


Comorbidities associated with risk of ICU admission in elderly patients with COVID-19

Data from academic hospital in Saudi Arabia

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Abstract

The coronavirus disease 2019 (COVID-19) has affected millions of people worldwide, of which 5% required intensive care, especially mechanical ventilation. The prognosis depends on several factors including comorbidities. This study was conducted to identify the comorbidities associated with the intensive care unit (ICU) admission in elderly with COVID-19 admitted to a tertiary academic hospital. A retrospective cross-sectional study was conducted at KSUMC including all hospitalized patients (age \geq 65 years) with laboratory-confirmed severe acute respiratory syndrome coronavirus 2 infection admitted between March 2020 and August 2021. Data collection included sociodemographic characteristics, underlying comorbidities, and the Charlson comorbidity index. Comorbidities were compared between the elderly patients with COVID-19 admitted to the ICU and those not admitted to the ICU. The odds ratios were calculated and a P value of $< .05$ and 95% confidence intervals were used to report the statistical significance. A total of 444 patients (ICU = 147, non-ICU = 297) were included in the study. The study revealed that elderly patients with COVID-19 admitted to ICU had a higher rate of mortality ($n = 64$, 67.4%; $P < .0001$) and a higher proportion of them had shortness of breath ($n = 97$, 38.3%; $P = .007$) compared to the elderly patients not admitted to ICU. The mean length of stay ($P < .0001$), and weight ($P = .02$) among ICU patients were higher than the values for the non-ICU group, while the mean oxygen saturation (SpO₂; $P = .006$) was lower among the ICU group. The comorbidities that demonstrated a statistically significant association with ICU admission were heart failure ($P = .004$, odd ratio (OR) = 2.02, 95% confidence intervals (CI) [1.263, 3540]), chronic obstructive pulmonary disease (COPD; $P = .027$, OR = 3.361, 95% CI [1.080, 10.464]), and chronic kidney disease ($P = .021$, OR = 1.807, 95% CI [1.087, 3.006]). The current study identified that the comorbidities such as COPD, heart failure, and factors like SpO₂ and length of stay are associated with an increased risk of ICU admission in elderly patients with COVID-19. These findings highlight the clinical implications of comorbidity among geriatric population.

Abbreviations: ACE2 = angiotensin-converting enzyme 2, CCI = Charlson comorbidity index, CI = confidence intervals, CKD = chronic kidney disease, COPD = chronic obstructive pulmonary disease, COVID-19 = coronavirus disease 2019, ICU = intensive care unit, KSUMC = King Saud University Medical City, OR = odd ratio, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2, SpO₂ = oxygen saturation.

Keywords: comorbidities, Coronavirus disease 2019 (COVID-19), elderly, intensive care unit (ICU)

1. Introduction

The coronavirus disease 2019 (COVID-19) is a novel disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The transmission route of the virus is through air droplets. The first case was recorded in Wuhan, China, in December 2019, causing millions of deaths worldwide.^[1] On March 11, 2020, the World Health Organization announced it as a pandemic.^[2] The disease spread dramatically until it became

an ongoing pandemic, causing considerable challenges and substantial harm to over 200 countries and regions worldwide. Clinical manifestations of COVID-19 may present with fever, headache, cough, expectoration, breathing difficulties, fatigue, pharyngalgia and loss of taste and smell.^[3]

The current management of COVID-19 is generally based on supportive therapy to prevent respiratory failure. However, increasing evidence indicates that many patients with COVID-19 are asymptomatic or have only mild symptoms but can

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request. All the data can be provided on request.

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transmit the virus to others.^[4] Moreover, patients with COVID-19 can present with different clinical symptoms depending upon varied factors. For instance, young and middle-aged patients are, most often, asymptomatic with no underlying comorbidities.^[5] However, elderly people are at greater risk of severe COVID-19 due to increased risk of comorbidities and cognitive decline in old age, resulting in long-term neuropsychiatric and cognitive deficits.^[6,7] The exact mechanism underlying these deficits is unknown, but they seems to be multifactorial.^[8]

It has been studied that comorbidities such as diabetes mellitus, hypertension, asthma, chronic kidney disease (CKD), heart failure, chronic obstructive pulmonary disease (COPD), and malignancies and human immunodeficiency virus are associated with the increased risk of intensive care unit (ICU) admission and mortality among the elderly patients suffering from COVID-19.^[9] Of these comorbidities, diabetes, hypertension and coronary heart disease are the most frequently encountered among COVID-19 patients.^[10] It has been suggested that impaired immune response with T-cell dysfunction and elevated interleukin-6 plays key role in the pathogenesis and severity of COVID-19 among diabetic patients.^[11] Moreover, risk of ICU admission among diabetic patients with COVID-19 is 14.2% than those without diabetes.^[12]

Prevalence of hypertension reaches up to 80% among the elderly and has been associated with worse COVID-19 outcome in terms of mortality.^[13] Similarly, cardiovascular complications such as congestive heart failure, atrial fibrillation, pulmonary embolism and acute coronary syndrome are high among the elderly patients with COVID-19 which result in longer hospital stay and increased mortality.^[14] In addition, there are several other risk factors which may contribute to ICU admission among the elderly patients with COVID-19.^[15]

Numerous studies have been conducted on different aspects of COVID-19; however, the literature on association of comorbidities with ICU admission among the elderly patients with COVID-19 is lacking from Saudi Arabia. Therefore, this study was conducted to identify the comorbidities and symptoms in the elderly patients with COVID-19 leading to a higher risk of ICU admission.

2. Methods

A retrospective cross-sectional study was conducted to evaluate the comorbidities associated with ICU admission in elderly patients with COVID-19 at King Saud University Medical City (KSUMC) in Riyadh, Saudi Arabia. The study was approved by the Institutional Review Board of the College of Medicine, King Saud University, which provided the research consent (E-21-6145). There were no ethical issues in conducting this study because it was a retrospective study targeting findings from existing clinical records. The authors declared that all methods were performed as per relevant guidelines and regulations (including the Declaration of Helsinki). All the elderly patients (age ≥ 65 years) with laboratory-confirmed SARS-CoV-2 infection admitted between March 2020 and August 2021 and hospitalized at KSUMC were included in the study. All the patients younger than 65 and those with negative COVID-19 polymerase chain reaction tests were excluded from the study. To assess the comorbidities that contribute to ICU admission in elderly patients with COVID-19, the elderly patients with COVID-19 admitted to ICU were compared with those not admitted to the ICU. The reason for choosing patients with COVID-19 as the control group was that the study did not aim to test whether COVID-19 led to ICU admission but to determine the comorbidities that increased the risk of ICU admission in elderly patients with COVID-19. Cases were defined as elderly patients with COVID-19 at KSUMC admitted to the ICU. The control group was defined as the

elderly patients with COVID-19 at KSUMC not admitted to the ICU.

Data were extracted from the electronic medical record using a data collection form with sociodemographic characteristics, including symptoms and vital signs at the time of admission and the underlying comorbidities such as endocrinopathy (diabetes, thyroid diseases and adrenal diseases), cardiac diseases (hypertension, ischemic heart disease, heart failure, dyslipidemia, arrhythmia, and valvular diseases), chronic respiratory diseases (COPD, bronchial asthma, interstitial lung disease, pulmonary vascular diseases, pulmonary tuberculosis, and obstructive sleep apnea), renal disease and end-stage renal diseases (CKD, glomerular disease, and urolithiasis), chronic liver disease (infectious hepatitis, liver cirrhosis and hepatic failure), diseases of the digestive system (noninfectious diseases of the upper or lower digestive system, pancreatic disease and biliary disease) chronic neurologic disease (cerebrovascular accidents, Parkinson, movement disorders, multiple sclerosis, epilepsy and Alzheimer disease), malignancies, rheumatologic diseases (rheumatoid arthritis and systemic lupus erythematosus) and hematologic disease (anemia, coagulopathy and bone marrow dysfunction). In addition, the Charlson comorbidity index (CCI) was calculated.

Data were analyzed using SPSS 26.0 (IBM Inc., Chicago, IL) statistical software. Descriptive statistics (i.e., the frequency, percentage, mean, and standard deviation) described the categorical and quantitative variables. A univariate analysis was conducted using the Student *t* test for independent samples. In addition, Pearson χ^2 test was used to assess the measure of association between the categorical study and outcome variables (ICU admission). The odds ratios were calculated to measure association. A multivariate binary logistic regression was used to find out the independent factors associated with ICU admission and a *P* value of $< .05$ and 95% confidence intervals were used to report the statistical significance and precision of the results.

3. Results

A total of 444 elderly patients (ICU = 147, non-ICU = 297) with COVID-19 admitted to KSUMC were enrolled in the study to assess the risk factors that contribute to ICU admission due to COVID-19 infection. There were 229 (51.6%) females, and an overall mean age was 75.4 years. Furthermore, the patients were classified into two groups based on ICU admission: patients admitted to the ICU (147 cases or 33.1%) and patients not admitted to the ICU (the control group with 297 cases or 66.9%). The rates of categorical study variables among the ICU and non ICU elderly patients are illustrated in Figure 1.

In terms of sociodemographic and clinical characteristics of the study subjects, presenting with shortness of breath was significantly associated with the risk of admission to the ICU in COVID-19 elderly patients ($n = 97$, 66%, $P = .007$). The other variables of chest pain, cough, appetite loss, fatigue, decreased consciousness, vomiting, diarrhea, abdominal pain, and sore throat were not statistically significant (Table 1).

Comparison of the mean values of the quantitative variables showed a statistically significant difference in the mean values of weight, SpO₂, and length of stay. Furthermore, the mean length of stay ($P < .0001$) and mean weight ($P = .02$) among ICU patients were higher than the values for the non-ICU group. Similarly, a significant difference was found between both groups in terms of shortness of breath and mean SpO₂ ($P = .007$, $P = .006$ respectively). In contrast, no statistically significant differences were found between ICU and non-ICU patients in terms of age, CCI, height, body mass index, temperature, and systolic and diastolic blood pressure (Table 2).

The association between comorbidities and the ICU admission of elderly patients with COVID-19 indicated a

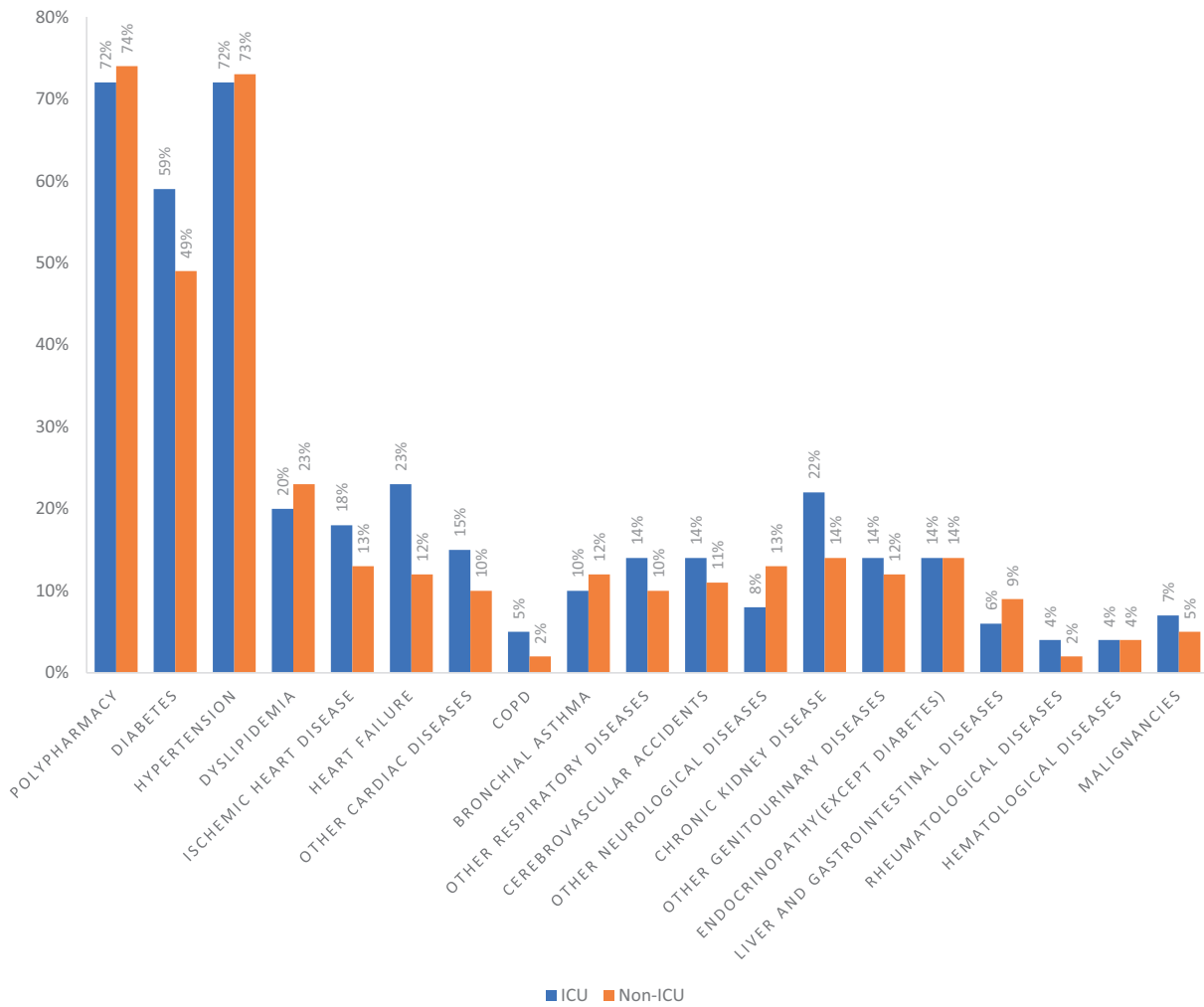


Figure 1. Rates of comorbidities variables among the intensive care unit (ICU) and non-ICU elderly patients.

Table 1
Association of Sociodemographic and clinical characteristics with ICU admission.

Characteristics	ICU (n = 147) n (%)	Non-ICU (n = 297) n (%)	P value
Gender			.054
Male	87 (59.2)	147 (49.5)	
Female	60 (40.8)	150 (50.5)	
Mortality symptoms	64 (43.5)	31 (10.4)	<.0001
Chest pain	15 (10.2)	43 (14.5)	.209
Shortness of breath	97 (66)	156 (52.5)	.007
Cough	55 (37.4)	95 (32)	.255
Loss of appetite	9 (6.1)	10 (3.4)	.177
Fatigue	20 (13.6)	45 (15.2)	.665
Decrease level of consciousness	13 (8.8)	18 (6.1)	.279
Vomiting	9 (6.1)	26 (8.8)	.333
Diarrhea	6 (4.1)	13 (4.4)	.885
Fever	41 (27.9)	59 (19.9)	.057
Abdominal pain	6 (4.1)	10 (3.4)	.704
Sore throat	4 (2.7)	5 (1.7)	.465
Other symptoms	4 (2.7)	7 (2.4)	.816

ICU = intensive care unit.

statistically significant association for heart failure ($P = .004$, odd ratio (OR) = 2.02, 95% CI [1.263, 3540]), COPD ($P = .027$, OR = 3.361, 95% CI [1.080, 10.464]), and CKD ($P = .021$,

OR = 1.807, 95% CI [1.087, 3.006]). Polypharmacy, diabetes, hypertension, dyslipidemia, ischemic heart disease, other cardiac diseases, cerebrovascular accidents, asthma, interstitial lung diseases, pulmonary vascular diseases, pulmonary tuberculosis, obstructive sleep apnea, other respiratory diseases, endocrinopathy, genitourinary diseases, neurological diseases, rheumatological diseases, liver and gastrointestinal diseases, hematological diseases and malignancies were not significantly associated with ICU admission (Table 3).

The final model of multivariate analysis which included the following 5 variables (SpO₂, length of stay, heart failure, COPD and chronic kidney disease) showed a significant association between SpO₂ ($P = .004$, aOR = 0.989, 95% CI [0.982, 0.997]), length of stay ($P < .0001$, aOR = 1.083, 95% CI [1.060, 1.106]), heart failure ($P = .044$, aOR = 1.813, 95% CI [1.016, 3.237]), and COPD ($P = .019$, aOR = 4.263, 95% CI [1.270, 14.307]) with the ICU admission of elderly patients with COVID-19 (Table 4). In terms of outcome this study reported a significant association between the ICU admission of elderly patients with COVID-19 and the mortality rate ($n = 64$, 43.5%, $P < .0001$).

4. Discussion

The current study evaluated the clinical characteristics and highlighted the most likely comorbidities associated with a higher risk of ICU admission among the elderly patients with

COVID-19. The study revealed significant association of both COPD and heart failure with ICU admission. Although the literature supports the findings of the study in the general population; however, there is paucity in literature that has

specifically addressed the geriatric population.^[16] Diabetes mellitus and hypertension have been reported to increase the risk of ICU admission in previous studies but were not reported in the present study.^[12,17] In the present study, the mortality rate, mean length of stay and weight were significantly higher in ICU patients. Moreover, the present study reported significantly increased number of patients with shortness breath, and lower values of SpO2 in the ICU group.

Although not specific to the geriatric population, COPD had been reported to be associated with a higher risk of ICU admission.^[6,18] Moreover, multiple studies have revealed that COPD is one of the most significant risk factors for developing severe COVID-19.^[19,20] A meta-analysis conducted by Jain and Yuan^[16] have reported COPD as the significant predictive comorbidity for severe COVID-19 and ICU admission. Current evidence suggests that patients with COPD have a higher risk of ICU admission and severe COVID-19 because they are prone to viral infections, including SARS-CoV-2. This outcome is primarily due to the increased expression of ACE2 receptors in the small airways and could also be related to a poor lung reserve.^[18]

Finally, combination of multiple comorbidities increases the risk of complications and ICU admission, especially

Table 2
Comparison of mean values of quantitative study variables between ICU and non-ICU patients.

Variables	ICU (N = 147) (mean)	Non-ICU (N = 297) (mean)	Mean difference	t value	P value	95% CI of difference of mean
Age	75.41	75.38	0.03	0.036	.971	-1.617, 1.678
Length of stay	21.437	10.198	11.238	9.314	<.0001	8.866, 13.609
CCI	5.05	4.70	0.347	1.863	.063	-0.019, 0.714
Height	161.97	161.19	0.8105	0.634	.526	-1.725, 3.346
Weight	80.90	75.77	5.106	0.501	.02	0.8102, 9.402
BMI	32.5	29.75	2.629	1.164	.245	-1.812, 7.070
Temperature	37.47 (3.21)	37.21 (0.79)	0.2707	1.365	.173	-0.119, 0.660
SpO2	73.71	81.71	-7.854	-2.736	.006	-13.497, -2.212
Systolic BP	130.9 (25.06)	130.3 (22.13)	0.523	0.222	.824	-4.098, 5.144
Diastolic BP	68.85 (17)	70.06 (20.95)	-1.200	-0.795	.427	-4.166, 1.767

BMI = body mass index, BP = blood pressure, CCI = Charlson comorbidity index, CI = confidence interval, ICU = intensive care unit, OR = odd ratio, SpO2 = oxygen saturation.

Table 4
Independent variables associated with the intensive care unit admission (using multivariate binary logistic regression).

Variables	Adjusted odds ratio	P value	95% CI of adjusted odds ratio
COPD	4.263	.019	1.270, 14.307
Heart failure	1.813	.044	1.016, 3.237
Length of stay	1.083	<.0001	1.060, 1.106
SpO2	0.989	.004	0.982, 0.997

CI = confidence interval, COPD = chronic obstructive pulmonary disease, SpO2 = oxygen saturation.

Table 3
Association of comorbidities variables with the ICU admission.

Variable	ICU (N = 147)	Non-ICU (N = 297)	χ ² value	P value	OR	95% CI of OR
Polypharmacy	106 (72.1)	221 (74.4)	0.521	.470	0.843	0.529, 1.342
Diabetes	86 (58.5)	145 (48.8)	3.793	.055	1.478	0.991, 2.203
Hypertension	106 (72.1)	218 (73.4)	0.083	.773	0.937	0.602, 1.459
Dyslipidemia	30 (20.4)	69 (23.2)	0.453	.501	0.847	0.532, 1.374
Cardiac diseases						
Ischemic heart disease	27 (18.4)	39 (13.2)	2.088	.148	1.1483	0.867, 2.535
Heart failure	34 (23.1)	37 (12.5)	8.335	.004	2.114	1.263, 3.540
Other cardiac diseases	22 (15)	30 (10.1)	2.2251	.134	1.566	0.869, 2.825
Respiratory diseases						
COPD	8 (5.4)	5 (1.7)	4.888	.027	3.361	1.080, 10.462
Bronchial asthma	14 (9.5)	36 (12.1)	0.664	.415	0.763	0.398, 1.464
Interstitial lung disease	7 (4.8)	5 (1.7)	3.544	.060	2.920	0.911, 9.363
Pulmonary vascular diseases	4 (2.7)	7 (2.4)	0.054	.816	1.159	0.334, 4.023
Pulmonary tuberculosis	3 (2)	5 (1.7)	0.071	.790	1.217	0.287, 5.162
Obstructive sleep apnea	1 (0.7)	6 (2)	1.138	.286	0.332	0.040, 2.785
Other respiratory diseases	6 (4.1)	7 (2.4)	1.029	.310	1.763	0.582, 5.343
Neurological diseases						
Cerebrovascular accidents	21 (14.3)	33 (11.1)	0.928	.335	1.333	0.741, 2.398
Other neurological diseases	12 (8.2)	38 (12.8)	2.111	.146	0.606	0.306, 1.198
Genitourinary diseases						
Chronic kidney disease	33 (22.4)	41 (13.8)	5.290	.021	1.807	1.087, 3.006
Other Genitourinary diseases	21 (14.3)	35 (11.8)	0.558	.455	1.248	0.698, 2.231
Endocrinopathy (except diabetes)	20 (13.6)	41 (13.8)	0.003	.954	0.983	0.553, 1.748
Liver and gastrointestinal diseases	9 (6.1)	26 (8.8)	0.938	.333	0.680	0.310, 1.491
Rheumatological diseases	6 (4.1)	5 (1.7)	2.341	.126	2.485	0.746, 8.282
Hematological diseases	6 (4.1)	12 (4)	<0.001	.983	1.011	0.372, 2.749
Malignancies	10 (6.8)	14 (4.7)	0.839	.360	1.475	0.639, 3.407

CI = confidence intervals, COPD = chronic obstructive pulmonary disease, ICU = intensive care unit, OR = odd ratio.

among the elderly patients. Previous studies support this study and reveal that CKD is associated with a higher risk of ICU admission, severe COVID-19 and a high mortality rate.^[21,22] In addition, patients with CKD are prone to viral infections, which could be explained by an impaired immune cell function.^[23] In the current study, heart failure with COVID-19 in elderly patients is a major risk factor for ICU admission. Other studies have also linked heart failure with a higher mortality rate in patients with COVID-19, a higher risk of severe COVID-19 and developing acute decompensated heart failure.^[24,25]

Our study has several limitations. Most importantly, the current study was conducted in one hospital, limiting the ability to generalize the findings for the elderly population in Saudi Arabia. A multicenter study with a larger sample size is recommended to generalize the results. Another limitation was the relatively small sample size to understand the causality of comorbidity with risk of ICU admission among the elderly patients.

5. Conclusion

The current study reveals that COPD and heart failure as well as factors like SpO₂ and length of stay were associated with a higher risk of ICU admission among the elderly patients with COVID-19 in Saudi Arabia. These findings highlight clinical implications of comorbidity among geriatric population. Diagnosing and treating patients with these comorbidities should be a priority to decrease the rate of ICU admission.

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