Black Sea Journal of Health Science
doi: 10.19127/bshealthscience.1109017

Open Access Journal
e-ISSN: 2619 – 9041

Research Article
Volume 5 - Issue 3: 430-437 / September 2022

EFFECT OF APACHE-II AND THE AGE-ADJUSTED CHARLSON COMORBIDITY INDEX AT PREDICTING MORTALITY IN PATIENTS WITH COVID-19

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Abstract: The COVID-19 pandemic disproportionately affects patients with comorbidities. Comprehensive comorbidity assessment is important in establishing the risk stratification of patients with COVID-19 after hospital admission. In this study, our aim is to investigate the effectiveness of Acute Physiology and Chronic Health Assessment II (APACHE-II) and Age Adjusted Charlson Comorbidity Index (ACCI) in predicting mortality in COVID-19 patients admitted to the Intensive Care Unit (ICU). Patients aged >18 years who were admitted to the intensive care unit with the diagnosis of COVID-19 pneumonia in the Health Sciences University Bursa Yüksek İhtisas Training and Training Hospital between July 2021 and September 2021 were included in the study. The medical records of the patients were then scanned into the hospital automation system. Demographics, comorbidities, clinical features, laboratory parameters, APACHE-II score, treatments, and outcomes were recorded in a standard form. ACCI score was calculated from the data and recorded. The 276 patients analyzed were divided into two groups as surviving (n=129) and developing mortality (n=147). The mortality rate was 58.93%, mostly male (58%), median age 65 years, ACCI score 1 (IQR.3) and APACHE-II score 2 (IQR.8). There was no difference between the groups in terms of age, gender distribution and APACHI-II score (P= 0.519, P= 0.927, P= 0.364, respectively). The groups did not differ in terms of comorbidity except for chronic renal failure (CRF), and CRF was significantly higher in patients who developed mortality (P= 0.037). The ACCI score was found to be higher in patients who developed mortality (P= 0.034). Death risk; Those with an ACCI score of >2 were 2.26 times higher than those with an ACCI score of ≤2 (P= 0.021). The APACHI-II score did not differ between the groups in terms of mortality (P= 0.380). As a result, high ACCI score was found to be effective in predicting mortality. It could potentially be used to identify at-risk patients infected with COVID-19 and to predict their clinical status.

Keywords: COVID-19 pneumonia, Comorbidity, Index, APACHI-II score, Intensive care unit, Mortality

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Received: April 26, 2022
Accepted: May 17, 2022
Published: September 01, 2022

Cite as: Eminoglu S, Ozgunay SE. 2022. Effect of apache-ii and the age-adjusted Charlson comorbidity index at predicting mortality in patients with Covid-19. BSJ Health Sci, 5(3): 430-437.

1. Introduction

The coronavirus disease (COVID-19) that emerged in Wuhan, China in December 2019 spread rapidly due to its high contagiousness and was defined as a pandemic. Since then, total confirmed cases and deaths continue to rise worldwide. As of 25 April 2022, the World Health Organization (WHO, 2022) reported approximately 507,501,771 confirmed cases of COVID-19 globally, including 6,220,390 deaths (WHO, 2022).

In patients diagnosed with COVID-19; studies have been conducted to show the impact of clinical, demographic, laboratory, epidemiological and radiological characteristics on mortality (Li et al., 2020). Many descriptive observational studies have also found that patients with comorbidities are disproportionately affected by COVID-19 and are associated with poorer clinical outcomes (Christensen et al., 2020; Guan et al., 2020; Shanbhag et al., 2021). Therefore, comprehensive assessment of comorbidities for risk stratification of hospitalized patients with COVID-19 and accurate prediction of prognosis are important for clinical management and outcomes.

The age-adjusted Charlson comorbidity index (ACCI) evaluates age and 19 medical comorbidities to calculate the total score with a specific score assigned to each comorbid condition. ACCI is a simple and easily applicable scoring system for estimating the risk of death from comorbid disease (Charlson et al., 1987; Bannay et al., 2016). In recent studies on COVID-19 patients; the ACCI score has been stated to have an independent prognostic value, confirming its use to predict adverse outcomes in terms of COVID-19 disease severity and mortality (Richards et al., 2011; Ferroni et al., 2020).

Acute Physiology and Chronic Health Assessment II (APACHE-II) is a widely used assessment to predict disease severity and in hospital mortality in critically ill

patients in the intensive care unit (ICU) (Richards et al., 2011; Sun et al., 2017). It is a scoring system that helps predict mortality within 24 hours of admission ICU, using the patient's findings, various laboratory values, and acute and chronic diseases. There are many studies evaluating various organ functions and predicting mortality in COVID-19 patients using the APACHE-II score (Zou et al., 2020; Cheng et al., 2021).

In this study, we evaluated the effectiveness of the APACHE-II score and the ACCI, which shows comorbid burden of disease, in predicting the risk of death in patients with COVID-19 infection admitted to the ICU.

2. Materials and Methods

Patients under 18 years of age and missing data were excluded from the study. The clinical records of the patients were scanned retrospectively by entering the hospital automation system. Demographic data, comorbidities, clinical features, laboratory parameters, APACHE-II score, treatments and results were collected and recorded in a standard form. ACCI score was calculated from the available information and recorded.

A Shapiro-Wilk test was used to assess whether the variables followed normal distribution. Variables were reported as median (interquartile range) values. According to the normality test results, Mann Whitney U test was used to compare the study groups. Categorical variables were compared by Chi-square test and Fisher's exact test. In order to estimate the sensitivity and specificity of ACCI and APACHE-II scores for predicting the presence of mortality, receiver operator characteristic (ROC) curve analysis was performed. Logistic regression analysis was performed to determine the risk factors affecting mortality. SPPS (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) software was used for performing statistical analysis and type I error was accepted as 5%.

3. Results

There were 284 patients admitted with the diagnosis of COVID-19 infection in the ICU between 15 July 2021 and 15 September 2021. Data for 8 patients were insufficient for this study. Variables were recorded for a total of 276 patients, and the patients were divided into two groups: those who survived (n=129) and those who developed mortality (n=147) (Figure 1). The patients were mostly male (58%), median age 65 (57-74.7) years, median ACCI score of 1 (IQR.3) and APACHE-II score of 20 (IQR.8).

In terms of comorbidities, 44.6% of patients had hypertension (HT), 27.5% had diabetes mellitus (DM), 21.4% had coronary artery disease (CAD), 15.6% had chronic obstructive pulmonary disease (COPD),9.1% had heart failure (HF), 4.32% had chronic renal failure (CRF), and 3.6% had cerebrovascular disease (CVD). Eighty-eight (31.9%) of the patients came to the ICU intubated. 116 (42.03%) were intubated median 5(IQR.5) days after admission to ICU. The median length of stay in the total ICU was 10 (IQR, 8) days (Table 1).

The mortality rate was 58.93%. There was no difference between the groups in terms of age and gender distribution. It was determined that the ACCI score was higher in patients who developed mortality (P= 0.034). The APACHI-II score did not differ between the groups (P= 0.364). There was no difference between the groups in the distribution of comorbid diseases shown in Table 1, except for CRF. Chronic renal failure was observed at a rate of 6.70% in patients who developed mortality, and this result was significantly higher (P= 0.037).

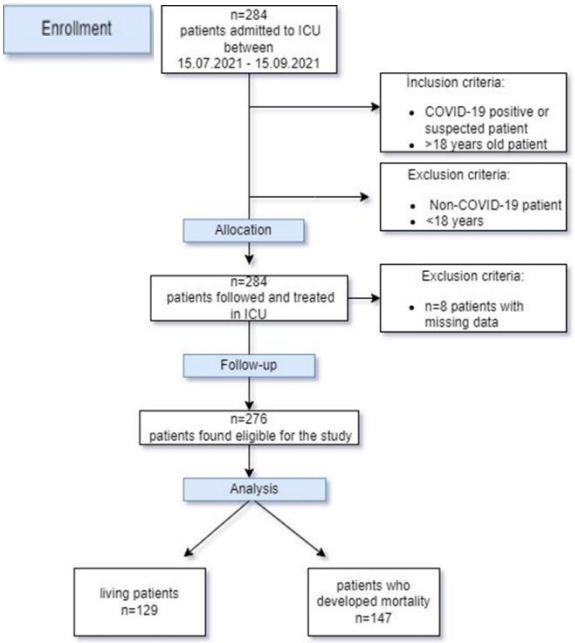

Figure 1. Flowchart of the study.

Coming to the intensive care unit intubated did not differ between patients who survived and those who developed mortality (P= 0.096). It was determined that among 116 patients who were intubated after coming to the ICU, the rates of intubation did not differ between patients who developed and survived mortality (P= 0.409). It was determined that 50 patients who were subsequently intubated in the mortality group were intubated on a median 4 (IQR,6) days when they came to the ICU and on a median 5 (IQR,4) days in the living group, and there was no difference between the groups in terms of the number of days of intubation in the ICU (P= 0.308). The length of stay in the ICU was longer in patients who developed mortality compared to those who survived (median 11 (IQR, 9.5) days, median 9 (IQR,6) days, P= 0.002, Table 1). The laboratory values of the patients who came to the ICU are shown in Table 1. There was no difference between the groups except for fibrinogen. Fibrinogen level was found to be significantly higher in patients with mortality (P= 0.019).

The distribution of treatments administered to patients in the ICU is shown in Table 2. Steroid treatment was used in 95.3% of the patients. There was no difference

between the groups in terms of all treatments used (P= 0.576, P= 0.109, P= 0.323, P= 0.458, P> 0.99, P= 0.358, "respectively). Vasopressor therapy, cytokine filter, Anakinra therapy, and dialysis application rates in the ICU were found to be significantly higher in patients who developed mortality than in patients who survived (P< 0.001, P= 0.008, P= 0.041, P= 0.014, respectively, Table 2).

Receiver operator characteristic (ROC) curve analysis was performed to estimate the sensitivity and specificity of ACCI for predicting the presence of mortality, and the cut-off point for ACCI was determined as >2. The area under the curve for ACCI was 0.58 (sensitivity 34.23%, specificity 77.95%, P= 0.031), showing that a CCI> 2 was significantly related to an increased risk of the presence of mortality (Figure 2). In our study, the ACCI score of 79 patients was >2, and the ACCI score of 197 patients was ≤2. The incidence of mortality was 64.60% (n=51) and 49.70% (n=98), respectively, and the mortality rate was found to be higher in the patient group with ACCI score >2 in the Univariate logistic regression model (P= 0.027, Table 3). However, in our study, the cut-off point could not be determined to predict the presence of mortality for the APACHE-II score. As a result of ROC analysis, it was determined that the area under the curve was not significant (AUC=0.53, P= 0.368).

Table 1. Demographic characteristics and comorbidities of the patients[§]

	Total (n=276)	Ex (n=149)	Survival (n=127)	p
Age (years), n (%)				
<50	39(14.10)	23(15.40)	16(12.60)	
50-59	47(17)	26(17.40)	21(16.50)	
60-69	87(31.50)	41(27.50)	46(36.20)	0.519[a]
70-79	63(22.80)	34(22.80)	29(22.80)	
≥80	40(14.50)	25(16.80)	15(11.80)	
Gender, n (%)				
Female	116(42)	63(42.30)	53(41.70)	0.927[a]
Male	160(58)	86(57.70)	74(58.30)	
ACCI, median	1(3), 1.83(±2.09)	1(3), 2.10(±2.28)	1(2), 1.50(±1.77)	0.034[b]
APACHE II, median	22(8)	22(8:39)	20(8:39)	0.364[b]
Comorbidity, n (%)	188(68.1)	98(52,1)	90(47.9)	0.365 [a]
HT	123(44.60)	62(41.60)	61(48)	0.285[a]
DM	76(27.50)	40(26.80)	36(28.30)	0.781[a]
CAD	59(21.40)	33(22.10)	26(20.50)	0.735[a]
CF	25(9.10)	15(10.10)	10(7.90)	0.527[a]
COPD	43(15.60)	23(15.40)	20(15.70)	0.943[a]
CVD	10(3.60)	5(3.40)	5(3.90)	>0.99[c]
CRF	12(4.30)	10(6.70)	2(1.60)	0.037[a]
Coming to ICU, n (%)				
Intubated	88(31.90)	55(62.50)	33(37.50)	0.052[a]
Not intubated	188(68.10)	94(50.00)	94(50.00)	
number of days intubated, median*	1(0)	1(0)	1(0)	0.978[a]
Intubation in ICU, n (%)	116(42,03)	66(44.30)	50(39.40)	0,409[a]
Intubation day in ICU, **median	5(5)	4(6)	5(4)	0,308[b]
Laboratory findings, median				
WBC	11.88(7.43)	12(7.53)	11.55(7.41)	0.820[a]
Lymphocyte	0.70(0.53)	0.65(0.55)	0.75(0.59)	0.132[a]
platelet	254(147)	241(165.50)	259(135)	0.225[a]
CRP	121.50(122.30)	116(122.15)	126(123.20)	0.450[a]
INR	1.08(0.34)	1.10(0.36)	1.08(0.33)	0.949[a]
Fibrinogen	598.50(442.30)	628(457)	574(377)	0.019[a]
D'Dimer	2.68(5)	2.57(5)	3(4)	0.618[a]
Ferritin	860.50(933)	893(881)	795(1030)	0.706[a]
LDH	561(401)	568(373)	561(433)	0.667[a]
Number of days of hospitalization in ICU, median	10(8)	11(9.50)	9(6)	0.002[a]

[§]Data were reported as median (interquartile range), mean (± standard deviation) or n (%).
*It was calculated on n=88 patients who came to the ICU as intubated.
**It was calculated on n=116 patients who were intubated after coming to the ICU. [a]Chi-square Test, [b]Mann-Whitney U Test, [c]Fisher's Exact Test

Table 2. Distribution of treatments applied to patients

n(%)	Total (n=276)	Ex (n=149)	Survival (n=127)	p
ICU hospitalization oxygen requirement				
Intubated	88(31.90)	55(36.90)	33(26.00)	
HFO	130(47.10)	65(43.60)	65(51.20)	
CPAP	32(11.60)	15(10.10)	17(13.40)	0.323[a]
O_2 mask with reservoir	13(4.70)	8(5.40)	5(3.90)	
Nasal oxygen	13(4.70)	6(4.00)	7(5.50)	
Steroid use in the ICU	263(95.30)	141(94.60)	122(96.10)	0.576[a]
Steroid Given in ICU				
Methylprednisolone	210(76.10)	106(71.10)	104(81.90)	
Dexamethasone	53(19.20)	35(23.50)	18(14.20)	0.109[a]
None	13(4.70)	8(5.40)	5(3.90)	
Steroid Dose*				
1000 mg	27(10.30)	10(7.10)	17(13.90)	
500 mg	6(2.30)	4(2.80)	2(1.60)	
250 mg	104(39.50)	52(36.90)	52(42.60)	
120 mg	12(4.60)	5(3.50)	7(5.70)	
80 mg	49(18.60)	26(18.40)	23(18.90)	
40 mg	2(0.80)	1(0.70)	1(0.8)	
20 mg	8(3)	6(4.30)	2(1.60)	
8 mg	38(14.40)	26(18.40)	12(9.80)	
6 mg	14(5.30)	9(6.40)	5(4.10%)	
4 mg	3(1.10)	2(1.40)	1(0.80)	
ICU vasopressor therapy	176(63.80)	130(87.2)	46(36.20)	<0.001
Cytokine filter	8(2.90)	8(5.40)	0	0.008[c]
Immunoplasma therapy	7(2.54)	5(3.40)	2(1.60)	0.458[c]
Kaletra	7(2.54)	4(2.70)	3(2.40)	>0.99[c]
Ritonavir/ Lopinavir	9(3.26)	8(5.40)	1(0.80)	0.041[c]
Dialysis	26(9.42)	20(13.40)	6(4.70)	0.014[a]
Need for plasmapheresis	36(13.04)	22(14.80)	14(11.0)	0.358[a]

[§]Data were reported as n (%). HFO= high flow oxygen, CPAP= continuous positive airway pressure.
*It was calculated on n=263 patients given steroids. [a]Chi-square Test, [c]Fisher's Exact Test

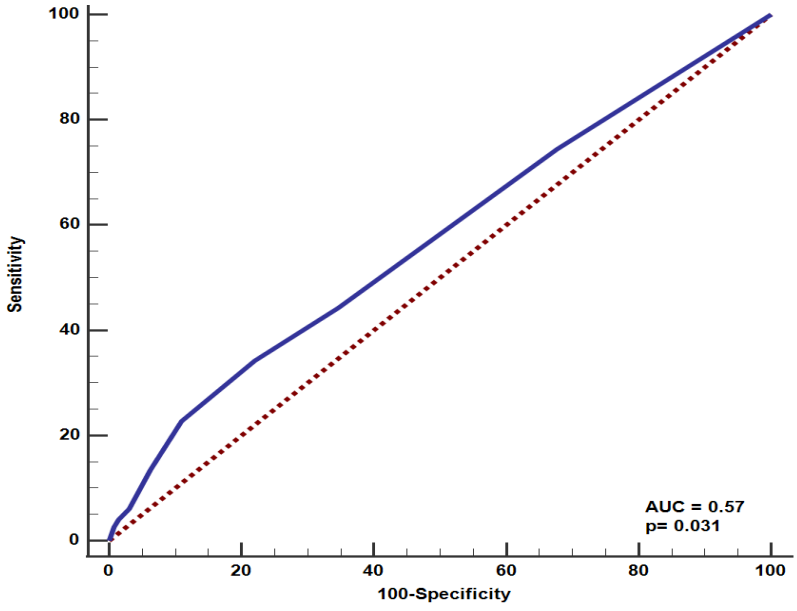

Figure 2. Receiver-operator characteristic (ROC) curves for determining the presence of mortality. The area under the curve (AUC) for Charlson Comorbidity Index is 0.58 with P= 0.031.

Logistic regression analysis was performed to determine the factors affecting the development of mortality and the results are presented in Table 3. Variables were first tested with univariate logistic regression analysis and variables satisfying the P< 0.20 condition were included in the multivariate logistic regression model. The regression model created as a result of the analysis was found to be significant (P< 0.001) and it was determined that the data set was compatible with the regression model (P= 0.147). When Table 3 is examined; It was determined that the risk of mortality in patients with a CCI score of >2 was 2.26 times higher than in the CCI≤2 patient group. Again, it was determined that the risk of mortality in patients with a need for vasopressors was 12.48 times higher than in patients without a need for vasopressors. It was determined that the patient's length of stay in the ICU, the presence of CRF, the patient's intubated admission to the ICU, and the patient's dialysis did not affect mortality.

Table 3. Identification of risk factors affecting mortality development

	Univariate LRM			Multivariate LRM		
	Wald	OR(95%CI)	p	Wald	OR (95%CI)	p
Age (years)						
<50	0.12	0.86(0.37:2.03)	0.733			
50-59	1.50	0.62(0.29:1.33)	0.220			
60-69	0.25	0.82(0.36:1.83)	0.621			
70-79	0.10	1.16(0.47:2.86)	0.748			
ICU hospitalization period	8.28	1.06(1.02:1.10)	0.004	2.02	1.03(0.99:1.09)	0.156
HT (presence)	1.14	0.77(0.48:1.24)	0.285			
DM (presence)	0.08	0.93(0.55:1.58)	0.781			
CAH (presence)	0.11	1.11(0.62:1.98)	0.735			
KY (presence)	0.40	1.31(0.57:3.03)	0.528			
COPD & ASTHMA (presence)	0.01	0.98(0.51:1.88)	0.943			
SVO (presence)	0.07	0.85(0.24:2.99)	0.797			
CRY (presence)	3.67	0.22(0.05:1.04)	0.055	2.26	4.14(0.65:26.36)	0.132
Arrival in ICU (intubated)	2.75	1.56(0.92:2.65)	0.097	0.62	1.27(0.37:2.40)	0.472
lymphocyte	0.46	0.89(0.63:1.25)	0.496			
D-dimer	0.80	1.02(0.98:1.07)	0.370			
LDH	0.92	1(0.99:1.01)	0.337			
APACHE II	0.77	1.02(0.98:1.06)	0.380			
CCI (>2)	4.92	1.84(1.07:3.15)	0.027	5.29	2.26(1.13:4.53)	0.021
Steroid Use (Presence)	0.31	0.72(0.23:2.27)	0.577			
Need for vasopressors (Presence)	65.62	12.05(6.60:22)	<0.001	58.08	12.48(6.51:23.89)	<0.001
Cytokine Filter (Presence)	<0.1	-	>0.99			
Immunoplasma therapy (Presence)	0.84	2.17(0.41:11.38)	0.359			
Kaletra (Presence)	0.03	1.14(0.25:5.19)	0.865			
Dialysis (Presence)	5.59	0.32(0.12:0.82)	0.018	3.12	2.70(0.90:8.10)	0.077
Need for plasmapheresis (Presence)	0.84	1.40(0.68:2.86)	0.359			
Kaletra (Presence)	0.03	1.14(0.25:5.19)	0.865			

LRM= logistic regression model, OR= odds ratio, CI= confidence interval

4. Discussion

The mortality rate was high in patients with COVID-19 infection admitted to the ICU. The ACCI total score was significantly higher in patients with mortality, and the risk of mortality in patients with ACCI score >2 was 2.26 times higher than in the ACCI ≤2 patient group. The APACHI-II score did not differ between the groups with regard to mortality. The ACCI score was independently associated with mortality and outperformed the APACHE-II score in predicting hospital mortality in COVID-19 patients.

Mortality developed in 147 of 276 COVID-19 patients admitted to the ICU in our study. Multiple risk factors associated with mortality and disease severity have been reported in the literature. Many studies have shown that age, male gender, and comorbidities are predictors of mortality (Imam et al., 2020; Abate et al., 2020; Fang et al., 2020; Pérez et al., 2020). Perez et al. associated with a higher risk of death age ≥ 65 years at patients COVID-19. In our study, patients admitted to the ICU were mostly male (58%). The age of the patients ranged from 25 to 92 years, the median age was 65 years. However, contrary to these studies, the mortality outcomes of the disease in our study were similar between age and gender.

Many studies have reported that patients with comorbidities are affected by COVID-19 at varying rates and are associated with worse clinical outcomes (Imam et al., 2020; Abate et al., 2020; Fang et al., 2020; Pérez et al., 2020; Zhou and Fan, 2021). Abate et al.in a systematic review and meta-analysis in which they evaluated ICU admission rate and outcomes among coronavirus patients; revealed that the rate of comorbidity was 66% in 12 studies and 59% in 10 studies. In our study, the comorbidity rate at ICU admission was 68.1%, and the most common were HT, DM, CHD, COPD, heart failure, CKD, and CVO. Our findings were consistent with studies in the literature. In our study, when the distribution of comorbid diseases according to the groups was examined, there was no difference between the groups except for CRF. Although the frequency of CRF was 4.32%, it was seen in 6.70% of patients who developed mortality and this result was significantly higher. Fang et al. In their systematic review and meta-analysis of COVID-19 patients, they stated that CRF mostly contributed to death, similar to our study, and that the cause was an immunological condition due to a weakened immune system in patients with CRF. Again in our study, the rate of dialysis application was significantly higher in patients with COVID-19 who developed mortality compared to those who survived. This situation also coincided with comorbidity.

Early detection of COVID-19 patients whose condition will progress to serious illness is of great importance. For this purpose, various scoring and evaluation systems have been used in many studies. Of these, the Charlson comorbidity index has been reported as an important prognostic marker (Bannay et al., 2016; Christensen et al., 2020; Imam et al., 2020; Shanbhag et al., 2021; Sabaz and Aşar, 2021). It is a simple and easy scoring system that evaluates the total comorbidity burden. ACCI, which was developed considering the effect of age on mortality, has been used to estimate mortality in patients with COVID-19 (Kim et al., 2021). Kim et al. found the median ACCI 2 for their nationwide cohort of COVID-19. In a multivariate Cox proportional analysis for mortality, they found a higher risk of mortality in patients with CCIS ≥3 (OR, 22.96 [95% CI 7.20-73.24]), and reported that ACCI was the best predictor for severe clinical outcome in COVID-19. Kuswardhani et al. (2020) in their systematic review and meta-analysis, a high CCI score was associated with increased mortality and disease severity in COVID-19 patients, and they reported a 16% increase in mortality for each increase in the CCI score. Varol et al. (2020) in their studies in which they investigated the effect of CCI on mortality in patients infected with SARS-CoV-2 virus; found a median CCI score of 1 (0-11) in the cohort and reported that patients with a CCI score >2.5 (OR = 10.7; 95% CI 4.5-25.6) had a 10.7-fold higher risk of mortality than those with ≤2.5. In our study, the median ACCI score was 1 (IQR,3). In the multivariate logistic regression analysis, we determined that the risk of mortality in patients with ACCI >2 (OR=2.26; 95%CI 1.13:4.53, P= 0.021) was 2.26-fold higher than in the CCI≤2 patient group. The low rate compared to other studies can be explained by the fact that the patient populations are much larger than in our study. In conclusion, the effect of ACCI on predicting mortality in our study was similar to the literature.

Another widely used evaluation system in the literature for COVID-19 patients is the APACHE-II scoring system (Zou et al., 2019; Cheng et al., 2021; Chen et al., 2021). Zou et al. (2019) in their study on the effect of 3 scoring systems (APACHE-II, SOFA and CURB65) on predicting mortality in patients with COVID-19, they showed that the APACHE-II score was independently associated with hospital mortality and was better in predicting mortality compared to the other two scoring systems. They reported that an APACHE-II score of ≥17 is an early warning indicator of mortality. Cheng et al. found a median APACHE-II score of 17 in their study, in which they evaluated the severity and mortality of COVID-19 pneumonia with different scores, and stated that the APACHE-II score was a strong predictor of COVID-19 pneumonia severity and mortality. Chen et al. evaluated the performance of CURB-65, PSI, and APACHE-II to predict COVID-19 pneumonia severity and mortality. Contrary to previous studies, they stated that the sensitivity of an APACHE-II score of ≥11 was low and should be used with caution. In our study, the median APACHE-II score was 22. However, there was no difference in mortality between the groups. Similar to the results of our study, Plotnikow et al. (2020) and Yang et al. (2020) reported in their study that the APACHE-II score failed to distinguish the severity of the patients, and they could not find any difference between patients who developed and survived mortality. The reason for the failure of the APACHE-II score to predict mortality; It may be that COVID-19 patients are accompanied by various comorbidities, but there is no scoring for comorbidities in the APACHE-II score.

Angiotensin converting enzyme (ACE) is an enzyme bound to the membranes of cells in the lungs, arteries, heart, kidneys, and intestines. It plays an important role in the regulation of blood pressure (Fang et al., 2020). ACE is also the binding site of the COVID-19 virus (Pérez et al., 2020). Excretion takes place via the kidneys. In our study, CRF was more common in patients who developed mortality. Again in the multivariate logistic regression model, it was determined that the risk of mortality in patients with a need for vasopressors was 12.48-fold higher than in patients without a need for vasopressors. The reason for this result may be the decreased excretion of ACE through the kidneys and the negative effects of common comorbidities such as HT, DM and HF on the vessels.

Sabaz and Aşar (2021) in their study evaluating the relationship between mortality and different scoring systems in COVID-19 patients in the ICU, they found that the duration of stay in the ICU was significantly longer in patients who survived than those who developed

mortality. Contrary to this study, in our study, the duration of stay in the ICU was found to be significantly longer in those who developed mortality compared to those who survived. However, in the logistic regression analysis performed to determine the factors affecting the development of mortality, the length of stay in the ICU, the presence of CRF, the patient's admission to the ICU as intubated, and the application of dialysis to the patient were not effective on mortality.

Our study had several limitations. This study was single-center, retrospective, and had a relatively small sample size. Therefore, there may be other unidentified independent predictors of mortality. Treatment protocols were not uniform, as they had been constantly evolving since the beginning of the pandemic. The effects of this condition on the prognosis of the patients were uncertain. Also, when calculating ACCI, the researchers were not blinded to the result because they had to access data from patients' medical records.

5. Conclusion

In conclusion, in this study, the authors showed that approximately one in two COVID-19 patients admitted to the ICU developed mortality. Their found an independent association between higher ACCI scores and the mortality rate. Because ACCI assesses total comorbidity burden and age at ICU admission, its potential use in identifying at-risk patients infected with COVID-19 and estimating their clinical status is recommended. It is thought that it can contribute to the intensive care planning and treatment of risky patients in clinical practice.

Author Contributions

Concept: S.E. (50%) and S.E.O. (50%), Design: S.E. (50%) and S.E.O. (50%), Supervision: S.E. (50%) and S.E.O. (50%), Data collection and/or processing: S.E. (50%) and S.E.O. (50%), Data analysis and/or interpretation: S.E. (50%) and S.E.O. (50%), Literature search: S.E. (50%) and S.E.O. (50%), Writing: S.E. (50%) and S.E.O. (50%), Critical review: S.E. (50%) and S.E.O. (50%), Submission and revision S.E. (50%) and S.E.O. (50%). All authors reviewed and approved final version of the manuscript.

Conflict of interest

The authors declared that there was no potential conflict of interest related to the research, authorship, and/or publication of this article.

Ethical Approval/Informed Consent

This study was approved by the Department of Health COVID-19 Scientific Research Evaluation Board and the local Ethics Committee (2011-KAEK-25 2021/07-19). In accordance with the principles of the Declaration of Helsinki, it was conducted at University of Health Science Bursa Yuksek Ihtisas Training and Education hospital between July 2021 and September 2021. Patients admitted to the ICU and diagnosed with confirmed or probable COVID-19 pneumonia according to the guidelines of the Ministry of Health Scientific Committee (2021) (bilgi.saglik.gov.tr) were included in this retrospective study.

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