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Clinical Pattern, Management Outcome, and Associated factors of patients admitted to COVID-19 ICU Center of St. Paul's Hospital Millennium Medical College

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ABSTRACT

Background*: The coronavirus disease 2019, caused by the recent severe acute respiratory syndrome novel virus, is considered one of the greatest global public health crises by the WHO. It claimed millions of lives globally, with death occurring among populations with certain contributing factors. This study aimed to assess the clinical profile, management outcome, and associated factors of COVID-19-infected patients who were admitted to St. Paul Hospital Millennium Medical College COVID-19 ICU Center.*

Methods*: Institution-based cross-sectional study was conducted in St. Paul's Hospital Millennium Medical College among patients admitted to the COVID-19 ICU from June 8, 2020, to May 30, 2021. A systematic random sampling technique was applied to select eligible patients' charts. The data were entered and analyzed using SPSS version 26. Descriptive analysis was used for statistical analysis of baseline data, and regression analysis was used to determine the association between dependent and independent variables. A p-value <0.05 was considered significant.*

Results*: A total data of 272 patients were analyzed, with a median age of 60.5 years and more than two-thirds, 183(67.3%) being males. Most (75.7%) had a pre-existing comorbid medical condition, and a majority (71.3%) had a COVID-19 disease of critical disease severity. Overall, the in-ICU mortality rate was 64.3%. Multivariable analysis showed that mortality was significantly associated with intubation (AOR: 2.813; 95% CI: 1.176–6.731), pulmonary embolism (AOR: 36.702; 95% CI: 4.062–331.605), Vasopressor usage (AOR: 84.954; 95% CI: 23.413–308.254), Dialysis or RRT (AOR: 4.191; 95% CI: 1.511-11.620) and ARDS (AOR: 21.149; 95% CI: 4.217–106.075) were associated with death among the studied patients.*

Conclusion*: The most common comorbidities were hypertension, diabetes, and CKD. Moreover, high mortality among ICU-admitted COVID-19 patients was strongly associated with septic shock with vasopressor use, ARDS, Pulmonary embolism, RRT, and intubated patients.*

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1. Introduction

In December 2019, Wuhan, Hubei Province, China, reported a cluster of pneumonia cases of unknown cause, later identified as severe acute respiratory syndrome Coronavirus2 (SARS-COV2). COVID-19 was declared a pandemic by the WHO on March 11, 2020. As of January 17, 2021, 1 year had passed since the pandemic began, at which more than 93 million cases and 2 million deaths were reported worldwide.[1] Ethiopia has come among the COVID-19-affected countries as of March 15, the date on which one imported case was first detected. On May 7, 2020, there were 191 total notified cases and 4 deaths in Ethiopia.[2]

Coronaviruses belong to a large family of diverse enveloped, single-stranded positive-sense RNA viruses that are recognized to bring about respiratory, hepatic, neuronal, and gastrointestinal diseases in humans and animals. SARS-CoV, HCoVs-NL63, HCoVs-OC43, HCoVs-HKU1, HCoVs-229E, and MERS CoV, were until recently the coronaviruses that were known to affect humans. SARS-CoV and MERS-CoV infections resulted in 10% and 40% mortality rates in humans, respectively, the highest among the coronaviruses. SARS-CoV-2, the most recently ascertained Coronavirus, is the seventh of the coronavirus family known to affect Homo sapiens and currently has a mortality rate of 3.2%.[3]

Moreover, the probability of serious COVID-19 disease is higher in people aged ≥60 years, those living in a nursing home or long-term care facility, and those with chronic medical conditions.[4] The pandemic has significantly harmed a wide array of health services globally, particularly in low-and middle-income countries. African countries report the highest level of disruption in health service delivery.[5]

Coronavirus disease 2019 (COVID-19) has affected millions of people around the world since December 2019, of which 6 to 10% of patients develop a more severe form of COVID-19 and will require admission to the intensive care unit (ICU) mainly due to acute hypoxemic respiratory failure.[6] Based on severity, COVID-19 cases are classified as non-severe, severe, and critical COVID-19.[7] At present, most studies of COVID-19 have focused on risk factor analysis and mortality prediction for mild and moderate cases, which comprise a large proportion of patients with COVID-19. However,14% to 20% of cases are severe or even critical, and the mortality rate of these patients is as high as 50%.[8–10]

At present, most studies of COVID-19 have focused on risk factor analysis and mortality prediction for mild and moderate cases, which comprise a large proportion of patients with COVID-19. However, 14% to 20% of cases are severe or even critical, and the mortality rate of these patients is as high as 50%.[8–10]

Despite the increasing available literature on COVID-19, very few publications have emerged from Africa, including Ethiopia. There are few studies on the clinical patterns and outcomes of critically ill COVID-19 infected patients. The aim of this study is to assess the clinical profile, management outcome, and associated factors of COVID-19-infected patients who were admitted to the COVID-19 ICU in Saint Paul Hospital Millennium Medical College. This study will provide additional knowledge on the topic to help in early identification and management. Also, it will be a supportive study for further research in Africa, particularly Ethiopia.

2. Methods and Materials

This study was conducted at Saint Paul's Hospital Millennium Medical College (SPHMMC) COVID-19 ICU treatment center. SPHMMC is located in the

capital city of Ethiopia. It was established through a decree of the Council of Ministers in 2010. The hospital was designated officially starting on June 8, 2020, as the national center for the management of COVID-19-infected patients in Ethiopia, mainly serving the city and surrounding area populations. It has 13 ICU beds with mechanical ventilators and dialysis machines.

Sample Size

The sample size was calculated by using the single population proportion formula; a prevalence of (0.23) was used where 23 % of the overall mortality rate among patients who were admitted to COVID-19 ICU from a similar study done in Africa, Ghana[11], with a 10% error sample size of 286 patients was included using simple random sampling from a total of 523 patients admitted to COVID 19 ICU during the 12 months of the study period. Among 286 patients, only 272 charts were found to be eligible and were analyzed. Fourteen were excluded based on exclusion criteria.

Sampling technique

After receiving ethical approval from the ethical review committee, a retrospective chart review was done. A total of 272 patients were selected among those who were consecutively admitted to the ICU with real-time polymerase chain reaction (RT-PCR) confirmed COVID-19 from June 8, 2020, to May 30, 2021, after which the hospital closed due to the full resumption of other services.

All adult patients with laboratory-confirmed COVID-19 infection by RT-PCR assay of naso/oropharyngeal swab specimens and admitted to ICU during the study period were taken as source population. Our exclusion criteria were charts to which the primary outcome, i.e., death or life, was not documented. Alive patients can be transferred (to another facility or ward) or discharged. Additionally, lost charts were not included in the final study

Variables

Our dependent variable was the primary outcome, which can be either death or alive. N.B: Alive patients were those who were discharged or transferred.

Age, Sex, Clinical presentation (signs and symptoms), Chronic kidney disease, Diabetes mellitus, Hypertension, Heart failure, Laboratory values upon admission to ICU, vital signs at initial presentation, ICU length of stay, respiratory support, complication, and treatments given were independent variables.

Data Collection Tools and Procedures

Data were collected from patients' medical records using structured checklists. The questionnaire was prepared by reviewing different literature and undertaking modifications for the population studied. It was modified further after a pre-test and before the data collection, then followed and reviewed during data collection. Data was collected by trained Emergency Medicine and Critical Care Residents in SPHMMC who worked at the COVID-19 treatment center, and completeness was checked by the principal investigator. The information of all patients, including demographics, clinical presentation, comorbidity, complications, laboratory parameters, and outcome data, was extracted from medical records (electronic medical records were not applicable in the COVID-19 adult ICU during the study period). Close supervision was maintained during data collection, and filled checklists were double-checked daily by data collectors and the principal investigator for consistency and completeness before analysis.

Data Processing and Analysis

Data entering, coding, and cleaning were performed using Epi-info version 7.0, and statistical

analysis was done using SPSS (Statistical Package for Social Science) version 26. Frequency and cross-tabulation were used to check for missed values and variables. The demographic and clinical characteristics of patients were computed by using descriptive statistics such as mean (standard deviation), percentage, and frequencies. Logistic regression was used to determine the association between independent and dependent variables. Bivariate logistic regression was done for the assessment of the association between the dependent variable (mortality) and independent variables; only variables with a P-value<0.25 were (Table 3) displayed. Those variables with a p-value of ≤0.25 in bivariate logistic regression were taken to multivariate logistic regressions. Finally, the study findings were presented using diagrams, tables, and figures.

3. Result

Socio-demographic profile of study participants

A total of two hundred seventy-two patients' medical records were reviewed in this study. The median age at diagnosis was 60.5 years, with an interquartile range of 45–70 years. More than half, 142(52.2%) aged 60 years or more. Males accounted for over two-thirds, 183(67.3%) of the study population (Figures 1 and 2).

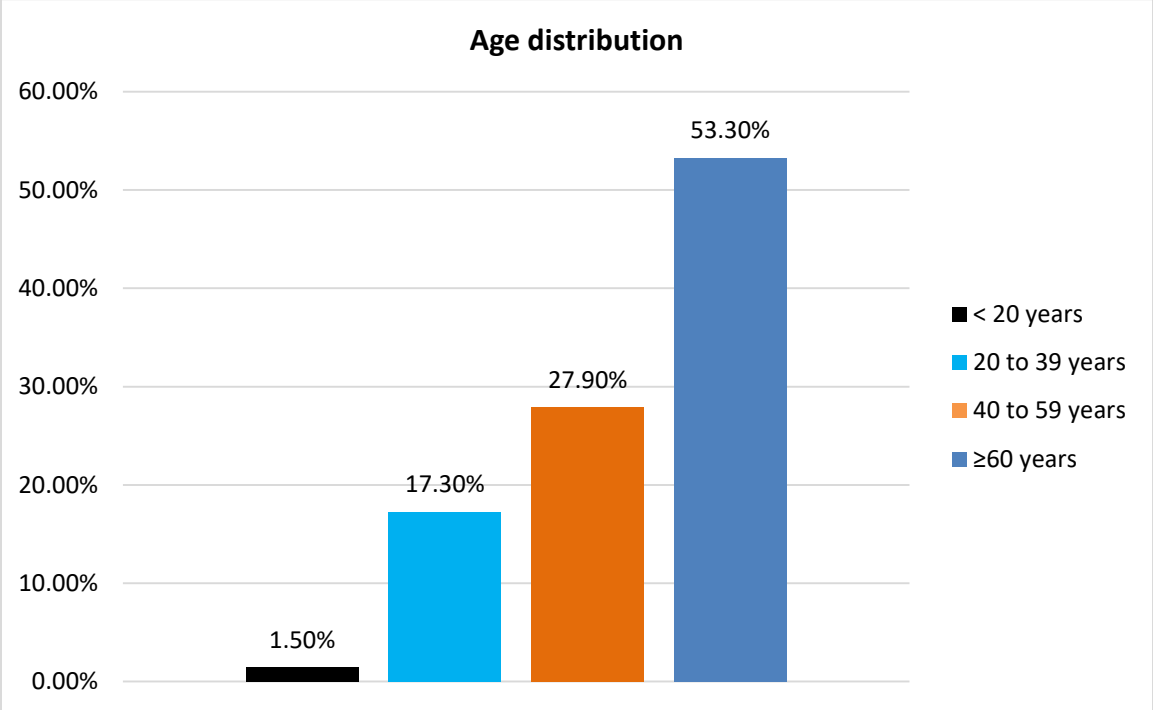

Figure 1: Age distribution of COVID-19 infected patients admitted to COVID-19 ICU Center of St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia from June 8, 2020, to May 30, 2021

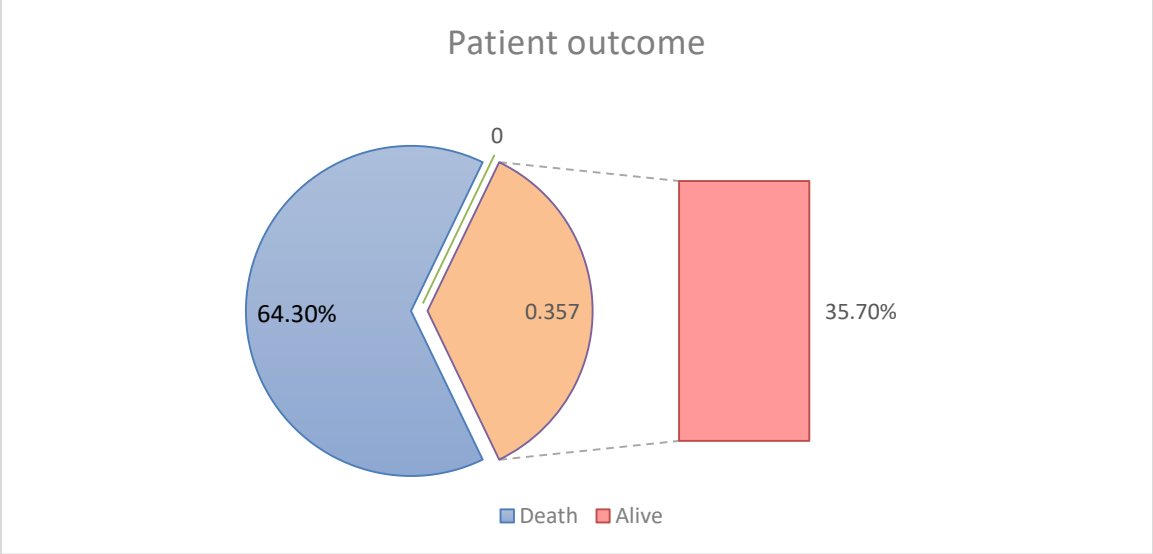

Figure 2: The outcome of COVID-19-infected patients admitted to the COVID-19 ICU Center of St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia, from June 8, 2020, to May 30, 2021

Clinical profile of study participants

Regarding the clinical profile of the studied patients, most, 206(75.7%) had some form of chronic comorbidity. Hypertension 109(40.1%), diabetes mellitus 90(33.1%) and chronic kidney disease 40(14.7%) were the most commonly documented comorbidity. The majority, 194(71.3%) of the patients were diagnosed with critical COVID-19 disease based on WHO classification, while a little more than a quarter, 75(27.6%), had a severe form of the disease (Table 1).

The median (interquartile range) time duration from onset of symptom(s) to hospital admission for the ICU-admitted patients was 5 (4–7) days, while the corresponding time duration from onset of symptom(s) to ICU admission was 6 (4–8) days. Similarly, the median (IQR) duration from the onset of initial symptom(s) to intubation was 8 (6–10) days. Most, 246(90.8%) of the patients had a systolic blood pressure measuring ≥90 mm of Hg at the initial presentation to the ICU.

Regarding the vital signs recorded at arrival to the ICU, two hundred forty-six (90.8%) patients had a baseline systolic blood pressure measuring 90mm of Hg or more, while 153(56.3%) were tachycardic, having a pulse rate exceeding 100 beats per minute. Most (243, 89.3%) of the patients were tachypneic, with more than 20 breaths per minute. Meanwhile, about two-thirds, 171(62.9%), were hypothermic as they had an axillary temperature of less than 36.5 ^{o}C. Finally, hypoxemia (peripheral oxygen saturation <90%) was noted in 161 (59.2%) of the patients (Table 1).

Table 1: Clinical data of COVID-19 infected patients admitted to COVID-19 ICU SPHMMC, Addis Ababa, Ethiopia, from June 8, 2020, to May 30, 2021

Variable	Frequency	Percent (%)
Comorbidity		
No	66	24.3
Yes	206	75.7
Type of comorbidity		
Hypertension	109	40.1
Diabetes mellitus	90	33.1
Chronic kidney disease	40	14.7
Bronchial asthma	21	7.7
Malignancy	13	4.8
Retroviral infection	13	4.8
Stroke	10	3.7
Chronic obstructive lung disease	9	3.3
Tuberculosis	8	2.9
Other	18	6.6
Disease severity		
Mild	3	1.1
Severe	75	27.6
Critical	194	71.3
Chief complaints		
Cough	118	43.4
Shortness of breath	112	41.2
Myalgia	20	7.4
Fever	17	6.3
Diarrhea	3	1.1
Anosmia	2	0.7
Duration of symptoms in days(median+ IQR)	5	4–7
Duration from the onset of symptoms to ICU admission(median+ IQR)	6	4–8
Time interval before intubation in days (median+ IQR)	8	6–10
Systolic blood pressure (mmHg)		
<90	25	9.2
≥90	246	90.8
Pulse rate		
<60 beats per minute	4	1.5
60-100 beats per minute	115	42.3
>100 beats per minute	153	56.3
Respiratory rate		
<12 breaths per minute	1	0.4
12-20 breaths per minute	28	10.3
>20 breaths per minute	243	89.3
Axillary temperature (C)		
<36.5	171	62.9
36.5–37.5	69	25.4
>37.5	32	11.8
Oxygen saturation (%)		
<90	161	59.2
90–95	92	33.8
>95	19	7.0

Laboratory, complication, and management-related data

About the laboratory data of the studied patients, the majority (201, 73.9%) of the patients had leukocytosis, evidenced by a baseline white blood cell count of 11,000 cells/L. Of all, 105(38.6%) had a hemoglobin level of less than 12g/dL at initial presentation to the ICU, and 162(39.7%) of the patients had thrombocytopenia (platelet count <150,000).

On the other hand, all patients needed ventilator support, with 108(39.7%) and 164(60.3%) receiving noninvasive and invasive mechanical ventilator support, respectively. The median (IQR) days on mechanical ventilation for the intubated patients was 14(6–20) days. Further, hospital-acquired pneumonia, septic shock, and acute kidney injury were the leading intra-facility complications, affecting 138 (50.7%), 117 (43%), and 110 (40.4%) of the patients, respectively. Moreover, neuromuscular blocking agents were administered to 28 (10.3%) of the patients, while renal replacement therapy and vasopressors were given to 58 (21.3%) and 111 (40.8%) of the patients. Finally, the overall median length of hospital stay was 17 days, with an interquartile range of 9–23.75 (Table 2).

Table 2: Laboratory, complication, and management-related data of COVID-19 infected patients admitted to COVID-19 ICU Center of St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia from June 8, 2020, to May 30, 2021

Variable	Frequency	Percent (%)
Leukocyte count(*109/L)		
<11	71	26.1
≥11	201	73.9
Hemoglobin (g/dL)		
<12	105	38.6
≥12	167	61.4
Platelet (*103)		
<150	162	39.7
≥150	210	60.3
Respiratory support		
Noninvasive ventilation	108	39.7
Invasive mechanical ventilation	164	60.3
Duration in mechanical ventilation in days (median + IQR) (n=164)	14	6–20
No	108	39.7
Yes	164	60.3
Type of in-ICU complication		
Hospital-acquired pneumonia	138	50.7
Septic shock	117	43.0
Acute kidney injury	110	40.4
Acute respiratory distress syndrome	63	23.2
Deep venous thrombosis	24	8.8
Pulmonary embolism	23	8.5
Ventilator-associated pneumonia	21	7.7
Disseminated intravascular coagulopathy	4	1.5
Adjuvant therapy given		
Neuromuscular blocking agent	28	10.3
Renal replacement therapy	58	21.3
Vasopressor	111	40.8
Length of hospital stay in days(In median + IQR)	17	9–23.75

Assessment of management outcome and associated factors with mortality

In the present study, about two-thirds (n=173) of all patients died, making a mortality rate of 64.3% (95CI: 58.6–70.1%). Among those who left the ICU alive, fifty (18.4%) were discharged successfully, and forty-seven were transferred to other units (Figure 3). After a stepwise multivariate logistic analysis, the only variables that showed statistically significant association with mortality were intubation ARDS, pulmonary embolism, and vasopressor usage.

Table 3: Binary logistic regression result on ICU management, interventions and complications of patients with COVID-19 who were died in ICU after admission.

Variable	Number of deaths	Score	P-value	OR
Comorbidity	150(70%)	10.695	0.001	0.569
Intubated (1)	135(83%)	54.96	0.000	.362
Complications				
DVT	14(60.9%)	0.109	0.639	37.469
HAP	101(72%)	8.205	0.880	1.945
VAP	18(86%)	5.320	0.071	3.592
AKI	91(82%)	24.369	0.051	4.171
Pulmonary Embolism	22(96%)	9.172	0.001	13.804
DIC	4(100%)	2.454	0.172	
Septic shock	115(97%)	106.027	0.016	44.563
ARDS	26(93%)	12.468	0.000	9.188
Management				
Renal replacement Therapy	52(83%)	12.468	0.004	3.305
Vasopressor use	118(79.1%)	109.549	0.000	64.865
NMBA used	16(94%)	3.994	0.056	9.660
Antifungal Used	32(76.2%)	4.164	0.077	1.947

The result showed that mortality was significantly associated with (Table 4), intubation (AOR: 2.813; 95% CI: 1.176–6.731), pulmonary embolism (AOR: 36.702; 95% CI: 4.062–331.605), Vasopressor usage (AOR: 84.954; 95% CI: 23.413–308.254), Dialysis or RRT (AOR: 4.191; 95% CI: 1.511-11.620) and ARDS (AOR: 21.149; 95% CI: 4.217–106.075).

Table 4: Results of multivariate logistic regression analysis of factors associated with mortality among COVID-19 infected patients admitted to COVID-19 ICU Center of St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia.

Factors	OR	S.E.	Wald	df	Sig.	AOR	95% C.I. for EXP(B)	
Intubation	1.034	.445	5.398	1	.020	2.813	1.176	6.731
Not intubated		.196	4.8	1	0.000	0.652		
Vasopressor use	3.603	1.123	10.292	1	.001	36.702	4.062	331.605
Vasopressors not used		.17	12.4	1	.000	0.547		
Pulmonary Embolism(PE)	2.07	.724	8.2	1	.004	7.9	1.9	32.93
Without PE		.186	17.776	1	0.00	0.456		
ARDS	1.433	.520	7.584	1	.006	4.191	1.511	11.620
Without ARDS		0.222	24.4	1	.000	0.335		

Note: Only variables with p-value <0.05 were shown here from multivariate logistic regression

4. Discussion

The COVID-19 pandemic continues as a significant global health threat, with a disproportionately high case-to-fatality ratio in settings with poor healthcare and limited resources.[12,13] Identifying the factors for these poor short-term outcomes among hospitalized patients helps guide evidence-based interventions and mitigate the problem. Thus, this study was conducted to explore the mortality rate of COVID-19 disease and associated factors by analyzing patients admitted to the intensive care unit of St. Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia.

The current study showed a high mortality rate, with patients having a critical based on disease severity at presentation, comorbidity (diabetic mellitus, hypertension), septic shock, and intubated patients having an increased risk for death.

Our study demonstrated a comparable mortality rate of 64.3% to the earlier Ethiopian study conducted in north-central Ethiopia, where the overall prevalence of mortality was 67.4% among adult patients admitted to the ICU during the COVID-19 pandemic.[14] Similarly, it was very close to the findings of Elhadi and other authors, who found an ICU mortality of 60.4% among critically ill COVID-19 patients in Libya.[15] The above findings were slightly higher than the in-hospital mortality (48.2%) observed in a multicenter prospective cohort study conducted over multiple African nations.[16]

In contrast, it was much higher than the ICU and hospital mortality rates (20.2%) obtained in a tertiary care center in the United Arab Emirates.[17] The present mortality rate was also much higher than the mortality rate documented among COVID-19 patients in Western Ethiopia, in which the mortality rate and incidence rate of mortality were 16.04% and 14.1 per/1000, respectively.[18] The in-hospital mortality reported in our cohort was higher than the one observed in Latin America (24.1%).[19]

Furthermore, it was also different from the reports of Dongelmans and others who documented crude hospital mortality of 29.9% and 32.0% during Wave 1 and Wave 2 among patients in the Netherlands set, respectively.[20] The overall hospital mortality noted in this study was more than thrice as much as that of the USA, Poland, Germany, and Sweden, being 19.8%[6], 18.4% [21], 17% [22], and 30.3%.[23] It was quite different from the Americans, who recorded mean ICU and hospital mortality rates of 18.4% and 23.8%, respectively.[24]

Our study reported (Table 3) that 83% with (AOR 1.499: 95% CI 1.176–6.731) mortality rate among intubated patients who received IMV. This was comparable with earlier reports of 86–97% from the study done in Wuhan.[25,26]

Vasopressor usage and pulmonary embolism were other significantly associated factors of this adverse outcome. This was also supported by the study done in South Africa, which demonstrated that the need for inotropes or vasopressors was associated with mortality (OR 6.36, 95% CI 1.89–21.36) and A. Alharthy et al., respectively.

Our result showed that 79% of deaths among patients who received vasopressors which was slightly lower than the study done in Atlanta, Georgia, United States, those patients with shock requiring vasopressors (90.3% vs 53.7%; p <0.001) and higher percentage death was observed in patients receiving RRT,83%as compared to the study done by[29] that compare mortality in patients with renal failure requiring renal replacement therapy (53.2% vs 18.4%; p <0.05).

In this particular study, ARDS was another significantly associated complication with COVID-19 ICU mortality (AOR 21.14795%CI: 4.217-106.075),

which was supported by the report done in a systematic review[30], ARDS mortality and ARDS (AOR 6.52, 95% CI 2.66–16.01). The wide CI interval in our case could be explained by a small sample size, which may need further study with a large sample size. These disparities across the different regions can be justified by differences in patient characteristics and socioeconomic status, ICU admission thresholds, health care systems, and availability of variable numbers of ICU beds.[14] Multiple possible explanations can be enumerated for the high mortality noted in this study.

In part, the high critical care mortality might be due to the scarcity of essential resources of care, including steroid therapy, in African countries such as Ethiopia.[16] Most of the studied patients were critically ill at admission to higher care, with various comorbidities. This high mortality might be due to medical complications such as acute respiratory distress syndrome, septic shock, hospital-acquired pneumonia, ventilation-acquired pneumonia, and high intubation rate, which were shown to be strongly associated with mortality.

Furthermore, this study was conducted during the period when COVID-19 cases were intense in Ethiopia when many patients could not be admitted properly and promptly to the ICU due to a shortage of resources and a lack of ICU beds on the background of a high patient flow, which could lead to delay in patient care and subsequent poor outcome. An additional likely explanation is the scarcity of healthcare supplies and inadequate training of healthcare practitioners, as noted in other similar settings.[15] In this regard, better preparedness and state-level control of the surge in COVID-19 infections were quoted to be the possible reasons for better outcomes in affluent countries.[24]

In this particular study, the presence of a comorbid medical condition, intubation, higher length of stay, and patients who develop ARDS were independently associated with the risk of death from COVID-19 disease. These findings were supported by several studies, including the works of Jasparda et al.[31], Mezgebu et al.[32], and Kaso et al.[33] that showed an independent association between the presence of comorbidity and poor short-term outcomes among patients with COVID-19. Again, this study showed that patients with critical disease at admission were more likely to die in comparison to patients who were not critical in addition to the hospital, and this is supported by the study done by Elhadi et al. and Oliveira et al., which showed an independent association of disease severity and death.[6,15] Additionally, a systematic review by Taylor et al. supports this finding.[34]

Limitations

Some important variables that can potentially affect mortality were not consistently available for all patients, and hence, they were not included in the final model. These included neuromuscular blocker effects, the use of systemic corticosteroids, prone positioning, and coagulation profiles. The study was conducted at a single center, and thus, the findings may not be generalizable.

5. Conclusion

This study showed a high mortality rate in the study setting, claiming the lives of two-thirds of the ICU-admitted patients. Patients with critical disease severity, comorbidity, intubation, and those patients who were who developed ARDS and septic shock were at increased risk for death.

Implications of the study

The study tried to touch a timely clinical area, where there is a scarcity of data on African patients with COVID-19 that describes outcomes along with contributing factors during the COVID-19 crisis.

Abbreviation

ARDS: Acute Respiratory Distress Syndrome
CI-Confidence Interval
COVID-19-CoronaVirus 2019
EMCCR- Emergency Medicine and Critical Care Resident
HDU-High Dependence Unit
ICU–Intensive Care Unit
IQR-Interquartile Range
MERS-Middle East Respiratory Syndrome
MV-Mechanical Ventilation
OR–Odd Ratio
RT-PCR-Real-Time Reverse Transcriptase Polymerase Chain Reaction
SARS-COV2- Severe Acute Respiratory Syndrome Corona Virus 2
SPHMMC–Saint Paul's Hospital Millennium Medical College
SPSS-Statistical Package for Social Science
WHO-World Health Organization

Author Contributions

All authors made substantial contributions to the conception, design, acquisition of data, analysis, interpretation of data, drafting of the manuscript, and the critical review of the draft

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Conflict of Interest

The authors declare that they have no competing interests

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