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Characteristics and outcomes of COVID-19 intensive care patients

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ABSTRACT

Background: The novel Corona virus strain COVID-19 created a pandemic condition, leading to extensive deaths and putting immense pressure on the global health systems due to high demand for hospitalization and intensive care units (ICUs) admission.

Aim: This study was aimed to evaluate the characteristics of ICU patients with COVID-19 infection to explore the factors associated with morbidity and mortality during hospital admission.

Method: A retrospective observational study was conducted in King Saud Hospital and Al-Bukayriyah General Hospital, Al-Qassim region, KSA from March 2020 until October 2021, among COVID-19-ICU patients. Data regarding patients' demographics, comorbidities, signs, and symptoms were collected, as well as the need for ventilation, duration of ICU stay and death rate. All data were analyzed and the associations between variables were evaluated.

Results: The study included 120 patients (60% were males, 40% female, with a mean age of 64.6± 17.9 years). The most prevalent comorbidities were diabetes (54.2%) and hypertension (40%). The mean length of ICU stay was nine days. A significant association was observed between the mortality rate, the length of stay in ICU, and the need for invasive ventilation ($P \leq 0.05$). A significant association was found between pulmonary diseases and the need for ventilation, and between kidney diseases and the length of ICU stay.

Conclusion: Males, elderly, diabetics, and hypertensive patients infected with COVID-19 were at a significant risk of developing severe symptoms, which further deteriorated their condition.

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Future studies are warranted with larger sample size and longer duration for better evaluation of the clinical characteristics of COVID-19 patients admitted in ICU.

Keywords: *Comorbidity; COVID-19; Intensive care units (ICU); Respiratory; Qassim region; Retrospective Study*

INTRODUCTION

Novel coronavirus was reported to cause the spread of COVID-19 first reported in Wuhan, Hubei province of China in December 2019 (Mabrouk et al. 2021). The virus was named Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2), and the resulting disease was named coronavirus disease-2019 (COVID-19) (Haider and Hyder, 2020). With social distancing and face masking as the primary preventive approaches, and with limited therapeutic options, COVID-19 became a pandemic infectious disease that primarily affected the respiratory system for two to fourteen days after exposure to the virus, leading to more than 60 crore confirmed cases with 6.4 million deaths (Hyder and Haider, 2020; AlRasheedi et al., 2021; WHO Corona dashboard, https://covid19.who.int/).

The COVID-19 pandemic has put unprecedented strain on healthcare systems globally due to the rapidly rising demand for ICUs admissions (Xie et al. 2020). It has become increasingly important for many countries to determine how many beds, personnel, and equipment they will need to care for those infected with the pandemic. Therefore, to predict future demand for COVID-19 treatment, it is essential to know more about the factors that influence the severity of the disease besides deciding the length of the hospital stay (Xie et al. 2020). Besides millions of deaths, approximately 15% to 20% of COVID-19 cases necessitated hospitalization, out of which 3% to 5% required critical care (Bhatraju et al. 2020). Early reports from Wuhan showed that the death rate in patients admitted to intensive care units was 52-62%, but for patients who required invasive mechanical ventilation, the death rate increased to 86-97% (Auld et al. 2020). According to a recently published systematic review, early evidence on length of stay of COVID-19-infected patients in hospitals and ICU, the average hospital stay ranged from four to fifty-three days in China compared to the four to twenty-one days in other countries, while the average stay in ICU ranged from five to nineteen days with insignificant difference between China and other countries. Length of stay were also influenced by patient characteristics, i.e., age and comorbidities as they influence disease severity (Rees et al. 2020)). Hence, capacity-planning should focus these factors to predict the number of beds required at each level of care. In most COVID-19-infected patients, there was mild to moderate respiratory illness and recovered without needing special treatment, however, the risk of developing more severe and serious symptoms of COVID-19 infection increased in the elderly patients (Macera et al. 2021). Similarly, the risk of disease increased in patients with chronic diseases or in obese patients. These cases may require admission to ICU (Macera et al. 2021).

Dres *et al*. evaluated the prognosis of COVID-19-infected elderly ICU-admitted patients in a prospective cohort study. They reported that patients over 70 years were more than a quarter of the total COVID-19-infected population in our study participants admitted to ICUs during the first COVID-19 pandemic wave (Dres et al. 2021). Their overall Day-90 mortality rate was 46%, with a dismal prognosis for patients over 80. Given the prolonged mechanical ventilation and extended ICU and hospital stay, for the high-risk and vulnerable population, more research is needed to determine the psychological, neurocognitive, and functional outcomes of their long-term outcomes. Ahlstrom *et al.*, described the role of relevant comorbidities, i.e., diabetes, hypertension, chronic kidney failure, asthma, obesity, and solid organ transplantation, and the effect of drugs, i.e., immunosuppressive therapy, on the risk of ICU admission and mortality after are all considered independent risk factors that may lead to admission to ICU (Ahlstrom et al. 2021).

A retrospective cohort study evaluated the clinical characteristics and therapeutic outcomes of severe cases of COVID-19 infected patients in the Al-Baha region, Saudi Arabia (AlGhamdi et al. 2021). The authors found that most patients with COVID-19 admitted to the ICU were elderly or had comorbidities, such as heart disease and diabetes. Another multicenter, non-

interventional cohort study evaluated the clinical characteristics and outcomes of COVID-19-infected patients in the ICU and reported that many factors contributed to increased mortality risk (AlSulaimani et al. 2021). [11] Diabetes and hypertension were the most common causes. The study was restricted to patients from two hospitals in Riyadh and Jeddah.

We focused our study in the same category of patients to find an association between different clinical variables, comorbidities or risks and the ICU mortality rate among COVID-19 patients. We evaluated the clinical characteristics of ICU patients with COVID-19 infection in Al-Qassim region, Saudi Arabia, in order to explore the factors associated with increased mortality among those patients who admitted in ICU for management.

METHODOLOGY

Study design and population

A retrospective-Observational- study was designed and conducted in King Saud Hospital and Al-Bukayriyah General Hospital, Al-Qassim region, KSA from March 2020 to October 2021 in adult COVID-19 patients requiring ICU admission.

Inclusion criteria

- Adult patients with confirmed diagnosis of COVID-19, who had severe symptoms and required ICU admission for their management.

Exclusion criteria

- COVID-19 patients, with mild or moderate symptoms requiring hospitalization, but not ICU admission.
- Patients younger than 18 years old.
- COVID-19 patients who were admitted to ICU for any other illnesses.
- Patients with insufficient data in their clinical records.

Sample size

A total of 120 medical records of COVID-19 infected patients were reviewed and included in this study, who met the inclusion and exclusion criteria of the study. Only patients with complete information were enrolled in the study.

Data collection tool and sites

Data were collected from medical records of COVID-19 infected patients, who were admitted to the ICU of King Saud Hospital and Al-Bukayriyah General Hospital, Qassim region, KSA. Data collection was carried out using a designed form, which included four parts; the first part was used for demographic data of the patients, the second part for the comorbidities information (cardiac, pulmonary, or kidney disease, diabetes, obesity, immune diseases, cancer, transplantation), the third part for the signs and symptoms of patients infection and vital signs (fever, cough, respiratory distress, gastrointestinal symptoms, oxygen saturation, and the need for invasive or non-invasive ventilation) and the fourth part about hospital admission date, discharge day, or death.

Data analysis

Data were analyzed using the statistical package for social science program software (SPSS-version 28). All variables were assessed using descriptive statistics for (percentages and frequencies). Pearson's Chi-squared test ($\chi 2$) and Odd ratio were used to find the association between variables. Results were considered significant with P-value ≤ 0.05.

RESULTS

Demographic data

The total number of patients included was 120 60% of them were male, and the majority of them (81.7%) were Saudi nationals. The largest patient age group was from 61 to 80 years (43.3%), followed by 41 to 60 years (25.8%), and 81-year-old or more (19.2%). The smallest patient age group was 20 to 40 years (11.7%). Some other demographic data included in the study have been summarized in Table-1.

TABLE 1: Demographic data of the patients (N=120)

Variable		Number	Percentage
Gender	Male	72	60.0
	Female	48	40.0
Nationality	Saudi	98	81.7
	Non-Saudi	22	18.3
Age Mean± D (64.22± 17.915)	20 to 40 years	14	11.7
	41 to 60 years	31	25.8
	61 to 80 years	52	43.3
	81 years and above	23	19.2

Past Medical history

The medical history of the patients enrolled in the study showed that most of the patients had a history of diabetes (54.2%), had hypertension (40%), obesity (35%), and pulmonary diseases (25.8%) (Table-2 & Figure -1)

TABLE 2: Medical history and comorbid diseases of the patients (n=120).

Disease	Frequency	Percentage
Diabetes	65	54.2
HTN	48	40
Obesity	42	35
Pumonary diseases	31	25.8
Kidney diseases	22	18.3
Heart diseases	20	16.7
Cancer	3	2.5
Other diseases	14	11.7

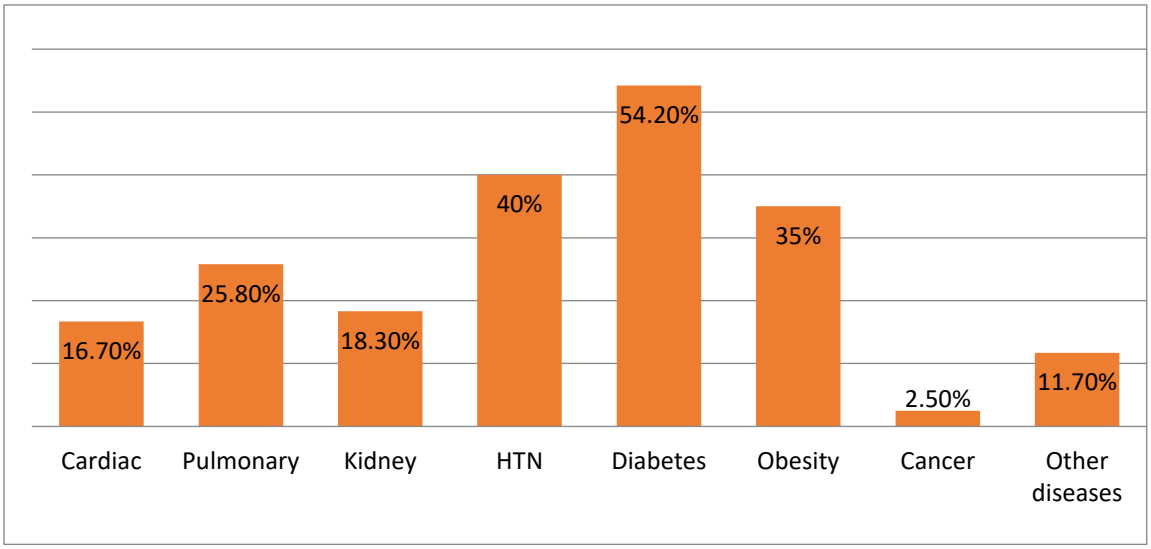

FIGURE 1: Medical history and comorbidities in patients included in the study (n=120).

Patients' symptoms and vital signs

Concerning patient's symptoms, vital signs, and need for invasive ventilation, they had high respiratory rates (71.4%), cough (70.8%), fever (61.9%), respiratory distress (50%), and about 52.5% needed invasive ventilation (Table-3; Figure-2).

TABLE 3: Patients' symptoms, vital signs and need to ventillation (n=120).

Signs or symptoms	Frequency	Percentage
Fever	73	61.9
Cough	84	70.8
Respiratory distress	69	57.5
GIT symptoms	25	20.8
↑ BP	27	26.7
↑ Respiratory Rates	80	71.4
↑ Heart Rates	48	43.2
Need for invasive ventilation	63	52.5

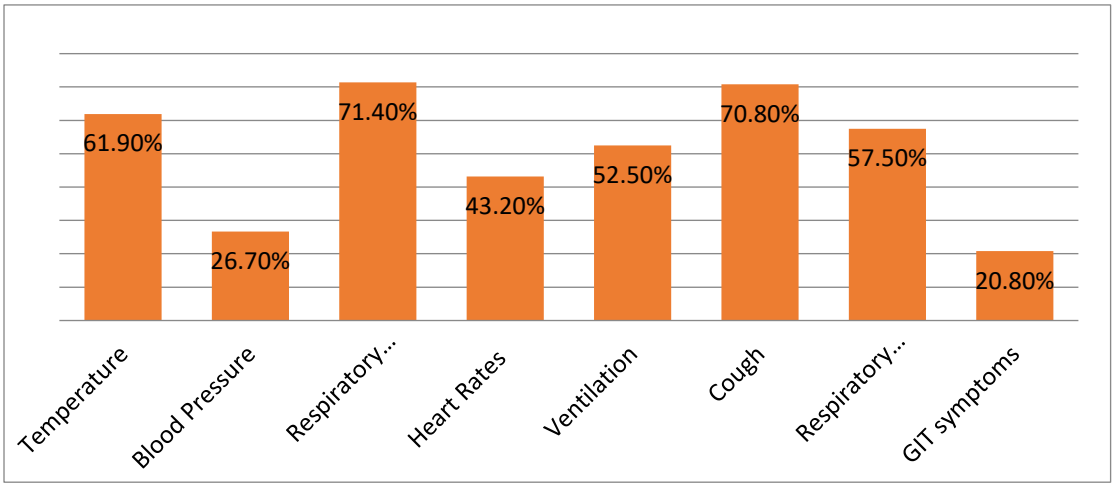

FIGURE 2: Breakdown of the symptoms, vital signs, and need for ventillation in the patients (n=120) included in the study.

Length of hospital stay and death rate

The mortality rate among patients was 23.3%. The length of hospital stay ranged between one to fifty-eight days with median duration of eight days (Table-4).

TABLE 4: Length of hospital stay and mortality rate (n=120).

Variable		Number	Percentage
Died Patients		28	23.3
Duration of hospital stay (days)	Minimum	Maximum	Mean± SD
	1	58	9.84±8.478

The association between patients' death statistics and other variables

We observed association between patients' mortality rate and different variables in the study, i.e., comorbidities, need for ventilation, and the length of hospital stay. A statistically significant association ($p < 0.05$) was found between mortality rateand comorbidities, such as cardiac diseases, and diabetes, besides an association between mortality rate and the need for invasive ventilation and the duration of hospital stay. For example,as summarized in Table-5, 45% of patients with cardiac diseases died (Odds Ratio 3.488),30.8% of patients with diabetes died (Odds Ratio 2.611),44.4% of patients needed invasive ventilation died (Odds Ratio 1.800), and 35.4% of patients spent more than nine days in the hospital and ultimately died (Odds Ratio 3.041).

However, we did not observe significant association between mortality rate and other variables (Table-5).

TABLE 5: Association between patients' mortality rate and co-morbidities.

Variable		Death		p-value	Odds Ratio
		NO	YES		
Gender	Female	77.1%	22.9%	0.930	1.040
	Male	76.4%	23.6%		
Age	< 60 years	73.3%	26.7%	0.504	0.746
	60 years and above	78.7%	21.3%		
Cardiac	No	81.0%	19.0%	**0.012***	**3.488**
	Yes	55.0%	45.0%		
Pulmonary	No	78.7%	21.3%	0.384	1.507
	Yes	71.0%	29.0%		
Kidney	No	78.6%	21.4%	0.298	1.711
	Yes	68.2%	31.8%		
HTN	No	79.2%	20.8%	0.428	1.411
	Yes	72.9%	27.1%		
Diabetes	No	85.5%	14.5%	**0.036***	**2.611**
	Yes	69.2%	30.8%		
Obesity	No	76.9%	23.1%	0.928	1.042
	Yes	76.2%	23.8%		
Cancer	No	76.1%	23.9%	0.333	0.761
	Yes	100.0%	0.0%		
Other diseases	No	77.4%	22.6%	0.622	1.367
	Yes	71.4%	28.6%		
Need for invasive ventilation	No	100.0%	0.0%	**0.000****	**1.800**
	Yes	55.6%	44.4%		
The number of days	9 days or less	84.7%	15.3%	**0.011***	**3.041**
	> 9 days	64.6%	35.4%		

**: Significant at 0.01 / *: Significant at 0.05

We also observed significant association (p <0.05) between mortality rate and the need for invasive ventilation, (Odds Ratio 1.80), All of the patients (100%) who died needed invasive ventilation. Similarly, there was significant association (p <0.05) between pulmonary diseases (4.2%) and the need for invasive ventilation (Odds Ratio 3.52). However, there was no significant association between the need for invasive ventilation and other variables in the study (Table-6).

TABLE 6: Association between the need for invasive ventilation and different variables.

Variable		Need for invasive-ventilation		p-value	Odds Ratio
		No	Yes		
Gender	Male	48.6%	51.4%	0.765	1.118
	Female	45.8%	54.2%		
Age	Less than 60 years	46.7%	53.3%	0.887	0.948
	60 years and above	48.0%	52.0%		
Cardiac	No	51.0%	49.0%	0.086	2.429

	Yes	30.0%	70.0%		
Pulmonary	No	55.1%	44.9%	**0.005****	**3.522**
	Yes	25.8%	74.2%		
Kidney	No	48.0%	52.0%	0.832	1.106
	Yes	45.5%	54.5%		
HTN	No	43.1%	56.9%	0.232	0.640
	Yes	54.2%	45.8%		
Diabetes	No	50.9%	49.1%	0.492	1.287
	Yes	44.6%	55.4%		
Obesity	No	47.4%	52.6%	0.985	0.993
	Yes	47.6%	52.4%		
Cancer	No	46.2%	53.8%	0.065	0.462
	Yes	100.0%	0.0%		
Other diseases	No	45.3%	54.7%	0.181	0.460
	Yes	64.3%	35.7%		
Death	NO	62.0%	38.0%	**0.000****	**1.800**
	YES	0.0%	100.0%		

**: Significant at 0.01

There was a significant association ($p < 0.05$) between mortality rate and the length of hospital stay (Odds Ratio 3.041)., A total of 60.7% of patients who died spent more than nine days in the hospital. A significant association ($p < 0.05$) was also observed between kidney diseases and the length of hospital stay (Odds Ratio 2.60). A total of 59.1% of patients with kidney diseases spent more than nine days in the hospital (Table-7).

TABLE 7: The association between the duration of hospital stay and other variables.

Variable		**The duration of ICU stay**		**P-value**	**Odds Ratio**
		9 days or less	Above 9 days		
Gender	Male	61.1%	38.9%	0.761	1.122
	Female	58.3%	41.7%		
Age	Less than 60 years	66.7%	33.3%	0.248	1.571
	60 years or more	56.0%	44.0%		
Cardiac	No	61.0%	39.0%	0.617	1.280
	Yes	55.0%	45.0%		
Pulmonary	No	59.6%	40.4%	0.865	0.930
	Yes	61.3%	38.7%		
Kidney	No	64.3%	35.7%	**0.043***	**2.600**
	Yes	40.9%	59.1%		
HTN	No	59.7%	40.3%	0.939	0.971
	Yes	60.4%	39.6%		
Diabetes	No	61.8%	38.2%	0.708	1.150
	Yes	58.5%	41.5%		
Obesity	No	59.0%	41.0%	0.755	0.885
	Yes	61.9%	38.1%		

Cancer	No	59.0%	41.0%	0.152	0.590
	Yes	100.0%	0%		
Other diseases	No	60.4%	39.6%	0.816	1.143
	Yes	57.1%	42.9%		
Death	NO	66.3%	33.7%	0.011*	3.041
	YES	39.3%	60.7%		

*: Significant at 0.05

DISCUSSION

This retrospective study evaluated the characteristics and outcomes of COVID-19 patients in the intensive care unit of hospitals. The analysis of the data was performed from the medical records of laboratory-confirmed COVID-19 cases admitted to the intensive care unit in King Saud Hospital and Al Bukayriyah General Hospital in Al- Qassim region of KSA. The number of participants in our study was 120 patients, of which (60%) were males with mean age of 64, and the most were Saudi patients (81.7%). The results of our study were consistent with the published data wherein males and the elderly (61 years or older) were at the risk of severe COVID-19 infection, who needed admission to ICU (Pijls et al. 2021). The elderly patients were more likely to get very sick from COVID-19. Older adults with COVID-19 might need hospitalization, intensive care, or a ventilator to support their breathing. The difference in the immunity levels between males and females significantly affect their ability to fight SARS-2-CoV-2, mediated by different factors such as sex hormones and high expression of coronavirus receptors in men, and lifestyle, i.e., higher smoking compared to women (Bwire et al. 3030). Moreover, women follow the preventive measures more, i.e., frequent hand-washing, wearing a face mask, and staying at home. Most common comorbidities among our patients were diabetes with 54.2%, followed by hypertension with 40%. In addition, obesity, lung, kidney, and heart diseases accounted for 35%, 25.8%, 18.3%, and 16.7%, respectively (Bwire et al. 3030).

Patients with diabetes mellitus and hypertension have been reported as the most common comorbidities associated with an increased risk of severe COVID-19 symptoms that necessitated ICU admission Ahlstrom et al. 2021; Al-Sulaimani et al. 2021). Furthermore, the most common symptoms and signs among our patients with COVID-19 in the ICU were tachypnea (71.4%), followed by cough (70.8%), fever (61.9%), and respiratory distress (57.5%). At the same time, gastrointestinal symptoms were the least common among other symptoms. The results of our study were in concordance with other studies, which found that the most common symptoms in patients with COVID-19 in the ICU were cough (89.4%) and fever (85%), while the least common included gastrointestinal symptoms (Alsofyan et al. 2020). Although the proportions of these symptoms were higher than our study, this may be attributed to the difference in the sample size compared to other studies. Our study did not report any other significant abnormalities observed in other studies. Pearson's Chi-square test was used to determine an association between the need for invasive ventilation, number of days spent in the ICU, and patient mortality, with other variables in the study. More than half (52.5%) of our patients required invasive ventilation in the ICU. We observed a significant statistical association ($p < 0.05$) between the need for invasive ventilation and the patients with pulmonary diseases (Odds Ratio 3.52). We also found a significant statistical association ($p < 0.05$) between the need for invasive ventilation and death (Odds Ratio 1.80). All the patients who died needed invasive ventilation. These data are similar to the early reports of COVID-19 patients from Wuhan and the United States, which reported that the survival probability of COVID-19 patients on mechanical ventilation was very low (Auld et al. 2020). Moreover, the duration of COVID patients stay in the ICU ranged from one day to 58 days (average nine days). Our results were close to those of two retrospective studies conducted in Saudi Arabia in terms of the average number of days of ICU stay. Whereas, AlWafi reported an average ICU as six days (AlWafi et al. 2021), AlGhamdi reported average number of ICU stay ranging from four to twelve days (AlGhamdi et al. 2021).The reason for the observed difference can be due to the different inclusion criteria in the study and patient characteristics such as age, comorbidities and

other factors, which may increase or decrease the number of days of stay in the ICU. In addition, we also found a significant association between kidney diseases and the duration of hospital stay (odds ratio 2.60), as 59.1% of patients with kidney disease spent more than nine days in the hospital. Also, we found association between death and the duration of hospital stay (odds ratio 3.041), as 60.7% of the patients who died spent more than nine days in the hospital, which indicates that the more days a patient spends in the hospital, the higher the risk of death. The total number of patients who died in our study was twenty-eight (23.3%). We also found a significant association between mortality rate and comorbidities, i.e., diabetes, cardiovascular pathologies, besides the need for invasive ventilation, and the duration of ICU stay at 30.8%, 45%, 44.4%, and 35.4%, respectively.

Limitations of the study

Despite interesting data, one limitation of our study is the small sample size. Some restrictions due to MOH protocol during the pandemic led to difficulty acquiringa larger sample size and including more areas in the Qassim region. Moreover, there was difficulty in collecting patients' data as some of the patient files were incomplete and hence, needed to be excluded. Future studies are warranted with larger sample size, which will help identify other factors associated with increased morbidity and mortality among COVID-19 patients in the ICU.

CONCLUSIONS & RECOMMENDATIONS

This study concluded that the severity and rate of COVID-19 infection were higher among men than women. Patients in advanced age group (61 years or older) were the most susceptible to severe symptoms, requiring admission to ICU. The most common comorbidities among patients were diabetes and hypertension, while tachypnea, cough, and fever were the most common signs and symptoms among our patients.

There was a significant association between death and some comorbidities as diabetes and cardiac diseases in COVID-19 patients. Moreover, there was also association between the duration of ICU stay and increased demand for invasive ventilation, and mortality. An association between history of pulmonary diseases and the increased need for invasive ventilation was also observed. Future studies with larger sample sizes are needed to evaluate the clinical characteristics of COVID-19 patients to identify factors that may increase the severity of iCOVID-19 infection. We also recommend these studies to include other factors that may play an important role and identify the complications the survivors may experience after discharge. It may be helpful in the clinical perspective to study the COVID-19 vaccines and their effectiveness in reducing the severity of COVID-19 infection in relation to the need for ICU admission and mortality rate.

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