	53	70.7	
None	3	12	11	22	14	18.7	
Consolidation (n,%)							0.102
Yes	15	60	20	40	35	46.7	
No	10	40	30	60	40	53.3	
Consolidation involvement (n,%)							**0.024**
Unilateral	6	24	2	4	8	10.7	
Bilateral	9	36	18	36	27	36.0	
None	10	40	30	60	40	53.3	
Complication (n,%)							**<0.001**
No	20	80	14	28	34	45.3	
Yes	5	20	36	72	41	54.7	

Table 3. Comparison of the complication status in terms of scoring systems

	COMPLICATION									
	YES			NO			TOTAL			p
	Median	Min	Max	Median	Min	Max	Median	Min	Max	
APACHE II	26	21	33	21	17	27	25	17	33	**0.004**
PSI	150	125	185	150.5	120	174	150	120	185	0.492
SOFA	8	5	11	5.5	4	7	7	4	11	**0.001**
qSOFA	2.5	2	3	2	1	2	2	1	3	**0.036**
SMART-COP	7	5	8	5.5	4	7	6	4	8	**0.032**
MuLBSTA	13	11	15	12.5	11	13	13	11	15	0.374
CURB65	4	3	4	3	2	4	3	2	4	0.119
A-DROP	3.5	3	4	3	2	4	3	2	4	0.078
NEWS2	12	9	13	10	8	12	11	8	13	**0.010**

Table 4. Comparison of mortality in terms of scoring systems

	Group I			Group II			Total			p
	Median	Min	Max	Median	Min	Max	Median	Min	Max	
APACHE II	20	14	25	26	21	32	25	14	32	**0.001**
PSI	128	112	159	164	131	190	150	112	190	**0.006**
SOFA	5	3	7	8	5	10	7	3	10	**0.001**
qSOFA	2	1	2	2.5	2	2	2	1	2.5	**0.017**
SMART-COP	5	4	6	7	5	8	6	4	8	**0.001**
MuLBSTA	13	11	17	13	11	15	13	11	17	0.896
CURB65	3	2	3	4	3	4	3	2	4	**0.001**
A-DROP	3	2	3	3.5	3	4	3	2	4	**0.001**
NEWS2	9	8	11	12	10	13	11	8	13	**0.001**

ROC analysis for complication showed that all scoring systems except PSI, qSOFA, MuLBSTA, CURB65, and A-DROP scores were statistically significant in terms of AUC values ($p<0.05$). ROC analysis determined an APACHE II score above 23 to increase the risk of complications (sen:0.71, spe:0.65). Similarly, the SOFA score of 7.5 (sen:0.56, spe:0.82), the SMART-COP score of 7.5 (sen:0.37, spe:0.85), and the NEWS2 score of 11.5 (sen:0.54, spe:0.74) were statistically significant in increasing the risk of complications by ROC analysis. The highest value was observed in the APACHE II score in terms of sensitivity value in the parameters examined through complication estimation (sen:0.71). In other words, we observed that this score correctly predicted the occurrence of complications by 71% in patients with an APACHE II score above 23. We found that the scoring system that makes the most accurate estimation in terms of specificity value was SMART-COP in the parameters examined through complication estimation (spe:0.85). In other words, we estimated with an accuracy rate of 85% that patients with a SMART-COP score below 7.5 would not experience any complications (Table 5, Fig. 1).

Table 5. ROC analysis for complication

	Cut-off	Area (95%CI)	Std Error	Sensitivity	Specificity	p
APACHE II	>23	0.693 (0.575 0.811)	0.060	0.71	0.65	**0.004**
PSI	>184.5	0.546 (0.415 0.677)	0.067	0.29	0.85	0.492
SOFA	>7.5	0.718 (0.603 0.834)	0.059	0.56	0.82	**<0.001**
qSOFA	>2.5	0.629 (0.503 0.754)	0.064	0.27	0.94	0.056
SMART-COP	>7.5	0.643 (0.519 0.767)	0.063	0.37	0.85	**0.034**
MuLBSTA	>13.5	0.559 (0.427 0.692)	0.068	0.39	0.77	0.380
CURB65	>4.5	0.600 (0.473 0.728)	0.065	0.20	0.99	0.136
A-DROP	>3.5	0.612 (0.484 0.740)	0.065	0.44	0.71	0.097
NEWS2	>11.5	0.672 (0.551 0.793)	0.062	0.54	0.74	**0.011**

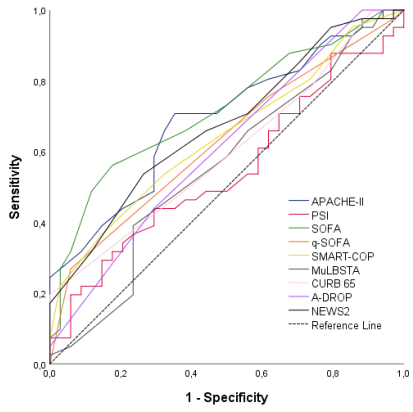

Fig. 1. Complication ROC curve

It was determined that an APACHE II score above 23 posed a risk for mortality; similarly, a PSI score of 140, SOFA score of 7.5, qSOFA score of 1.5, SMART-COP score of 6.5, CURB65 score of 3.5, A-DROP score of 3.5, and NEWS2 score of 9.5 were found to pose a significant risk for mortality when ROC analysis was performed for mortality. MuLBSTA score was not significant in predicting mortality in terms of AUC values ($p=0.897$). The highest value was observed in the qSOFA score in terms of sensitivity value in the tests examined through mortality estimation (sen:0.78), in other words, it was seen that this score correctly predicted mortality by 78% in patients with a qSOFA score above 1.5. On the other hand, we observed that the scoring system that makes the most accurate estimation in terms of specificity value was the SOFA score (spe:0.88). In other words, we estimated with an accuracy rate of 88% that patients with a SOFA score below 7.5 would survive (Table 6, Fig. 2).

Table 6. ROC analysis for mortality

	Cut-off	Area (95%CI)	Std Error	Sensitivity	Specificity	p
APACHE II	>23	0.729 (0.606 0.852)	0.063	0.68	0.72	**0.001**
PSI	>140	0.697 (0.675 0.820)	0.063	0.72	0.64	**0.006**
SOFA	>7.5	0.782 (0.677 0.866)	0.053	0.52	0.88	**<0.001**
qSOFA	>1.5	0.656 (0.524 0.787)	0.067	0.78	0.48	**0.029**
SMART-COP	>6.5	0.759 (0.651 0.868)	0.055	0.58	0.84	**<0.001**
MuLBSTA	>8.5	0.509 (0.363 0.655)	0.074	0.92	0.84	0.897
CURB65	>3.5	0.720 (0.602 0.838)	0.060	0.62	0.76	**0.002**
A-DROP	>3.5	0.737 (0.616 0.858)	0.062	0.48	0.84	**0.001**
NEWS2	>9.5	0.738 (0.622 0.854)	0.059	0.76	0.60	**0.001**

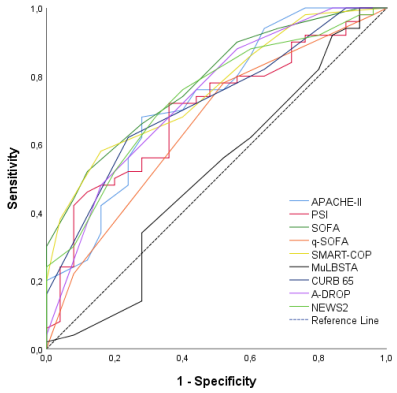

Fig. 2. Mortality ROC curve

4. Discussion

The COVID-19 pandemic has led to healthcare system lockdown in many countries worldwide and even its collapse in some countries. Appropriate criteria should be established for the hospitalization of patients with severe illnesses, and medical resources should be used as accurately as possible if this happens. Intensive care scoring systems help select ICU inpatients at this point (14). In addition to reports from the US and China, European surveillance data suggest that approximately 15-20% of hospitalized patients with COVID-19 have died or developed severe illnesses requiring intensive care. In this respect, using scoring systems by emergency or intensive care physicians is essential in identifying severe COVID-19 patients and evaluating treatment.

NEWS2, qSOFA, and CRB65 are the most commonly used clinical risk scoring systems, but no study has shown precisely which should be used in COVID-19 patients so far. Another option is to revise the existing scoring systems used to predict mortality in patients with severe COVID-19 (10,11). This study aimed to determine the power of existing scoring systems used in ICUs in predicting morbidity and mortality in COVID-19 patients.

Advanced age and pre-existing diseases are considered risk factors for patients with severe COVID-19. In addition, many studies have shown that the severity of the disease is associated with the severity of patients' thoracic CT scans and many laboratory test parameters, including various enzyme levels, coagulation factors, inflammatory markers, and absolute immune cell count in peripheral blood (16,17). We found BUN, creatine, total bilirubin, CK-MB, troponin, lactate, and base deficit values in arterial blood gas to be higher in the group of patients who died and closely followed these prognostic parameters in our patients followed up in ICUs in our study, as indicated in the literature.

Evaluation of disease severity is critical in guiding therapeutic options such as hospitalization or the need for ICU hospitalization in evaluating and managing pneumonia (3). The pneumonia severity index allows the classification of patient groups according to mortality risks and characteristics. A variable-based score needs to be calculated in PSI and may therefore not be practical for routine practice in intensive hospital emergency departments or primary care centers but can be easily used in ICUs. The CURB65 score accurately predicts clinical outcomes in viral-induced community-acquired pneumonia. The use of the CURB65 score is much simpler than PSI, but the sensitivity to predict mortality in pneumonia is reported to be lower than PSI (18,19). We found that PSI and CURB65 were insufficient in predicting morbidity and sufficient in predicting mortality in our study. Accordingly, a PSI score of 140 and a CURB65 score of 3.5 posed a significant risk for mortality.

The SOFA score, first developed in 1994, is used to estimate the results of patients in the ICU. The SOFA score assesses organ dysfunction in six different systems using a 5-point scale. A higher SOFA score has been reported to be associated with an increased mortality rate in hospitalized COVID-19 patients (3). Liu et al. determined that the SOFA score was above three and the qSOFA score was above 1 in critical COVID-19 patients. In addition, they stated in this study that the SOFA score was a highly sensitive indicator of in-hospital mortality in COVID-19 patients and prognostically superior to qSOFA (11). The median SOFA score was reported as 3 in another study examining 109 patients who died due to complications associated with COVID-19 pneumonia (20). Another study conducted on patients with COVID-19 pneumonia reported that the median SOFA score of the patients at the time of the first admission

was three, and the median SOFA score of 3 patients who died was 5 (2). We found in our study that SOFA and qSOFA scoring systems were sufficient in predicting both morbidity and mortality. Accordingly, a SOFA score of 7.5 and a qSOFA score of 1.5 posed a significant risk for mortality. In fact, the sensitivity value for qSOFA was 78%, and the specificity value for SOFA was 88%, which were the highest values among the scoring systems in our study. Accordingly, we determined with an accuracy rate of 88% that patients with a SOFA score below 7.5 would survive and that we could correctly predict mortality rate by 78% in patients with a qSOFA score above 1.5.

The MuLBSTA score is used to predict mortality in viral pneumonia, and 5 to 11 scores are reported to be reliable accordingly. The value 11 is a cut-off value indicating that the disease will worsen and the patient should be referred to the ICU (14). MuLBSTA scoring systems include markers such as multilobular infiltration, lymphopenia, and the presence of bacterial co-infection, which play an essential role in predicting disease progression and worsening. However, it cannot predict the progression and worsening of the disease significantly more accurately than the patient's risk score. Therefore, Iijima et al. stated that CRP value, known as one of the primary mechanisms that show high inflammatory status and explain the worsening of COVID-19 and related to complex cytokine storm, should also be considered. They also reported that they would predict the worsening of the disease more accurately than the MuLBSTA score with this scoring system modified in their study (14). We found in our study that the MuLBSTA score was insufficient to predict morbidity (p=0.380) or mortality (p=0.897) in critical COVID-19 patients followed up in the ICU compared to other scoring systems.

The A-DROP score is a modified version of the CURB65 score and provides predictive power similar to the CURB65 score. Fan et al. examined the accuracy of their various scores to predict mortality in 654 COVID-19 patients admitted to the hospital and reported that A-DROP was the best scoring system for predicting mortality in patients with critical COVID-19 pneumonia with a value of 0.87 AUC (95% CI 0.84–0.90), sensitivity value was 80%, and specificity value was 86% (1). They also stated that PSI might be inadequate in COVID-19 pneumonia since more emphasis is placed on the underlying disease than on respiratory function in PSI than A-DROP (1). Even though A-DROP was insufficient to predict complications and morbidity (p=0.097), it showed 48% sensitivity and 84% specificity with 0.73 AUC (95% CI 0.61-0.85) and the highest specificity value after SOFA in predicting mortality in our study.

NEWS2 scoring system evaluates respiratory rate, oxygen saturation, systolic blood pressure, heart rate, temperature, and level of consciousness and is easy to use in the emergency department. It proved to be a valid tool for identifying acutely ill patients with infection (1). Myrstad et al. reported that the NEWS2 score at the time of admission was superior to qSOFA and other commonly used clinical risk scores in predicting severe COVID-19 disease and hospital mortality. One advantage of NEWS2 compared to other scores is that it uses both hypoxemia and supportive oxygen therapy as scoring parameters. However, the increased oxygen requirement may not be fully reflected in the NEWS2 score, where oxygen supplementation is evaluated only as a binary variable (yes/no). However, the authors stated that they detected severe disease with 80% sensitivity and 84% specificity in patients with a NEWS2 score above 6 (10). Jang et al. reported that the NEWS2 score predicted clinical deterioration such as ARDS, septic shock development, and intensive care needs in critical COVID-19 patients and also predicted 28-day mortality and clinical outcomes as accurately as SIRS and qSOFA (21). We found that the NEWS2 score was sufficient to predict both morbidity (p=0.011) and mortality (p=0.001) in our study and that it was even the most successful scoring system after qSOFA with a 76% sensitivity value in predicting mortality, and the cut-off value was 9.5.

In conclusion, we found that many of the scoring systems used in ICUs were sufficient in predicting morbidity and mortality in patients with severe COVID-19 pneumonia. We found that APACHE II and SMART-COP were superior to others in predicting morbidity, and SOFA and qSOFA were superior to others in predicting mortality among these scoring systems.

The limitations of our study were as follows: First, our study is a single-center retrospective study with a small number of participants. However, our results will help determine the criteria for admission to the hospital and the criteria for admission to the ICU to prevent the collapse of the healthcare system. Second, we only included patients who were discharged or died and excluded those still hospitalized. Third, selection bias cannot be avoided. We did not use data from a large population, and the severity of COVID-19 may differ among hospitals and around Turkey. However, the strength of our study is that the patients included in the study consisted of patients followed up by a single intensive care team in the same hospital and applied the same treatment protocol.

Conflict of interest

The authors declared no conflicts of interest with respect to this article's authorship and/or publication.

Financial disclosure

The authors declared that this study has received no financial support.

Acknowledgments

We send our thanks to Mehmet Karadağ from Hatay Mustafa Kemal University, Tayfur Ata Sökmen Faculty of Medicine,

Department of Biostatistics and Medical Informatics for his contributions to the statistical evaluation of this study.

Authors' contributions

Concept: H.K.Ç., Design: H.K.Ç., Z.D., Data Collection or Processing: H.K.Ç., R.B.F., Analysis or Interpretation: H.K.Ç., M.K., Literature Search: H.K.Ç., Z.D., R.B.F., Writing: H.K.Ç.

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