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ORIGINAL ARTICLE / ÖZGÜN ARAŞTIRMA MAKALESİ

The Prognostic Value of SOFA, qSOFA, CURB-65 and 4C Mortality Scoring Systems in COVID-19 Pneumonia Patients Presenting to the Emergency Department

Acil Servise Başvuran COVID-19 Pnömonili Hastalarda SOFA, qSOFA, CURB-65 ve 4C Mortalite Skorlama Sistemlerinin Prognostik Değeri

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ABSTRACT

Aim: The aim of this study is to investigate the relationship between mortality and CURB-65, SOFA, qSOFA, and 4C mortality scores in COVID-19 patients presenting to the emergency department.

Material and Methods: This prospective observational study included patients presenting to the emergency department who tested positive for COVID-19 PCR and were diagnosed with pneumonia on chest CT.

Results: A total of 160 patients, of whom 81 (50.6%) were female, were included in the study. Examination of patient mortality within 30 days revealed that 50 (32.3%) patients died. According to the SOFA score, mortality was observed in 2 (9.1%) of patients with scores of 0-1, 13 (17.8%) of those with scores of 2-3, 9 (32.1%) of those with scores of 4-5, 14 (66.7%) of those with scores of 6-7, 9 (75%) of those with scores of 8-9, 1 (66.7%) of those with scores of 10-11, and in 1 patient (100%) with a score of 12-14. According to the qSOFA score, mortality was observed in 2 (10%) of patients with a score of 0, 7 (13%) with a score of 1, 25 (42.4%) with a score of 2, and 16 (59.3%) with a score of 3. According to the CURB-65 score, mortality was observed in 4 (19%) of patients with scores of 0-1, 5 (9.1%) of those with a score of 2, and 41 (48.8%) of those with scores of 3 or higher. Regarding the 4C mortality score, mortality was not observed in any of the 5 patients with scores of 0-3, while mortality occurred in 1 (5.3%) of those with scores of 4-8, 11 (19.6%) of those with scores of 9-14, and in 38 (47.5%) of the remaining patients. Statistically significant relationships were found between SOFA, qSOFA, CURB-65, and 4C mortality scores and mortality ($p<0.001$ for all).

Conclusion: In COVID-19 patients, SOFA, qSOFA, CURB-65, and 4C mortality scores were significantly higher in deceased patients.

Keywords: COVID-19, SOFA, qSOFA, CURB-65, 4C mortality, prognosis

ÖZ

Amaç: Bu çalışmada amacımız acil servise başvuran COVID-19 hastalarında; CURB-65, SOFA, qSOFA ve 4C mortalite skorlarının mortalite ile ilişkisini araştırmaktır.

Gereç ve Yöntemler: Bu prospektif gözlemsel çalışmaya; acil servise başvuran, COVID-19 PCR testi pozitif olan ve torax BT'de pnomoni saptanan hastalar dahil edildi.

Bulgular: Çalışmaya 81'i (%50,6) kadın 160 hasta dahil edildi. Hastalar 30 günlük mortalite durumları bakımından incelendiğinde 50 (%32,3) hastanın öldüğü görüldü. SOFA skoruna göre 0-1 puan alan hastaların 2 (%9,1)'sinde, 2-3 puan alan hastaların 13 (%17,8)'ünde, 4-5 puan alan hastaların 9 (%32,1)'unda, 6-7 puan alan hastaların 14 (%66,7)'ünde, 8-9 puan alan hastaların 9 (%75)'unda, 10-11 puan alan hastaların (%66,7)'inde ve 12-14 puan alan olan 1 hastada (%100 mortalite geliştiği görüldü. qSOFA skoruna göre; 0 puan alan hastaların 2 (%10)'inde, 1 puan olan hastaların 7 (%13)'sinde, 2 puan alan hastaların 25 (%42,4)'inde, 3 puan alan hastaların 16 (%59,3)'ında mortalite geliştiği görüldü. CURB-65 skoruna göre; 0-1 puan alan hastaların 4 (%19)'ünde, 2 puan alan hastalardan 5 (%9,1)'inde, 3 ve daha fazla puan alan hastalardan 41 (%48,8)'inde mortalite geliştiği görüldü. 4C mortalite skoruna göre; 0-3 puan alan 5 hastada mortalite gelişmezken, 4-8 puan alanların 1 (%5,3)'inde,9-14 puana alan hastaların 11 (%19,6)'inde, geri kalan hastaların 38 (%47,5)'inde mortalite gelişti. SOFA, qSOFA, CURB-65 ve 4-C Mortalite skorları ile mortalite arasında istatistiksel olarak anlamlı ilişki tespit edildi (hepsi için $p<0,001$).

Sonuç: COVID-19 hastalarında; SOFA, qSOFA, CURB-65 ve 4C-Mortalite skorları ölen hastalarda anlamlı derecede yüksek tespit edildi.

Anahtar Kelimeler: COVID-19, SOFA, qSOFA, CURB-65, 4C-Mortalite, prognoz

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Introduction

Coronavirus disease 2019 (COVID-19) rapidly spread around the world after the first cases of infection appeared, causing a global pandemic. Since its first appearance, different clinical appearances occur in COVID-19 infections. This clinical spectrum ranges from asymptomatic, mild or moderate respiratory infections to severe cases that develop acute respiratory distress syndrome or multiple organ dysfunction resulting in death (1). Although the impact of COVID-19 infections has decreased over time, increases in the number of cases and deaths can be observed periodically. According to World Health Organization data, as of February 4, 2024, nearly 800 million confirmed cases and more than seven million deaths have been reported worldwide (2).

In research conducted since the early days of COVID-19, prognostic factors related to this disease have been the focus of attention. For this purpose, previous studies have investigated the demographic characteristics of patients (age, gender, etc.), comorbid factors (diabetes, hypertension, etc.), laboratory results (CRP, ferritin, etc.), electrocardiography characteristics, and the relationships between clinical findings and mortality (1,3-5). Again, in this process, many scoring systems have been researched and developed to predict clinical severity and prognosis in COVID-19 patients. CURB-65, sequential organ failure assessment score (SOFA), quick sequential organ failure assessment (qSOFA), and 4C mortality scores are among the most interesting ones in this sense (6-9). There are many studies in the literature investigating the effectiveness of these scoring systems in predicting prognosis in COVID-19 patients (6-14).

Our aim in this study is to investigate the relationship between CURB-65, SOFA, qSOFA, and 4C mortality scores and mortality in the same patient group with COVID-19 pneumonia admitted to the emergency department.

Material and Methods

This study was planned as a prospective observational study. The study was conducted in patients admitted to the Emergency Department of Samsun Education and Research Hospital between March 2022 and September 2022. Samsun Education and Research Hospital Scientific Research Ethics Committee permission dated 23.03.2022 and numbered BAEK/2022/4/2 was obtained for our study.

All patients who applied to the emergency department had a thorax computed tomography (CT) scan in the presence of a clinical indication (patients with moderate/severe symptoms of COVID-19; Patients with comorbid factors that may cause the disease to progress, even if they have mild symptoms), had a positive COVID-19 polymerase chain reaction (PCR) test, had pneumonia, were over 18 years of age, and gave informed consent (either themselves or their legal guardians) were included in the study (15). Thorax CT images of the patients were classified as mild, moderate and severe involvement according to COVID-19 pneumonia involvement (16). Participants' vital findings (respiratory rate, blood pressure, body temperature, pulse rate, saturation), whole blood count, urea, creatinine, sodium, potassium, AST, ALT, total bilirubin, C-reactive protein, blood gas results at the time of admission were recorded on the data collection form. Using these data, qSOFA, SOFA, CURB-65, and 4C Mortality scores of each case were calculated. The emergency department results of the patients were followed. On the 30th day of admission, mortality information in the hospital information system was recorded, and the inquiry made through phone calls was included in the participant form. qSOFA, SOFA, CURB-65, and 4C mortality scoring systems were compared between the deceased and non-deceased groups. Additionally, laboratory parameters, comorbid factors, admission symptoms, etc., were compared between the groups that developed mortality and those that did not.

Statistical analysis

The collected data were analyzed using the IBM SPSS package program (version 25) and MedCalc (Version 20; MedCalc Software Ltd, Ostend, Belgium). Analyzes were examined at a 95% confidence level. To determine the analysis method to be used, the Kolmogrov-Smirnov test results were examined to determine whether the data showed normal distribution. Descriptive statistics were expressed as the mean and standard deviation in normally distributed numerical data, as median (minimum-maximum) in non-normally distributed data, and as number (n) and percentage (%) in nominal data. In pairwise group comparisons, the Student-T test was used to compare numerical data that conformed to the normal distribution, the Mann-Whitney U test was used to compare data that did not fit, and the Chi-square test or Fisher's exact test was used to compare categorical data. The correlation between qSOFA, SOFA, CURB-65, and 4C Mortality scoring systems and mortality was evaluated with Spearman correlation analysis. For all analyses, the statistical significance level was accepted as $p<0.05$.

Results

81 (50.6%) of the 160 patients included in the study were women. The mean age of all patients was 71.19 ±17.28 years. While the mean age of women was 72.65 ±16.96, the mean age of men was 69.70 ±17.58 (p=0.281). While 27.5% (n=44) of the patients were under 65, 72.5% (n=116) were 65 or older. The most common presenting complaint of the patients was myalgia, which was detected in 75% of the patients (n = 120). This complaint was followed by shortness of breath 66.9% (n=107), fever 63.7% (n=102), cough 55.6% (n=89) and change of consciousness 45.6% (n=73). When evaluated according to the comorbid characteristics of the patients, the most common comorbidities were hypertension, with a rate of 55.6% (n = 89), and coronary artery disease (CAD), with a rate of 43.7% (n = 70). When patients are evaluated according to laboratory values, the median value of creatine is 0.99 mg/dL (Min: 0.26-Max: 9.45), the median value of total bilirubin is 0.6 mg/dl (Min: 0.03-Max: 8.13), platelet median value was 223.5 109/L (Min: 58 - Max: 856), PO2/FiO2 ratio median value was 285.13 (Min: 114.26-Max: 579.31). The demographic data, admission complaints, vital signs, comorbid factors, and laboratory values of the patients are given in Table 1.

According to the thoracic CT imaging results of the patients, mild involvement was detected in 37 patients (23.1%). Moderate involvement was found in 85 patients (53.1%),

and severe involvement was present in the remaining 38 patients (23.8%). Mortality developed in 3 (8.1%) of 37

	Female	81 (50.6)
Gender, n (%)	Male	79 (49.4)
Age (years),(mean±SD)	Total (n:160)	71.19 ±17.28
Age, (years), n (%)	<65	44 (27.5)
	≥65	116 (72.5)
Complaint, n (%)	Myalgia	120 (75)
	Shortness of breath	107 (66.9)
	Fever	102 (63.7)
	Cough	89 (55.6)
	Alteration of consciousness	73(45.6)
	Dizziness	34 (21.3)
	Sore throat	22 (13.8)
Vital Findings	SBP (mmHg)	116 (50-253)
	DBP (mmHg)	70 (30-153)
	MAP (mmHg)	86.33 (36.60-186.33)
	RR (n/min)	24 (15-39)
	HR (/min)	105 (57-156)
	Temperature (°C)	37.6 (36.1-40)
	Received Oxygen (lt/min)	4 (0-10)
	SpO_2 (%)	92 (66-100)
Comorbid Diseases, n (%)	Hypertension	89 (55.6)
	Cardiovascular disease	70 (43.7)
	Diabetes mellitus	56 (35)
	Nursing Home Patient	51 (32)
	Chronic pulmonary disease	31 (19.4)
	Cerebral vascular disease	31 (19.4)
	Malignancy	27 (16.9)
	Chronic kidney failure	16 (10)
	Asthma	15 (9.4)
Laboratory Values Median (Min-Maks)	Glucose (mg/dL)	129.5 (58.8-458)
	Creatinine (mg/dL)	0.99 (0.26-9.45)
	Urea (mg/dL)	54.10 (11.60-560)
	Direct Bilirubin (mg/dL)	0.14 (0.02-2.58)
	Total Bilirubin (mg/dL)	0.6 (0.03-8.13)
	Sodium (mmol/L)	136 (107-165)
	Potassium (mmol/L)	4.2 (3.1-6.7)
	AST (U/L)	29.25 (8.5-1586)
	ALT (U/L)	16 (2.60-956)
	CRP (mg/L)	83.55 (0.5-511.2)
	WBC (10^3/µL)	8.94 (0.4-55.70)
	NEU (10^3/µL)	6.81 (0.1-26.50)
	Hemoglobin(g/dL)	11.55 (6-17.2)
	Lymphocyte count (10^3/µL)	1.02 (0.1-20.0)
	Platelets count (10^9/L)	223.5 (58-856)
	NLR (%)	6.42 (0.5-88.5)
	pH	7.37 (6.78-7.56)
	PCO_2 (mmHg)	40 (24.6-102)
	PO_2 (mmHg)	98.75 (69.7-220)
	Lactate (mmol/L)	1.8 (0.5-19)
	Base deficit	0.35 (-31-14.60)
	HCO_3 (mmol/L)	24.95 (3.7-38.6)
	FiO_2	37.0 (21-61)
	PO_2/FiO_2	285.13 (114.26-579.31)

Table 1. Demographic Characteristics, Presenting Complaints, Vital Findings, Comorbid Diseases and Laboratory Values of Patients.
SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, MAP: Mean Arterial Pressure, RR: Respiratory Rate, HR: Heart Rate, SpO2: Oxgne Saturation, AST: Aspartate Aminotransferase, ALT: Alanine Aminotransferase, CRP: C- Reactive Protein, WBC: White Blood Cell Count, NEU: Neutrophil, NLR: Neutrophil to Lymphocyte Ratio, HCO3: Bicarbonate, FiO2: Fraction of Inspired Oxygen

patients with mild involvement, 25 (29.4%) of 85 patients with moderate involvement and 22 (57.9%) of 38 patients with severe involvement (p<0.001). Of the 160 patients, 75 (46.9%) were admitted to the ward and 85 (53.1%) to the intensive care unit. In 5 (6.7%) of 75 patients hospitalised in the ward, clinical deterioration occurred during the follow-up period, and these patients were transferred to intensive care unit. While the average age of the patients who were followed in the ward was 65.68±19.33, the average age of the patients who were followed in the intensive care unit was calculated as 76.06±13.60. The average age of patients admitted to intensive care was significantly higher than that of patients admitted to the ward (p<0.001).

When the stated scoring values of the patients are examined, the median value of the SOFA score is 3 (Min: 0 - Max: 12), the median value of the qSOFA score is 2 (Min: 0 - Max: 3), the median value of the 4C- Mortality score is 14.5 (Min: 2 - Max: 21), the median value of CURB-65 score was calculated as 3 (Min: 1 - Max: 5).

When the patients were examined in terms of 30-day mortality, it was seen that 50 (32.3%) patients developed mortality during their follow-up. While the mean age of patients who did not develop mortality during follow-up was 68.05±18.20, the mean age of patients who developed mortality was 78.12±12.69. The mean age of patients who developed mortality was significantly higher than those who did not (p<0.001). Mortality was observed in 20 of 81 female patients (24.7%) and in 30 of 79 male patients (38%) included in our study. When the patients were examined in terms of sex and 30-day mortality, although the mortality rate of male patients was high, no statistically significant difference was found (p = 0.070) (Table 2).

When the relationship between the existing comorbid diseases and the mortality status of the patients was evaluated, it was seen that patients with diabetes mellitus (p<0.001), coronary artery disease (p=0.009), and patients with a history of malignancy had a statistically more mortal course (Table 2).

The relationship between the laboratory values of the patients and mortality is shown in Table 2. Accordingly, in patients who develop mortality; creatinine (p=0.001), urea (p<0.001), direct bilirubin (p=0.002), total bilirubin (p=0.019), potassium (p=0.01), AST (p=0.002), CRP (p=0.015), white blood count (WBC) (p=0.004), hemoglobin (p=0.031), neutrophil-lymphocyte ratio (NLR) (p=0.014), lactate (p<0.001), base deficit (BE) (p<0.001) and FiO2 (p<0.001) values were found to be high. HCO3 (p<0.001) and pO2/FiO2 (p=0.001) values were found to be low in these patients.

When the relationship between patients' admission SOFA score and mortality was examined; it was observed that mortality occurred in 2 out of 22 (%9.1) patients with a SOFA score of 0-1, in 13 out of 73 (%17.8) patients with a score of 2-3, in 9 out of 28 (%32.1) patients with a score of 4-5, in 14 out of 21 (%66.7) patients with a score of 6-7, in 9 out of 12 (%75) patients with a score of 8-9, in 2 out of 3 (%66.7) patients with a score of 10-11, and in 1 out of 1 patient

(%100) in the group with a score of 12-14. A statistically significant difference was detected between SOFA score and mortality (p<0.001) (Table 3).

	Mortality Group	Survival Group	P values
Gender*			
Female	20 (24.7)	61 (75.3)	0.070
Male	30 (38)	49 (62)	
Age (years)*			
<65	9 (20.5)	35 (79.5)	0.070
≥65	41 (64.7)	75 (35.3)	
Vital Findings**			
SBP (mmHg)	109 (50-253)	119 (65-213)	0.177
DBP (mmHg)	67 (30- 153)	73.50 (32- 116)	0.082
MBP (mmHg)	81.66 (36,67- 186,33)	87.83 (43- 148,33)	0.094
RR (n/min)	25.5 (17- 39)	23 (15- 32)	**<0.001**
HR (/min)	107 (60 – 140)	105 (57- 156)	**0.026**
Temperature (C°)	37.6 (36,1-39)	37.6 (36.2- 40.0)	0.549
SpO_2 (%)	90.5 (66- 98)	94 (70- 100)	**<0.001**
Comorbid Factors*			
Diabetes mellitus	27 (48.2)	29 (51,8)	**<0.001**
Cerebral vascular disease	13 (41.9)	18 (88.1)	0.225
Hypertension	28 (31.5)	61 (68.5)	0.949
Cardiovascular disease	30 (42.9)	40 (57.1)	**0.009**
Chronic renal failure	5 (31.3)	11 (68.7)	1
Chronic pulmonary disease	13 (41.9)	18 (58.1)	0.225
Asthma	2 (13.3)	13 (86.7)	0.201
Malignancy	17 (63)	10 (37)	**<0.001**
GCS*			
15	38 (52.1)	35 (47.9)	**<0.001**
≤14	12 (13.8)	75 (86.2)	
Laboratory Parameters**			
Glucose (mg/dL)	142.95 (62-417)	127 (58-458)	0.428
Creatinine (mg/dL)	1.26 (0.26-9.1)	0.93 (0.3-9.45)	0**.001**
Urea (mg/dL)	84.3(15.2-386)	47.4 (11.6-560)	<**0.001**
Direct Bilirubin (mg/dl)	0.2 (0.04-2.58)	0.13 (0.02-1.29)	**0.002**
Total Bilirubin (mg/dl)	0.61 (0.21-8.13)	0.56 (0.3-1.91)	**0.019**
Na (mmol/L)	136 (125-156)	136(107-165)	0.208
K (mmol/L)	4.35 (3.1-6.7)	4.1 (3.1-5.9)	**0.01**
AST (U/L)	35.6 (8.5-1586)	25.95 (10.9-549)	**0.002**
ALT (U/L)	18.15 (4.5-956)	15,1 (2,6-305)	0.211
CRP (mg/L)	95.1 (7.7-511)	78.45 (0.5-457)	**0.015**
WBC (10^3/µL)	10.9 (0.4-45.1)	8.4 (2.6-55.7)	**0.004**
NEU (10^3/µL)	9.45 (0.1-26.3)	6.3 (1.57-26.5)	0.001
HB (g/dL)	10.85 (6-16.6)	11.75 (6.8-17.2)	**0.031**
LYM (10^3/µL)	1.01 (0.1-17.3)	1.02(0.27-20)	0.489
PLT (10^3/µL)	212 (58-783)	224.5 (88-856)	0.941
NLR	8.75 (0.5-88.5)	6.08 (0.64-46.5)	**0.014**
PH	7.36 (6.78-7.51)	7.38 (7.1-7.56)	0.112
pCO_2 (mmHg)	40 (24.6-102)	40(30,2-100)	0.52
pO_2 (mmHg)	95.1 (69.9-220)	100 (69.7-168)	0.255
Lactate (mmol/L)	2.35 (0.8-19)	1.5 (0.5-11.9)	**<0.001**
Base deficit	-2 (-31-8.8)	1.25 (11.3-14.6)	**<0.001**
HCO_3 (mmol/L)	22.35 (3.7-34.5)	25,3 (14.7-38.6)	**<0.001**
FiO_2	45 (21-61)	33 (21-61)	**<0.001**
pO_2/FiO_2	251 (129.34-457)	306(114.26-579.31)	**0.001**

Table 2. The Relationship of Patients' Gender, Vital Findings, Comorbid Factors and Laboratory Parameters with Mortality.
*: n (%), **: median (minimum-maximum), SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, MAP: Mean Arterial Pressure, RR: Respiratory Rate, HR: Heart Rate, SpO2: Oxygen Saturation, Na: Sodium, K: Potassium, AST: Aspartate Aminotransferase, ALT: Alanine Aminotransferase, WBC: White Blood Cell Count, NEU: Neutrophil, HB: Hemoglobin, NLR: Neutrophil to Lymphocyte Ratio, HCO3: Bicarbonate, FiO2: Fraction of Inspired Oxygen CRP: C- Reactive Protein, CVD: Cerebral Vascular Disease, CPD: Chronic Pulmonary Disease, CRF: Chronic Renal Failure, GCS: Glasgow Coma Scale

When the relationship between patients' qSOFA scores at admission and mortality was examined, it was observed that mortality occurred in 2 out of 20 patients (10%) with a score of 0, in 7 out of 53 patients (13%) with a score of 1, in 25 out of 59 patients (42.4%) with a score of 2, and in 16 out of 27 patients (59.3%) with a score of 3. Mortality rates were found to be statistically higher in patients with high qSOFA scores (p<0.001) (Table 3).

When the relationship between patients' CURB-65 scores and mortality was examined, it was observed that mortality occurred in 4 out of 21 patients (19%) with a score of 0-1, in 5 out of 55 patients (9.1%) with a score of 2, and in 41 out of 84 patients (48.8%) with a score of 3 or higher. A statistically significant relationship was detected between CURB-65 score and mortality (p<0.001) (Table 3). When the relationship between patients' 4C Mortality Score and mortality was examined, it was observed that mortality did not occur in any of the 5 patients with scores of 0-3 points, while mortality occurred in 1 out of 19 patients (5.3%) with scores of 4-8 points, in 11 out of 56 patients (19.6%) with scores of 9-14 points, and in 38 out of the remaining patients (47.5%). A statistically significant relationship was detected between the 4-C Mortality score and mortality (p<0.001) (Table 3).

When the correlation between SOFA, qSOFA, CURB-65, and 4C-Mortality scores and mortality was examined, a moderate positive correlation was detected between all these scores and mortality (p<0.001; for each) (Table 4).

In predicting 30-day mortality in COVID-19 patients, ROC curve analysis was used to determine the optimal cut-off values for the SOFA, qSOFA, CURB-65, and 4C mortality scoring systems. SOFA >2 predicted mortality with 70% sensitivity and 72.73% specificity (area under the curve: 0.765, 95% CI: 0.691-0.828, P < 0.001). qSOFA >1 predicted mortality with 82% sensitivity and 59.09% specificity (area under the curve: 0.705, 95% CI: 0.628-0.775, P < 0.001). CURB-65 >3 predicted mortality with 82% sensitivity and 60.91% specificity (area under the curve: 0.730, 95% CI: 0.654-0.797, P < 0.001). 4C-Mortality Score >3 predicted mortality with 76% sensitivity and 61.82% specificity (area under the curve: 0.708, 95% CI: 0.631-0.778, P < 0.001) (Table 5, Figure 1).

Scoring Systems	Correlation with Mortality	
	r	p values
SOFA	0.480	<0.001
qSOFA	0.382	<0.001
CURB-65	0.374	<0.001
4C Mortality	0.354	<0.001

Table 4. Correlation Analysis of Scoring Systems with Mortality

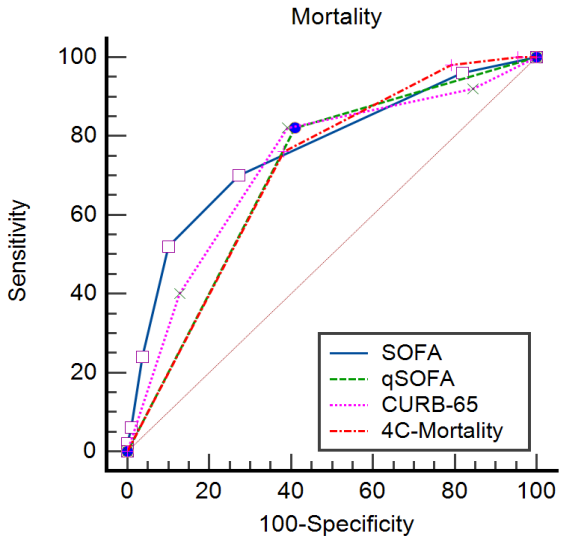

Figure 1. ROC Curve of the Relationship Between Scoring Systems and Mortality

	Cut-off value	AUC (95%CI)	Sensitivity (%)	Specificity (%)	+LR	-LR	p value
SOFA	>2	0.765 (0.691-0.828)	70	72.73	2.57	0.41	<0.001
qSOFA	>1	0.705 (0.628- 0.775)	82	59.09	2	0.30	<0.001
CURB-65	>3	0.730 (0.654-0.797)	82	60.91	2.1	0.30	<0.001
4C Mortality	>3	0.708 (0.631-0.778)	76	61.82	1.99	0.39	<0.001

Table 5. ROC Analysis Results of the Relationship between Patients' Scoring Systems and Mortality
AUC: Area under the curve, LR: Likelihood ratio

Discussion

The results of our study showed that In COVID-19 patients, SOFA, qSOFA, CURB-65, and 4C-Mortality scores are effective and useful scoring systems to show 30-day mortality. SOFA score >2 predicted mortality with 70% sensitivity and 72.73% specificity; qSOFA >1 predicted mortality with 82% sensitivity and 59.09% specificity; CURB-65 >3 predicted mortality with 82% sensitivity and 60.91% specificity; and 4C-Mortality Score >3 predicted mortality with 76% sensitivity and 61.82% specificity. Additionally, a moderate positive correlation was detected between these scoring systems and mortality in COVID-19 patients. To our knowledge, this is the first study to investigate the relationship between mortality and these four scoring systems in COVID-19 patients together.

A previous study reported that a SOFA score of ≥2 in COVID-19 patients indicates severe COVID-19 infection with 85.2% sensitivity and 80.4% specificity. In the same study, it was shown that a SOFA score of ≥5 was a strong indicator for 60-day mortality in COVID-19 patients (15). Another study reported that SOFA and qSOFA scores are strong indicators of in-hospital mortality in COVID-19 patients (18). In another study investigating the effectiveness of SOFA and qSOFA scores in predicting prognosis in COVID-19 patients, it was reported that ≥5 SOFA scores and ≥1 qSOFA scores are strong indicators of mortality (19). In our study, both SOFA

and qSOFA scores were found to be significantly higher in patients with mortality. Additionally, it was observed that there was a moderate positive correlation between these two scoring systems and mortality. Our findings support the literature.

In a study investigating predictive factors in 540 previously confirmed COVID-19 patients, it was reported that the CURB-65 score is an independent predictor of disease severity and mortality (20). It has also been shown that the CURB-65 scoring system is a stronger indicator than other pneumonia scoring systems in showing mortality in 257 hospitalized COVID-19 patients (21). In another study published in 2022, which investigated prognostic factors in COVID-19 patients, it was reported that high SOFA scores and CURB-65 scores are strong indicators of mortality (22). The findings of this study also show that In COVID-19 patients, a high CURB-65 score is an indicator of 30-day mortality. Our findings are consistent with the literature.

4C Mortality score is a system prepared to predict mortality in COVID-19 patients as very high, high, medium, and low risk of death. In a study conducted by Knight et al., the 4C Mortality score performed better than existing scores in hospitalized patients. It was stated that it could assist the clinician in the clinical management of patients hospitalized with COVID-19 (23). In a retrospective observational study conducted by Covino et al. with 210 COVID-19 patients, the early prediction performances of NEWS, COVID-GRAM, 4C Mortality score, and qCSI scoring systems were compared. The 4C Mortality score has been shown to have the best performance (24). In another previous study that included 1853 COVID-19 patients, it was reported that a 4C Mortality Score >8 predicts mortality with 80% sensitivity and 58% specificity (9). In our study, consistent with the literature, it is seen that the 4C Mortality score is significantly higher in patients who died. This scoring system can help the clinician predict the severity of the disease in COVID-19 patients.

Since the early days of COVID-19, numerous studies have been conducted to predict the severity of the disease and mortality. In these studies, it has been reported that patients of older age and male gender have more severe COVID-19 infections with higher mortality (3, 4). Our findings are similar to the literature. Again, previous studies have reported that patients with comorbid factors such as diabetes mellitus, coronary artery disease, hypertension, arrhythmia history, and malignancy history have more severe and fatal COVID-19 infection (3-6). In our study, supporting the literature, it was observed that the mortality of patients with diabetes mellitus, coronary artery disease, and a history of malignancy was higher.

In many previous studies, laboratory parameters indicating the severity and mortality of COVID-19 infection were studied (3-7, 11-14,25). In our study, consistent with the literature, we found that high creatinine, urea, total/direct bilirubin, potassium, AST, CRP, WBC, NLR, lactate and base deficit, and low HCO3 and Po2/FiO2 were associated with mortality in COVID-19 patients.

Limitations

One of the main limitations of the study is that it was conducted in a single center. In addition, the relatively low number of patients stands out as an important limitation.

Conclusion

In COVID-19 patients, SOFA, qSOFA, CURB-65, and 4C-Mortality scores were found to be significantly higher in deceased patients. Additionally, it was observed that there was a moderate positive correlation between these scoring systems and mortality. SOFA, qSOFA, CURB-65, and 4C-Mortality scores can be used as prognostic markers in COVID-19 patients.

Conflict of Interest: The authors declare that there is no conflict of interest.

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Authors' Contribution: YC: Planning/design of the study, data collection, writing. **MY (2):** Planning/design of the study, analysis/interpretation, data collection, writing, review and correction. **MO:** Planning/design of the study, analysis/interpretation, writing. **MG:** Planning/design of the study, writing, review and correction. **VVÇ:** Data collection, review and correction. **AY:** Analysis/interpretation, data collection, review and correction. **ŞHA:** Analysis/interpretation, data collection, review and correction. **MY (8):** Planning/design of the study, writing, review and correction. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Ethical Approval: This retrospective study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Local Ethics Committee approved this study. The study received approval from the Samsun Education and Research Hospital Scientific Research Ethics Committee permission dated 23.03.2022 and numbered BAEK/2022/4/2.

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