RESEARCH ARTICLE

Characteristics, management and outcomes of critically ill COVID-19 patients admitted to ICU in hospitals in Bangladesh: a retrospective study

AYAN SAHA[1,2], MOHAMMED MOINUL AHSAN[3], TAREK-UL QUADER[4], MOHAMMAD UMER SHARIF SHOHAN[5],
SABEKUN NAHER[6], PREYA DUTTA[1,7], AL-SHAHRIAR AKASH[8], H. M. HAMIDULLAH MEHEDI[9],
ASM ARMAN ULLAH CHOWDHURY[3], HASANUL KARIM[3], TAZRINA RAHMAN[10], AYESHA PARVIN[11]

[1] Disease Biology and Molecular Epidemiology Research Group, Chattogram, Bangladesh; [2] Children's Cancer Institute, Faculty
of Medicine, University of New South Wales, Australia; [3] Intensive Care Unit, 250 Beded General Hospital, Chattogram, Bangladesh;
[4] Intensive Care Unit, Chittagong Medical College, Chattogram, Bangladesh; [5] Department of Biochemistry and Molecular Biology,
University of Dhaka, Dhaka, Bangladesh; [6] Department of Microbiology, University of Chittagong, Chattogram, Bangladesh;
[7] Department of Pharmacy, BGC Trust University Bangladesh, Chattogram, Bangladesh; [8] Department of Genetic Engineering
and Biotechnology, University of Chittagong, Chattogram, Bangladesh; [9] Department of Medicine, 250 Beded General Hospital,
Bangladesh; [10] Department of Microbiology and Virology, Chittagong Medical College, Chattogram, Bangladesh;
[11] Department of Biochemistry, Chittagong Medical College, Chattogram, Bangladesh

Summary

Objectives. *This study aimed to analyze the epidemiological and clinical characteristics of COVID-19 cases and investigate risk factors including comorbidities and age in relation with the clinical aftermath of COVID-19 in ICU admitted cases in Bangladesh.*

Methods. *In this retrospective study, epidemiological and clinical characteristics, complications, laboratory results, and clinical management of the patients were studied from data obtained from 168 individuals diagnosed with an advanced prognosis of COVID-19 admitted in two hospitals in Bangladesh.*

Results. *Individuals in the study sample contracted COVID-19 through community transmission. 56.5% (n = 95) cases died in intensive care units (ICU) during the study period. The median age was 56 years and 79.2% (n = 134) were male. Typical clinical manifestation included Acute respiratory distress syndrome*

(ARDS) related complications (79.2%), fever (54.2%) and cough (25.6%) while diabetes mellitus (52.4%), hypertension (41.1%) and heart diseases (16.7%) were the conventional comorbidities. Clinical outcomes were detrimental due to comorbidities rather than age and comorbid individuals over 50 were at more risk. In the sample, oxygen saturation was low (< 95% SpO2) in 135 patients (80.4%) and 158 (93.4%) patients received supplemental oxygen. Identical biochemical parameters were found in both deceased and surviving cases. Administration of antiviral drug Remdesivir and the glucocorticoid, Dexamethasone increased the proportion of surviving patients slightly.

Conclusions. *Susceptibility to developing critical illness due to COVID-19 was found more in comorbid males. These atypical patients require more clinical attention from the prospect of controlling mortality rate in Bangladesh.*

Introduction

The Coronavirus Disease 2019 (COVID-19), came into limelight in early December 2019, when some cases of pneumonia were reported in Wuhan, Hubei, China; whose cause following laboratory assessment, was found to be a novel strain of virus belonging to the Coronavirus family and was labelled SARS-CoV-2 (Severe acute respiratory syndrome coronavirus 2) [1]. The spread of the infection is a rising, rapidly advancing circumstance and due to this whirlwind rate of spread, COVID-19 has been pronounced as a global pandemic by the WHO since March 11, 2020. As of 23rd September, more than 31.7 million positive cases of COVID-19 have been reported in 217 countries and territories with more than 975,315 deaths. COVID-19 targets the respiratory tract of humans and has similar clinical symptoms to SARS-CoV and MERS-CoV [2-4]. Typical symptoms experienced by COVID-19 positive individuals include fever, dry cough, fatigue, headache,

vomiting, diarrhoea, shortness of breath, myalgia, acute respiratory distress syndrome (ARDS) related symptoms and shock [5-9]. Previous studies reported that the patients who need intensive care tend to be older in age and male, and about 40% have comorbid conditions, including diabetes, cardiac diseases, hypertension, asthma and other chronic illnesses such as liver or kidney disease [10, 11]. According to the World Health Organization, about 5% COVID-19 patients, who are severe or critically ill require admission to an intensive care unit (ICU) [12]. However, shortages of standard healthcare resources, especially ICU supports are causing the high mortality rate of critically ill patients.

The COVID-19 pandemic has imposed an enormous burden and massive challenges to the health care system, especially ICUs, across developed, developing and underdeveloped countries. Likewise, Bangladesh also falls in the category of unfortified countries due to its high population and poor health care system [13]. In Bangladesh, current

median age is 26.7 years and mortality rate is 5.52 [14]. Moreover, life expectancy is 73.4 years and a total of 7% of the county's population are senior citizens [14, 15]. Most of these senior citizens, as well as middle-aged people in the country, have comorbidities, such as diabetes (9.7%), asthma (5.2%), hypertension (20%), cardiac disease (4.5%) and chronic pulmonary disease (11.9%), and around 1.3 to 1.5 million cancer patients in the country are vulnerable to COVID-19 [16-19]. All of these people, who belong to a vulnerable group, may require immediate hospitalisation and intensive care if they contract COVID-19 [11]. Compared to the eight worst affected countries, Bangladesh has the lowest number of COVID-19 ICU beds per 10,000 inhabitants (Supplementary Fig. 1). How the health management system with its poor and limited resources is responding to and tackling critical COVID-19 patients is a matter of inordinate concern. Therefore, it is important for health and government authorities to have information on the clinical features and outcomes of COVID-19 in critically ill cases for them to address the necessities of ICU facilities and prepare for a possible second wave of COVID-19 in Bangladesh. In China, India, Greece and the U.S., similar epidemiological studies have already been conducted sampling COVID-19 patients admitted in the ICU, in order to distinguish COVID-19's clinical implications on patients who had to be admitted in the ICU. Insights obtained from these studies can assist experts to further pinpoint exact management and follow-up medical routines [20-23]. Therefore, this study aims to investigate the epidemiological and clinical features, disease severity, treatment and clinical outcomes of critical COVID-19 cases in Bangladesh with the goal of portraying a bigger picture of severe clinical manifestations of COVID-19 so that the malleability Bangladesh's health care system can be modified in terms of tackling COVID-19.

Methods

PATIENTS AND DATA COLLECTION

This study's sample comprises 168 COVID-19 patients with definite outcomes who were admitted to Chittagong General Hospital and Chittagong Medical College Hospital (COVID-19 unit) between 1st April 2020 and 7th August 2020. The Chittagong General Hospital and Chittagong Medical College Hospital (COVID-19 unit) are specialised hospitals that have been authorised for managing most of the critical COVID-19 patients in the country's economic hub, namely Chattogram city. The epidemiological and demographic data for this study were obtained from the inpatients' files. Approval of this study was provided by the Institutional Review Board (IRB) of Chattogram General Hospital Ethics Committee. In terms of data collection and usage, patients and in some cases, their next of kin (first degree relatives) gave their accord.

THE CRITERIA FOR ICU ADMISSION

Management of all the COVID-19 patients admitted in the ICU were implemented according to the regulations set nationally for COVID-19 management in Bangladesh [24]. Based on clinical symptoms, patients were divided into mild, moderate, severe and critical groups. Most of the severe or critical patients and few moderate ill patients were admitted to the ICU. Those in the severe group have respiratory distress, i.e. a respiratory rate of ≥ 30 beats per minute in a resting state and an oxygen saturation of ≤ 92% SpO2, and those in the critical group experience respiratory failure, Sepsis and shock, thus requiring mechanical ventilation, as well as the combined failure of other organs, which require ICU monitoring and treatment. In both the hospitals combined during the study duration, a total of 1,835 COVID-19 patients were admitted. Of these 1,835 patients, 168 (9.16%) had to be admitted in the ICU and 95 of these 168 ICU patients died. Among the patients who survived, 55.9% (94/168) were in critical condition, 39.9% (67/168) were in severe condition and other 4.2% (7/168) were in moderate condition. The coordinative physicians were accountable for collecting this data from the patients. ARDS was defined according to the Berlin definition [25], and shock was defined according to the sepsis-3 criteria [26].

RT-PCR ASSAY FOR COVID-19

Whether the cases of the sample were positive with COVID-19 was confirmed via a real-time reverse transcription polymerase chain reaction (RT-PCR) assay of respiratory tract samples. Throat swabs were collected and maintained in the viral transport medium. The laboratory test assays for COVID-19 were conducted according to standards set by the World Health Organisation's (WHO). Upper and lower respiratory tract specimens were collected in order to extract SARS-CoV-2 RNA. The RNA was obtained and further tested by means of RT-PCR using the same method that was described previously [20].

STATISTICAL ANALYSIS AND PLOTTING

Descriptive statistical analyses were performed to express categorical variables with numbers and proportions. These were then compared using a chi-square test. P values of less than or equal to 0.05 (two-sided) were considered statistically significant. R-script and GraphPad Prism version 7.04 was used to perform all of the statistical analyses and the figure plotting. Patients with at least one type of comorbidity were considered comorbid, and those with no comorbidity were considered non-comorbid patients.

Results

CLINICAL FEATURES, EPIDEMIOLOGICAL FEATURES AND VITAL SIGNS EXAMINATION

Among the 168 COVID-19 patients admitted in the ICU with a confirmed outcome, 95 (56.5%) of the severely ill patients died in the ICU and the remaining 73 patients (43.5%) were transferred to the isolation ward following improvement (Tab. I). Although 66.7% of the patients were over 50 years old, the highest proportion (28.6%)

Tab. I. Demographic and baseline features of COVID-19 ICU patients.

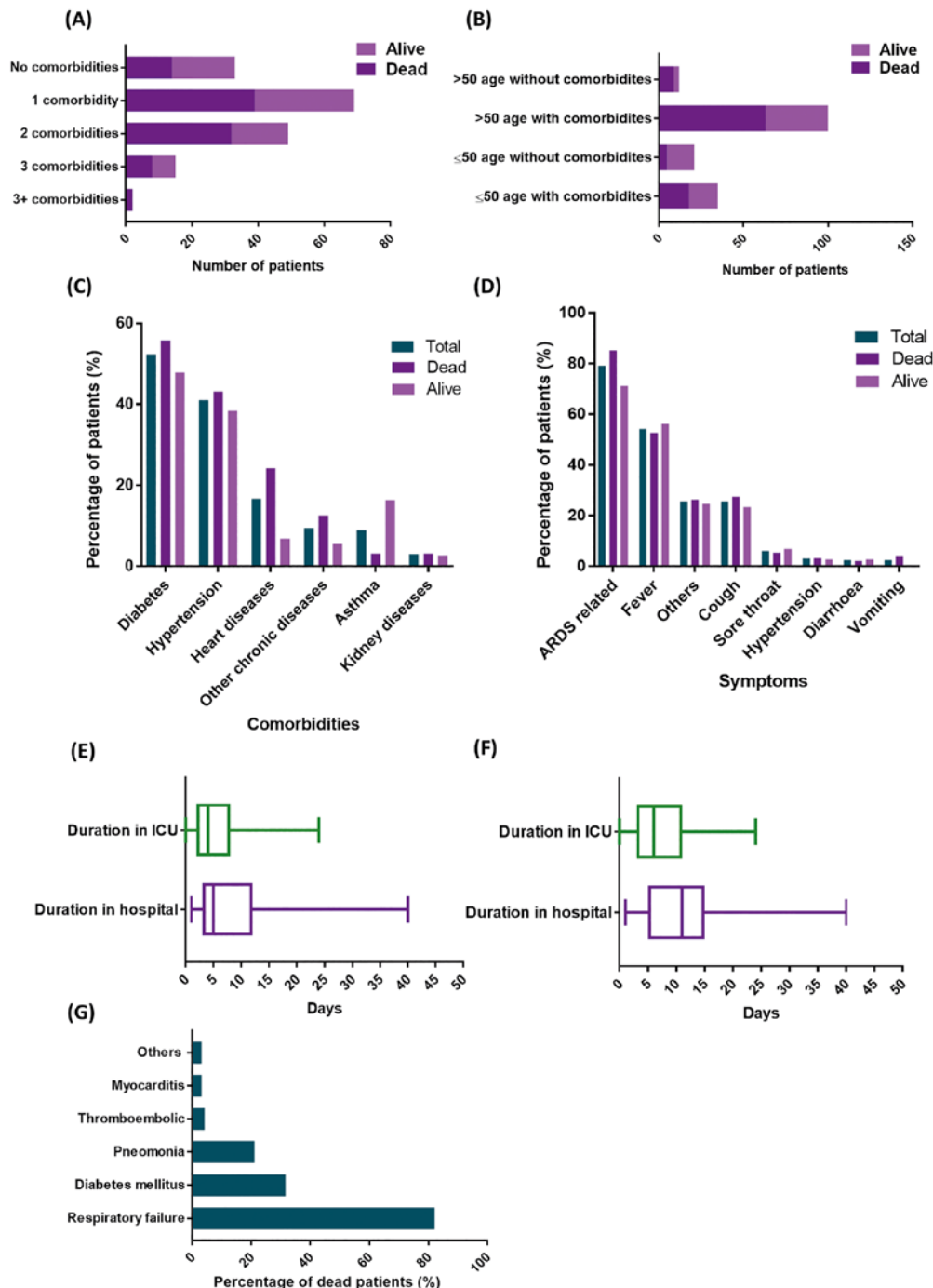| Variable	All patients (%)	Dead (%)	Alive (%)	Pearson's χ^2	P-value
Age (n = 168; dead = 95; alive = 73)					
11-20	2/168 (1.2%)	2/95 (2.1%)	0/73 (0.0%)	14.7	0.03
21-30	11/168 (6.5%)	4/95 (4.2%)	7/73 (9.6%)		
31-40	14/168 (8.3%)	4/95 (4.2%)	10/73 (13.7%)		
41-50	29/168 (17.3%)	13/95 (13.7%)	16/73 (21.9%)		
51-60	48/168 (28.6%)	34/95 (35.8%)	14/73 (19.1%)		
61-70	36/168 (21.4%)	20/95 (21%)	16/73 (21.9%)		
71-80	22/168 (13.1%)	15/95 (15.8%)	7/73 (9.6%)		
80+	6/168 (3.6%)	3/95 (3.1%)	3/73 (4.1%)		
Sex (n = 168; dead = 95; alive = 73)					
Male	134/168 (79.8%)	75/95 (78.9%)	59/73 (80.8%)	0.09	0.76
Female	34/168 (20.2%)	20/95 (21.0%)	14/73 (19.1%)		
Dwelling place (n = 168; dead = 95; alive = 73)					
Urban	110/168 (65.5%)	62/95 (65.3%)	48/73 (65.6%)	0.00	0.95
Rural	58/168 (34.5%)	33/95 (34.4%)	25/73 (34.2%)		
No	12/168 (7.1%)	9/95 (9.5%)	3/73 (4.1%)		
Comorbidities (n = 168; dead = 95; alive = 73)					
Diabetes	88/168 (52.4%)	53/95 (55.8%)	35/73 (47.9%)	1.02	0.31
Hypertension	69/168 (41.1%)	41/95 (43.2%)	28/73 (38.4%)	0.39	0.53
Heart diseases	28/168 (16.7%)	23/95 (24.2%)	5/73 (6.8%)	8.96	0.00
Other chronic diseases	16/168 (9.5%)	12/95 (12.6%)	4/73 (5.5%)	2.45	0.12
Asthma	15/168 (8.9%)	3/95 (3.2%)	12/73 (16.4%)	8.95	0.00
Kidney diseases	5/168 (3.0%)	3/95 (3.2%)	2/73 (2.7%)	0.02	0.87
Common symptoms during hospital admission (n = 168; dead = 95; alive = 73)					
ARDS related	133/168 (79.2%)	81/95 (85.3%)	52/73 (71.2%)	4.93	0.03
Fever	91/168 (54.2%)	50/95 (52.6%)	41/73 (56.2%)	0.21	0.65
Others	43/168 (25.6%)	25/95 (26.3%)	18/73 (24.7%)	0.06	0.81
Cough	43/168 (25.6%)	26/95 (27.4%)	17/73 (23.3%)	0.36	0.55
Sore throat	10/168 (6.0%)	5/95 (5.3%)	5/73 (6.8%)	0.19	0.67
Hypertension	5/168 (3.0%)	3/95 (3.2%)	2/73 (2.7%)	0.02	0.87
Diarrhoea	4/168 (2.4%)	2/95 (2.1%)	2/73 (2.7%)	0.07	0.79
Vomiting	4/168 (2.4%)	4/95 (4.2%)	0/73 (0.0%)	3.15	0.08

n: number of patients.

was between 51 and 60 years old. The proportion of male patients (79.8%) was more than female patients (20.2%). The COVID-19 individuals were into diverse professions and while the 10 (6.0%) of the patients had direct involvement in the healthcare system, most of the patients were from urban areas (65.5%). Persistence of a comorbidity was directly proportional to the state of being admitted in the ICU. As shown in Figure 1A, the proportion of deceased patients was relatively low in the group without comorbidities. Interestingly, the patients who were over 50 years old and had comorbidities comprise 66.3% of the total deaths, with the number of deaths being seven times the number of deaths in the group without comorbidities (Fig. 1B). About 82.1% (138/168) of patients had at least one coexisting chronic illness, predominantly diabetes (52.4%), hypertension (41.1%) or heart disease (16.7%) (Tab. I). The prevalence of diabetes, hypertension and heart disease in deceased patients was slightly higher (Fig. 1C). Interestingly, patients with asthma survived well compared to other comorbidities. The most common symptoms

experienced by patients were ARDS (133/168; 79.2%), fever (91/168; 54.2%) and coughing (43/168; 25.6%) (Fig. 1D). The median length of hospital stay was five days, and the median length of ICU stay was four days (Fig. 1E). The average duration of stay in the ICU was higher in surviving patients. In surviving patients, the median length of hospital stay was eleven days, and the median length of ICU stay was six days (Fig. 1F). In case of the deceased population of this study, respiratory failure (78/95; 82.1%), diabetes mellitus related complications (30/95; 31.6%), pneumonia (20/95; 21.0%), thromboembolic (4/95; 4.2%) and myocarditis (3/95; 7.4%) were found to be the most prevalent causes of death (Fig. 1G).

The body temperatures for all individuals in the study sample (Tab. II) were measured, and this ranged from 98°F to 102+°F. The vital signs at admission to the ICU were moderate fever ≥ 99°F for 40 patients (71.1%), heart rate ≥ 100 beats per minute for 85 patients (51%) and a respiratory rate of ≥ 25 breaths per minute in 56% of the recorded patients (Tab. II). The patients who
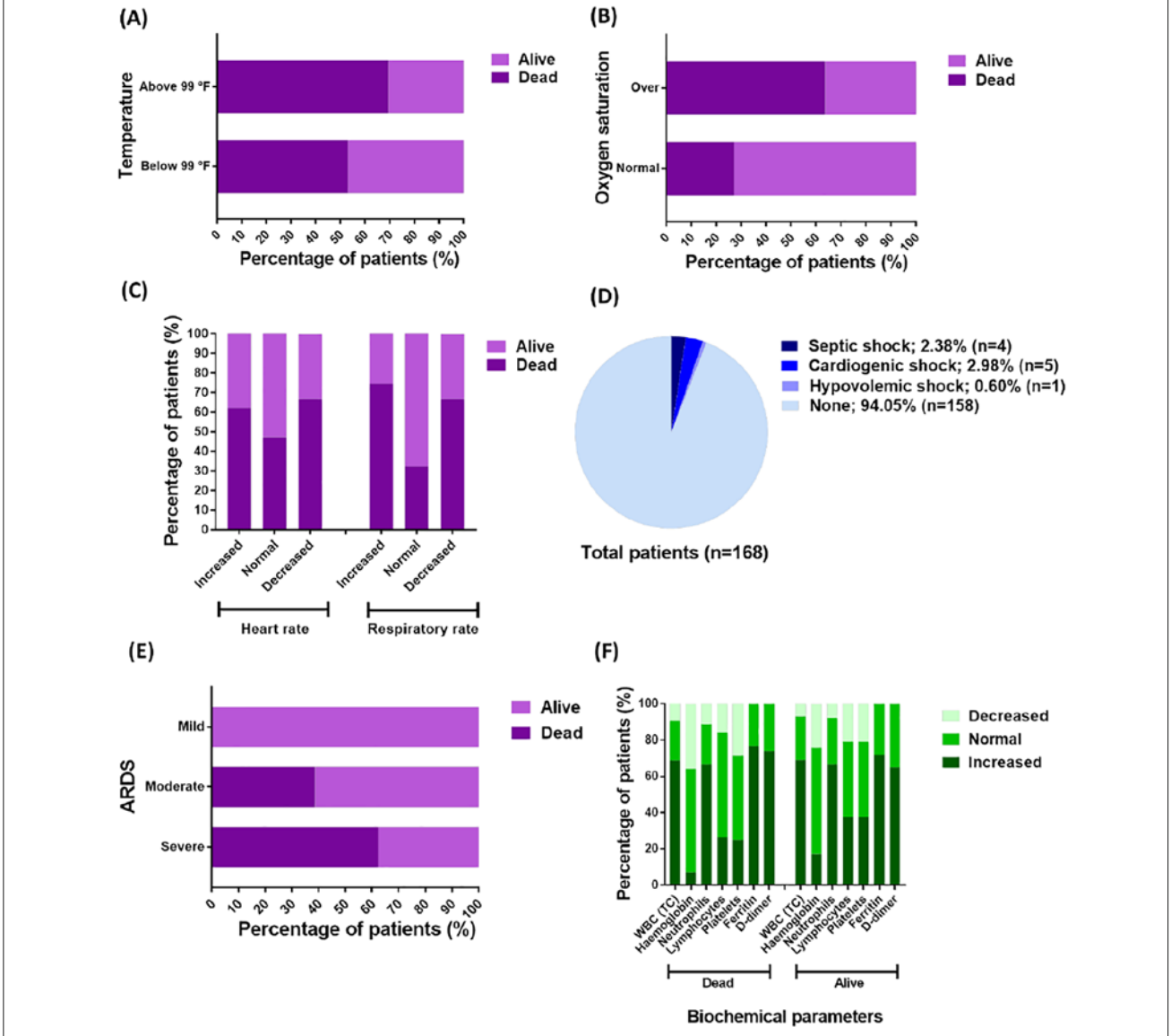
Fig. 1. The clinical features of Bangladeshi patients infected with COVID-19 admitted to the ICU. (**A**) Frequency of number of comorbidities in patients admitted to the ICU; (**B**) Relationship between age and comorbidities and its frequency in patients; (**C**) Percentage of the occurrence of different comorbidities in total, dead and alive patients; (**D**) Percentage of the occurrence of different symptoms in total, dead and alive patients; (**E**) Boxplot of the number of days in the ICU and hospital for patients admitted to the ICU, with the boxes spanning the 25 to 75 percentiles and the horizontal lines in the boxes representing the medians; (**F**) Boxplot of the number of days in the ICU and hospital for survived patients admitted to the ICU, with the boxes spanning the 25 to 75 percentiles and the horizontal lines in the boxes representing the medians;(**G**) Distribution of the reasons for death. ARDS: acute respiratory distress syndrome; ICU: intensive care unit.

had a moderate or high fever (≥ 99°F) tended to have a higher mortality rate than those with a mild or no fever (Fig. 2A). Oxygen saturation was low (< 5% SpO2) in 135 patients (80.4%) and the mortality rate of these patients was relatively high (Fig. 2B). The death rate of patients who had an abnormal heart rate and respiratory rate was higher (Fig. 2C). Shock occurred in 10 patients

(5.9%), including cardiogenic shock in 5 patients (2.9%) and septic shock in 4 patients (2.4%) (Fig. 2D). Of all 168 ICU patients, seven (4.2%) were classified as having a hypertensive crisis. Unfortunately, none of these patients survived. ARDS occurred in 167 (99.4%) patients, with 31 patients (18.5%) having moderate ARDS, three patients (1.8%) having mild ARDS and

Fig. 2. Vital signs, risk factors and laboratory findings. (**A**) Distribution of the clinical outcomes (dead or alive) of the patients in the no or low fever (≤ 99°F) group compared to those in the moderate or high fever (> 99°F) group; (**B**) Distribution of the clinical outcomes (dead or alive) of the patients in the normal oxygen saturation (≥ 95% SpO2) group compared to those in the low oxygen saturation (< 95% SpO2) group; (**C**) Distribution of dead and alive patients according to their heart rate and respiratory rate, namely whether it was increased, normal or decreased, with the normal reference values being a heart rate of 60 to 100 beats per minute and a respiratory rate of 12 to 20 breaths per minute; (**D**) Pie chart of the occurrence of septic shock, cardiogenic shock and hypovolemic shock; (**E**) Distribution of the clinical outcomes (dead or alive) of patients in the mild, moderate and severe ARDS groups; (**F**) Biochemical parameters of COVID-19 patients admitted to the ICU, with the normal reference values being: normal range of WBC of 4-10 × 10⁹ per L, normal range of haemoglobin of 130-175 g per L, normal range of neutrophils of 1.8-6.3 × 10⁹ per L, normal range of lymphocytes of 1.1-3.2 × 10⁹ per L, normal range of platelets of 125-350×10⁹ per L, D-dimer < 0.5 μg/mL, Ferritin < 500 μg/L. ARDS: acute respiratory distress syndrome; F: Fahrenheit; ICU: intensive care unit; L: litre; TC: total count; WBC: white blood cell.

133 patients (79%) experiencing severe ARDS. Eighty three out of the 133 severe ARDS patients (62.4%) died (Fig. 2E).

LABORATORY FINDINGS

The laboratory findings of the patients upon admission to the ICU are shown in Figure 2 and Table III. Statistical analysis was only conducted on the patients whose laboratory results were available. Elevated levels of White Blood Cell (WBC) and Neutrophils were identified in 68.9% (42/61), and 66.7% (44/64) patients, respectively. For 71 patients who underwent tests on

D-dimer, an excessive level was identified from 49 (69.0%) patients, with the level higher than 5 mg/L in 15 (21.1%) patients. Out of the 69 patients who had tests of Ferritin, elevated levels of Ferritin were identified in 53 (76.8%) patients (Tab. III). The biochemical parameters of the survived and non-survived patients were also compared, and it was found that they were essentially identical (Figure 2F).

MANAGEMENT AND MEDICATIONS

Oxygen therapy was administered in accordance with the patients' oxygen saturation. Over 90% of the

Tab. II. Vital signs at ICU admission of COVID-19 patients.

Variable	All patients (%)	Dead (%)	Alive (%)	Pearson's χ^2	P-value
Temperature (°F) (n = 168; dead = 95; alive = 73)					
< 98.0	5/168 (3.0%)	4/95 (4.2%)	1/73 (1.4%)	7.38	0.19
98 to 99	127/168 (75.6%)	66/95 (69.5%)	61/73 (83.5%)		
99.1 to 100	31/168 (18.4%)	21/95 (22.1%)	10/73 (13.7%)		
100.1 to 102	3/168 (1.8%)	2/95 (2.1%)	1/73 (1.4%)		
102+	2/168 (1.2%)	2/95 (2.1%)	0/73 (0.0%)		
Heart rate (normal: 60 to 100 beats per minute) (n = 168; dead = 95; alive = 73)					
Increased	85/168 (50.6%)	53/95 (55.8%)	32/73 (43.8%)	4.28	0.12
Normal	68/168 (40.5%)	32/95 (33.7%)	36/73 (49.3%)		
Decreased	15/168 (8.9%)	10/95 (10.5%)	5/73 (6.9%)		
Respiratory rate (normal: 12 to 20 breaths per minute) (n = 168; dead = 95; alive = 73)					
Increased	51/91 (56.0%)	38/53 (71.7%)	13/38 (34.2%)	15.09	0.00
Normal	34/91 (37.4%)	11/53 (20.8%)	23/38 (60.5%)		
Decreased	6/91 (6.6%)	4/53 (7.5%)	2/38 (5.3%)		
Blood pressure (systolic) (normal range: 90 to 120 mmHg) (n = 168; dead = 95; alive = 73)					
Hypertensive crisis	7/168 (4.2%)	7/95 (7.4%)	0/73 (0.0%)	7.42	0.06
Increased	78/168 (46.4%)	39/95 (41.0%)	39/73 (53.4%)		
Normal	50/168 (29.7%)	28/95 (29.5%)	22/73 (30.1%)		
Decreased	33/168 (19.7%)	21/95 (22.1%)	12/73 (16.5%)		
Blood pressure (diastolic) (normal range: 60 to 80 mmHg) (n = 168; dead = 95; alive = 73)					
Hypertensive crisis	7/168 (4.2%)	7/95 (7.3%)	0/73 (0.0%)	18.97	0.00
Increased	40/168 (23.8%)	22/95 (23.2%)	18/73 (24.7%)		
Normal	100/168 (59.5%)	47/95 (49.5%)	53/73 (72.6%)		
Decreased	21/168 (12.5%)	19/95 (20.0%)	2/73 (2.7%)		
Saturation of O2 (SpO2%) (normal range: 95 to 100) (n = 168; dead = 95; alive = 73)					
95 to 100	33/168 (19.6%)	9/95 (9.5%)	24/73 (32.8%)	33.88	1.813e-05
90 to 94	25/168 (14.8%)	7/95 (7.4%)	18/73 (24.6%)		
85 to 89	34/168 (20.2%)	26/95 (27.3%)	8/73 (11.0%)		
75 to 84	23/168 (13.8%)	15/95 (15.8%)	8/73 (11.0%)		
65 to 74	19/168 (11.3%)	11/95 (11.6%)	8/73 (11.0%)		
55 to 64	19/168 (11.3%)	16/95 (16.8%)	3/73 (4.1%)		
< 55	15/168 (9.0%)	11/95 (11.6%)	4/73 (5.5%)		
Acute respiratory distress syndrome (ARDS) (n = 168; dead = 95; alive = 73)					
Severe	133/168 (79.2%)	83/95 (87.4%)	50/73 (68.5%)	9.79	0.00
Moderate	31/168 (18.5%)	12/95 (12.6%)	19/73 (26.0%)		
Mild	3/168 (1.7%)	0/95 (0.0%)	3/73 (4.1%)		
None	1/168 (0.6%)	0/95 (0.0%)	1/73 (1.4%)		

* Number of patients with available information; ICU: Intensive care unit; n: number of patients.

patients who were admitted to the ICU (158/168; 93.6%) required oxygen during the disease. Of the 158 patients with available information, 64.8% (103/159) received oxygen support via a mask, and 25.2% (40/159) received oxygen support via a high flow nasal cannula.

Prone positioning was implemented to enhance oxygenation and improve lung recruitability in some patients with severe ARDS (151/168; 89.9%) (Tab. IV). Convalescent plasma (CP) was transfused into eight patients. However, only three of these eight patients survived after the convalescent plasma transfusion. As for the medications administered, 94 patients (56.0%) received antiviral agents, 164 patients (97.6%) received antimicrobial agents, 126 patients (75.0%) received an anti-allergic drug, 149 patients (88.7%) received anti-inflammatory drugs and 145 patients (86.3%) received vitamin and mineral supplements. Favipiravir (71/168; 42.3%) and Remdesivir (31/168; 18.4%) were

the most commonly used antiviral drugs among the ICU patients. However, the proportion of surviving patients was greater in the Remdesivir cohort than the Favipiravir cohort (Fig. 3A). Additionally, Methylprednisolone (97/168; 57.7%) and Dexamethasone (40/168; 23.8%) were the two most used glucocorticoids (Fig. 3A). Meropenem (126/168; 76.2%) was the most commonly used antibiotic, followed by Ceftriaxone (50/168; 29.8%), Azithromycin (33/168; 19.4%) and Moxifloxacin (33/168; 19.4%) (Fig. 3A). As shown in Figure 3B, the proportion of survived patients was slightly higher with the use of Meropenem, as well as Remdesivir and Dexamethasone, than with the use of Favipiravir or Methylprednisolone. Six patients were treated with Remdesivir and Dexamethasone and only one of them died. The vitamin C, vitamin D and zinc supplements that were commonly used did not show any improved clinical outcomes (Fig. 3C).

Tab. III. Laboratory findings of patients with COVID-19 in ICUs.

Variable	All patients (%)	Dead (%)	Alive (%)	Pearson's χ^2	P-value
White blood cell count (× 10^9 per L; normal range 4-10) (n* = 61; dead* = 32; alive* = 29)					
Increased	42/61 (68.9%)	22/32 (68.8%)	20/29 (69.0%)		
Normal	14/61 (23.0%)	7/32 (21.9%)	7/29 (24.1%)	0.15	0.93
Decreased	5/61 (8.2%)	3/32 (9.4%)	2/29 (6.9%)		
Haemoglobin (g/L; normal range 130-175) (n* = 57; dead* = 28; alive* = 29					
Increased	7/57 (12.3%)	2/28 (7.1%)	5/29 (17.2%)		
Normal	33/57 (57.9%)	16/28 (57.1%)	17/29 (58.6%)	1.82	0.40
Decreased	17/57 (29.8%)	10/28 (35.7%)	7/29 (24.1%)		
Neutrophils (× 10^9 per L; normal range 1.8-6.3) (n* = 66; dead* = 27; alive* = 39)					
Increased	44/66 (66.7%)	18/27 (66.7%)	26/39 (66.7%)		
Normal	16/66 (24.2%)	6/27 (22.2%)	10/39 (25.6%)	0.28	0.87
Decreased	6/66 (9.1%)	3/27 (11.1%)	3/39 (7.7%)		
Lymphocytes (× 10^9 per L; normal range 1.1-3.2) (n* = 48; dead* = 19; alive* = 29)					
Increased	16/48 (33.3%)	5/19 (26.3%)	11/29 (37.9%)		
Normal	23/48 (47.9%)	11/19 (57.9%)	12/29 (41.4%)	1.27	0.53
Decreased	9/48 (18.8%)	3/19 (15.8%)	6/29 (20.7%)		
Platelets (× 10^9 per L; normal range 125-350) (n* = 57; dead* = 28; alive* = 29)					
Increased	18/57 (31.6%)	7/28 (25.0%)	11/29 (37.9%)		
Normal	25/57 (43.9%)	13/28 (46.4%)	12/29 (41.4%)	1.20	0.55
Decreased	14/57 (24.6%)	8/28 (28.6%)	6/29 (20.7%)		
D-dimer (mg/L; normal range < 0.5) (n* = 71; dead* = 31; alive* = 40)					
Normal	22/71 (31.0%)	8/31 (25.8%)	14/40 (35.0%)		
> 0.5 to ≤ 5	34/71 (47.9%)	16/31 (51.6%)	18/40 (45.0%)		
> 5 to ≤ 10	11/71 (15.5%)	4/31 (12.9%)	7/40 (17.5%)	2.4	0.48
> 10	4/71 (5.6%)	3/31 (9.7%)	1/40 (2.5%)		
Ferritin concentration (μg/L; normal range < 500) (n* = 69; dead* = 30; alive* = 39)					
Normal	16/69 (23.2%)	7/30 (23.3%)	9/39 (28.1%)		
≥ 500 to < 1,000	25/69 (36.2%)	13/30 (43.3%)	12/39 (30.8%)		
≥ 1,000 to < 1,500	13/69 (18.8%)	5/30 (16.7%)	8/39 (20.5%)	1.65	0.80
≥ 1,500 to < 2,000	11/69 (15.9%)	4/30 (13.3%)	7/39 (17.9%)		
≥ 2,000	4/69 (5.8%)	1/30 (3.3%)	3/39 (7.7%)		

* Number of patients with available information; ICU: Intensive care unit; n: number of patients.

Discussion

On 22nd September 2020, COVID-19 cases in Bangladesh totalled to 352,178, with 260,790 recovered cases and 5,007 deaths. The information on the clinical characteristics of COVID-19 individuals having an advanced and deleterious prognosis of COVID-19 is still scarce although the positive cases are nowhere near decreasing. The median age of the critical COVID-19 patients of the sample in this study (56 years) is lower than that of Italy, the United States of America (USA), Greece and China [22, 27-29]. However, the gender propensity of this study's patients (mostly men) is consistent with that of COVID-19 patients in ICUs in Italy, USA and China [27-29]. The management of patients with several comorbidities is challenging due to their frailty and increased risk of mortality, which is amplified when these comorbid individuals are diagnosed with COVID-19. The current study has found that older (≥ 50) Bangladeshi male patients with previous comorbidities, such as diabetes, hypertension and heart diseases, are profoundly susceptible to COVID-19, which is comparative to the pattern that has been revealed in China, Italy and New York [8, 27, 29, 30].

In Bangladesh, most people diagnosed with diabetes are from urban areas, and the prevalence of diabetes is highest among those aged from 55 to 59 years [31]. The presence of comorbidity might explain COVID-19's severity in Bangladeshi patients aged 51 to 60 years.

Another finding from this study was that patients with asthma survived well compared to other comorbidities. As with other viruses, SARS-CoV-2 triggers asthma exacerbations, which is why asthma is listed as a risk factor for COVID-19 related morbidity. However, this study's finding is consistent with that of Leonardo Antonicelli et al. (2020), who found that asthma seems to play a minimal role in clinical severity [32]. ARDS (79.2%) was found to be the most prominent symptom within the study sample upon admission to the ICU, and this was also reflected in patients described in reports from China, USA and Europe [8, 27, 28]. Other noteworthy symptoms are fever (8.40%) and coughing (7.70%), and the results obtained by this study align with the trends concerning high prevalence seen in other countries [27-29]. Intestinal signs and symptoms, such as diarrhoea, were rarely developed by the patients in this study.

Tab. IV. Managements of patients with COVID-19 in ICUs.

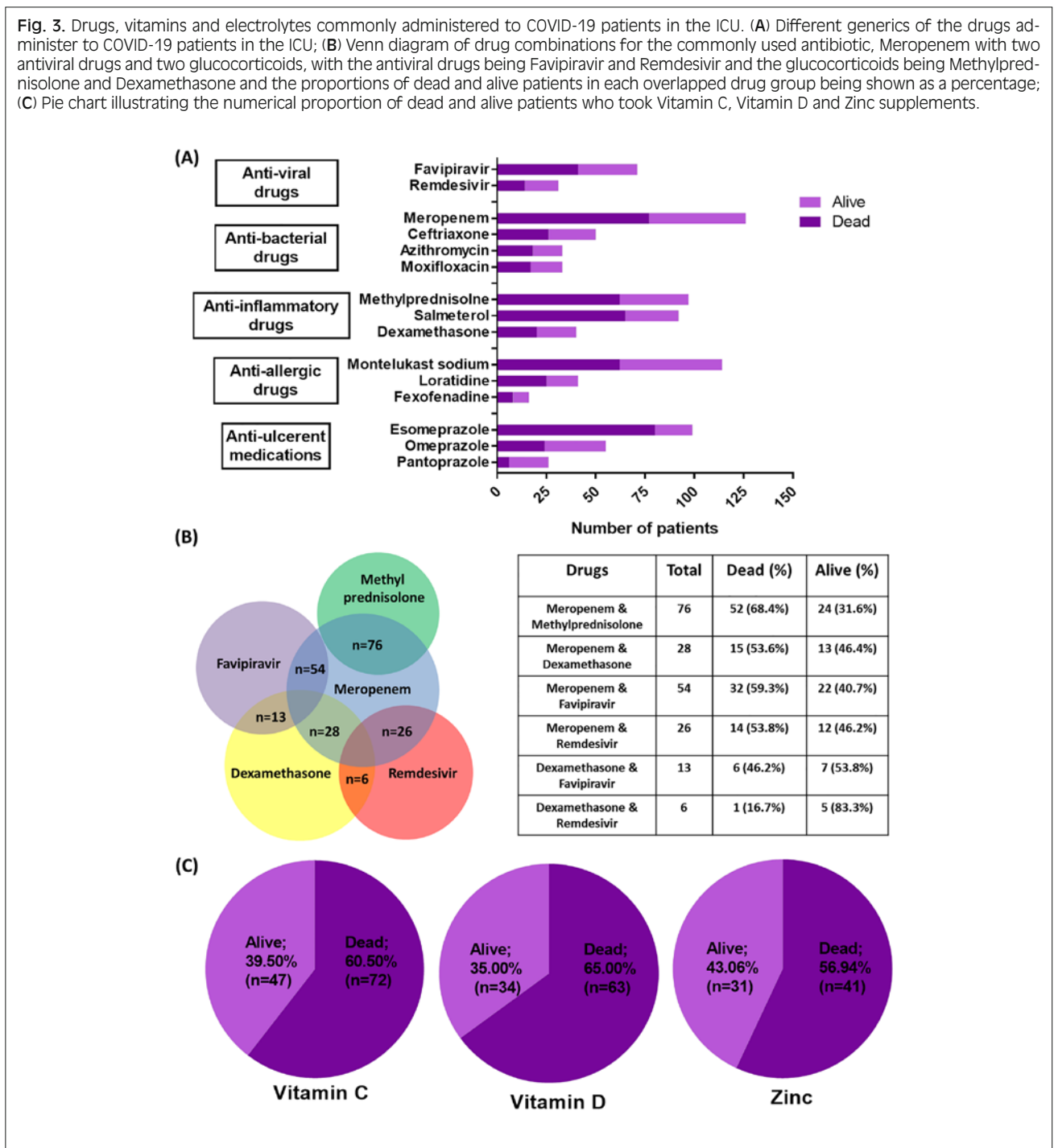| Variable	All patients (%)	Dead (%)	Alive (%)	Pearson's χ^2	P-value
Respiratory support (n* = 159; dead* = 86; alive* = 73)					
Oxygen delivery by mask	103/159 (64.8%)	50/86 (58.1%)	53/73 (72.6%)	8.69	0.03
High-flow nasal cannula	40/159 (25.2%)	28/86 (32.6%)	12/73 (16.4%)		
Oxygen delivery by nasal cannula	12/159 (7.5%)	5/86 (5.8%)	7/73 (9.6%)		
Non-invasive mechanical ventilation	3/159 (1.9%)	3/86 (3.5%)	0/73 (0.0%)		
Invasive mechanical ventilation	0/159 (0.0%)	0/86 (0.0%)	0/73 (0.0%)		
Extracorporeal membrane oxygenation (ECMO)	0/159 (0.0%)	0/86 (0.0%)	0/73 (0.0%)		
None	1/159 (0.6%)	0/86 (0.0%)	1/73 (1.4%)		
Oxygen supply (n* = 159; dead* = 86; alive* = 73)					
< 2 L min–1	2/159 (1.3%)	0/86 (0.0%)	2/73 (2.7%)	132.32	2.2e-16
> 2 to < 5 L min–1	17/159 (10.7%)	9/86 (10.5%)	8/73 (11.0%)		
> 5 to < 10 L min–1	34/159 (21.4%)	17/86 (19.8%)	17/73 (23.3%)		
> 10 to < 20 L min–1	97/159 (61%)	53/86 (61.6%)	44/73 (60.3%)		
> 20 to < 30 L min–1	1/159 (0.6%)	1/86 (1.2%)	0/73 (0.0%)		
> 30 to < 50 L min–1	5/159 (3.1%)	5/86 (5.8%)	0/73 (0.0%)		
> 50 to < 70 L min–1	2/159 (1.3%)	1/86 (1.2%)	1/73 (1.4%)		
> 70 L min–1	0/159 (0.0%)	0/86 (0.0%)	0/73 (0.0%)		
None	1/159 (0.6%)	0/86 (0.0%)	1/73 (1.4%)		
Prone position (n = 168; dead = 95; alive = 73)					
Yes	151/168 (89.9%)	86/95 (90.5%)	65/73 (89.0%)	0.10	0.75
No	17/168 (10.1%)	9/95 (9.5%)	8/73 (11.0%)		
Plasma transfusion (n = 168; dead = 95; alive = 73)					
Yes	8/168 (4.8%)	5/95 (5.3%)	3/73 (4.1%)	0.12	0.73
No	160/168 (95.2%)	90/95 (94.7%)	70/73 (95.9%)		
Antivirus drugs (n = 168; dead = 95; alive = 73)					
Yes	94/168 (56.0%)	56/95 (58.9%)	38/73 (52.1%)	0.80	0.37
No	74/168 (44.0%)	39/95 (41.1%)	35/73 (47.9%)		
Antibacterial drugs (n = 168; dead = 95; alive = 73)					
Yes	164/168 (97.6%)	95/95 (100.0%)	69/73 (94.5%)	5.33	0.02
No	4/168 (2.4%)	0/95 (0.0%)	4/73 (5.5%)		
Anti-allergic drugs (n = 168; dead = 95; alive = 73)					
Yes	126/168 (75.0%)	69/95 (72.6%)	57/73 (78.1%)	0.65	0.42
No	42/168 (25.0%)	26/95 (27.4%)	16/73 (21.9%)		
Antiemetic drugs (n = 168; dead = 95; alive = 73)					
Yes	12/168 (7.1%)	7/95 (7.4%)	5/73 (6.8%)	0.02	0.90
No	156/168 (92.9%)	88/95 (92.6%)	68/73 (93.2%)		
Vitamin and mineral supplements (n = 168; dead = 95; alive = 73)					
Yes	145/168 (86.3%)	90/95 (94.7%)	55/73 (75.3%)	13.14	0.00
No	23/168 (13.7%)	5/95 (5.3%)	18/73 (24.7%)		
Hypertension related drugs (n = 168; dead = 95; alive = 73)					
Yes	65/168 (38.7%)	38/95 (40.0%)	27/73 (37.0%)	0.16	0.70
No	103/168 (61.3%)	57/95 (60.0%)	46/73 (63.0%)		
Atypical neuroleptic/Anti-psychotic drugs (n = 168; dead = 95; alive = 73)					
Yes	6/168 (3.6%)	5/95 (5.3%)	1/73 (1.4%)	1.82	0.18
No	162/168 (96.4%)	90/95 (94.7%)	72/73 (98.6%)		
Anti-inflammatory drugs (n = 168; dead = 95; alive = 73)					
Yes	149/168 (88.7%)	87/95 (91.6%)	62/73 (84.9%)	1.82	0.18
No	19/168 (11.3%)	8/95 (8.4%)	11/73 (15.1%)		
Sedatives (n = 168; dead = 95; alive = 73)					
Yes	14/168 (8.3%)	6/95 (6.3%)	8/73 (11.0%)	1.17	0.28
No	154/168 (91.7%)	89/95 (93.7%)	65/73 (89.9%)		
Heart disease related drugs (n = 168; dead = 95; alive = 73)					
Yes	18/168 (10.7%)	10/95 (10.5%)	8/73 (11.0%)	0.01	0.93
No	150/168 (89.3%)	85/95 (89.5%)	65/73 (89.0%)		

Continues

Follows

Tab. IV. Managements of patients with COVID-19 in ICUs.

Variable	All patients (%)	Dead (%)	Alive (%)	Pearson's χ^2	P-value
Bronchodilator (n = 168; dead = 95; alive = 73)					
Yes	130/168 (77.4%)	76/95 (80.0%)	54/73 (74.0%)	0.86	0.35
No	38/168 (22.6%)	19/95 (20.0%)	19/73 (26.0%)		
Anti-ulcerent medications (n = 168; dead = 95; alive = 73)					
Yes	143/168 (85.1%)	81/95 (85.3%)	62/73 (84.9%)	0.00	0.95
No	25/168 (14.9%)	14/95 (14.7%)	11/73 (15.1%)		
Thyroid and hormone-related drugs (n = 168; dead = 95; alive = 73)					
Yes	5/168 (3.0%)	2/95 (2.1%)	3/73 (4.1%)	0.57	0.45
No	163/168 (97.0%)	93/95 (97.9%)	70/73 (95.9%)		

* Number of patients with available information; ICU: Intensive care unit; n: number of patients.

Fig. 3. Drugs, vitamins and electrolytes commonly administered to COVID-19 patients in the ICU. (**A**) Different generics of the drugs administer to COVID-19 patients in the ICU; (**B**) Venn diagram of drug combinations for the commonly used antibiotic, Meropenem with two antiviral drugs and two glucocorticoids, with the antiviral drugs being Favipiravir and Remdesivir and the glucocorticoids being Methylprednisolone and Dexamethasone and the proportions of dead and alive patients in each overlapped drug group being shown as a percentage; (**C**) Pie chart illustrating the numerical proportion of dead and alive patients who took Vitamin C, Vitamin D and Zinc supplements.

Majority of the study population had to rely upon supplemental oxygen while being cared for in the ICU. The cause of their inclination towards supplemental oxygen was severe to moderate ARDS which was indicated by their low oxygen saturation levels. In cases with depleting oxygen saturation, Oxygen therapy by high-flow nasal cannula (HFNC) and mechanical ventilators provide higher efficacy in the matter of additional oxygen support [33, 34]. However, given the spike in COVID-19 cases, the demand of HFNC has increased substantially because HFNC has been found to improve therapy by reducing the requirement of invasive ventilation [33]. Unfortunately, during the initial stages of this study HFNC could not be provided to the participating population and ventilators were limited as well which deprived patients of the support of mechanical ventilation when needed. This scarcity of proper ventilation might explain the prevalence of a high mortality rate in patients with a moderate to high fever and a low oxygen saturation.

Therapeutic plasma exchange has been recommended as a treatment measure for patients with severe COVID-19; however, this study found that therapeutic plasma exchange had no significant impact on the improvement of critically ill patients. According to a recent study, therapeutic plasma exchange can be effective in critically ill patients if it can be applied within the first week of symptom onset [35]. Unfortunately, most of the patients in the current study were admitted to the ICU in a critical condition due to the lack of available ICU beds. Therefore, it may have been too late for convalescent plasma therapy to have an effective impact.

To the extent of the author's knowledge, so far, this study is the only study on the medicine administered to critically ill COVID-19 patients in Bangladesh. Currently, there is no recommended treatment for COVID-19 infection in careful supportive care [36]. In this study, 97.6% of patients received antibacterial agents, 56% received antiviral therapy and 88.7% received anti-inflammatory drugs. Even though the antiviral drug Favipiravir was the mostly used antiviral drug, the survival rate was higher among the patients who had been given Remdesivir. Favipiravir concentrations become lower in critically ill patients than in healthy subjects, which might be one reason why Favipiravir is less effective [37]. Several countries, such as Japan, Taiwan and USA, and the European Union (EU) suggest the conditional use of Remdesivir to treat critical patients [38, 39]. Therefore, Remdesivir can be a better choice over Favipiravir in providing aid to COVID-19 individuals.

A recent report suggests that glucocorticoids may also minimize severe clinical outcomes in critical COVID-19 patients with ARDS [40]. The current study finds that Dexamethasone has comparatively better clinical outcomes than Methylprednisolone. According to a large clinical trial conducted in the United Kingdom (UK), Dexamethasone reduced deaths by about one-third in critical COVID-19 patients who were on ventilator support [41]. In this study, only one out of six patients who were treated with both Remdesivir and Dexamethasone died. However, further studies with larger sample sizes are required to evaluate the effectiveness of the combined use of Remdesivir and Dexamethasone.

Although the findings of this study were significant, limitations were also in order. Firstly, laboratory data collection to conduct a broad and extensive study was inevitably challenging as the laboratory results were not systematically collected. Secondly, the evaluated data was extracted retrospectively from patients' medical files and not all laboratory tests were conducted on all patients. Thirdly, because of the study's objective to identify the critical care needs of patients with the greatest severity of illness, the sample size is small. Therefore, more thorough assessment of comorbidities in larger samples of critical Bangladeshi patients with COVID-19 and future studies are required. Despite these limitations, this study represented the largest cohort of critically ill COVID-19 patients from Bangladesh reported to date.

Conclusions

To summarize, parallel to the data obtained from studies conducted in other countries, there is an elevated prevalence of comorbidities, such as diabetes, hypertension and heart diseases, in a profuse number of COVID-19 patients with critical exposures who are hospitalised in Bangladesh. Since this cohort is more vulnerable in terms of COVID-19 related morbidity and mortality, besides implementing an effective policy for the prevention and control of the disease in general, the authorities should pay more attention to these atypical patients. In conclusion, the findings reported here provide important context for effective strategies for the provision of comprehensive health care to critically ill COVID-19 patients. However, future studies with larger sample sizes are needed in order to assess the risk factors and associated clinical outcomes in a broader sense.

Abbreviations

ARDS: acute respiratory distress syndrome; COVID-19: Coronavirus disease 2019; ECMO: extracorporeal membrane oxygenation; ICU: intensive care unit; RT-PCR: Real-time reverse transcription polymerase chain reaction; USA: United States of America; UK: United Kingdom; WHO: World Health Organization.

Code availability

The source code and pipeline to reproduce our analyses can be accessed at https://github.com/sharifshohan/ Cross_Sectional_Study_Bangladesh.

Acknowledgements

The authors would like to acknowledge all patients and fellow healthcare workers for providing excellent patient care at considerable personal risk.

Conflicts of interest statement

The authors declare no conflict of interest.

Authors' contributions

AS, MMA, HMM, AP and TUQ: Study design. SN, ASA, AUC, HK, TR and PD: Literature review, Data collection. MUSS, HMM and AS: Data analysis, Visualization. SN, HMM and AS: Manuscript writing, Editing. All authors reviewed and approved the final manuscript paper; approved the final version and agreed to be accountable for the work.

References

[1] Bogoch II, Watts A, Thomas-Bachli A, Huber C, Kraemer MUG, Khan K. Pneumonia of unknown aetiology in Wuhan, China: potential for international spread via commercial air travel. J Travel Med 2020;27(2). https://doi.org/10.1093/jtm/taaa008

[2] Li B, Yang J, Zhao F, Zhi L, Wang X, Liu L, Bi Z, Zhao Y. Prevalence and impact of cardiovascular metabolic diseases on COVID-19 in China. Clin Res Cardiol 2020;109:531-8. https://doi.org/10.1007/s00392-020-01626-9

[3] Chan KS, Zheng JP, Mok YW, Li YM, Liu YN, Chu CM, Ip MS. SARS: prognosis, outcome and sequelae. Respirology (Carlton, Vic) 2003;8(Suppl 1):S36-40. https://doi.org/10.1046/j.1440-1843.2003.00522.x

[4] Badawi A, Ryoo SG. Prevalence of diabetes in the 2009 influenza A (H1N1) and the Middle East Respiratory Syndrome Coronavirus: a systematic review and meta-analysis. J Public Health Res 2016;5:733. https://doi.org/10.4081/jphr.2016.733

[5] Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z, Yu T, Xia J, Wei Y, Wu W, Xie X, Yin W, Li H, Liu M, Xiao Y, Gao H, Guo L, Xie J, Wang G, Jiang R, Gao Z, Jin Q, Wang J, Cao B. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet (London, England) 2020;395:497-506. https://doi.org/10.1016/S0140-6736(20)30183-5

[6] Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y, Zhao Y, Li Y, Wang X, Peng Z. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA 2020;323:1061-9. https://doi.org/10.1001/jama.2020.1585

[7] Wu F, Zhao S, Yu B, Chen Y-M, Wang W, Song Z-G, Hu Y, Tao Z-W, Tian J-H, Pei Y-Y, Yuan M-L, Zhang Y-L, Dai F-H, Liu Y, Wang Q-M, Zheng J-J, Xu L, Holmes EC, Zhang Y-Z. A new coronavirus associated with human respiratory disease in China. Nature 2020;579:265-9. https://doi.org/10.1038/s41586-020-2008-3

[8] Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, Liu L, Shan H, Lei CL, Hui DSC, Du B, Li LJ, Zeng G, Yuen KY, Chen RC, Tang CL, Wang T, Chen PY, Xiang J, Li SY, Wang JL, Liang ZJ, Peng YX, Wei L, Liu Y, Hu YH, Peng P, Wang JM, Liu JY, Chen Z, Li G, Zheng ZJ, Qiu SQ, Luo J, Ye CJ, Zhu SY, Zhong NS. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020;382:1708-20.

[9] Alimohamadi Y, Sepandi M, Taghdir M, Hosamirudsari H. Determine the most common clinical symptoms in COVID-19 patients: a systematic review and meta-analysis. JPMH 2020;61:E304-e12. https://doi.org/10.15167/2421-4248/jpmh2020.61.3.1530

[10] Wynants L, Van Calster B, Collins GS, Riley RD, Heinze G, Schuit E, Bonten MMJ, Damen JAA, Debray TPA, De Vos M, Dhiman P, Haller MC, Harhay MO, Henckaerts L, Kreuzberger N, Lohman A, Luijken K, Ma J, Andaur CL, Reitsma JB, Sergeant JC, Shi C, Skoetz N, Smits LJM, Snell KIE, Sperrin M, Spijker R, Steyerberg EW, Takada T, van Kuijk SMJ, van Royen FS, Wallisch C, Hooft L, Moons KGM, van Smeden M. Prediction models for diagnosis and prognosis of covid-19 infection: systematic review and critical appraisal. BMJ 2020;369:m1328. https://doi.org/10.1136/bmj.m1328

[11] Anwar S, Nasrullah M, Hosen MJ. COVID-19 and Bangladesh: challenges and how to address them. Front Public Health 2020;8:154. https://doi.org/10.3389/fpubh.2020.00154

[12] WHO. Clinical management of COVID-19. WHO 2020. Available at: https://www.who.int/publications/i/item/clinical-management-of-covid-19 (accessed on 08/08/2020).

[13] Islam AKMM, Majumder AAS. Hypertension in Bangladesh: a review. Indian Heart J 2012;64:319-23. https://doi.org/10.1016/S0019-4832(12)60096-0

[14] Bangladesh population 2020 (live) World Population Review 2020. Available at: https://worldpopulationreview.com/countries/bangladesh-population (accessed on 11/08/2020).

[15] Sutradhar I, Das Gupta R, Hasan M, Wazib A, Sarker M. Prevalence and risk factors of chronic obstructive pulmonary disease in Bangladesh: a systematic review. Cureus 2019;11:e3970-e. https://doi.org/10.7759/cureus.3970

[16] Khanam F, Hossain MB, Mistry SK, Afsana K, Rahman M. Prevalence and risk factors of cardiovascular diseases among Bangladeshi adults: findings from a cross-sectional study. J Epidemiol Glob Health 2019;9:176-84. https://doi.org/10.2991/jegh.k.190531.001

[17] Akter S, Rahman MM, Abe SK, Sultana P. Prevalence of diabetes and prediabetes and their risk factors among Bangladeshi adults: a nationwide survey. Bull World Health Organ 2014;92:204-13A. https://doi.org/10.2471/BLT.13.128371

[18] Bishwajit G, Tang S, Yaya S, Feng Z. Burden of asthma, dyspnea, and chronic cough in South Asia. Int J Chron Obstruct Pulmon Dis 2017;12:1093-9. https://doi.org/10.2147/COPD.S133148

[19] Hussain SMA. Comprehensive update on cancer scenario of Bangladesh. South Asian J Cancer 2013;2:279-84. https://doi.org/10.4103/2278-330X.119901

[20] Mannan A, Mehedi HMH, Chy NUHA, Qayum MO, Akter F, Rob MA, Biswas P, Hossain S, Ayub MI. A multi-centre, cross-sectional study on coronavirus disease 2019 in Bangladesh: clinical epidemiology and short-term outcomes in recovered individuals. New Microbes New Infections 2021;40:100838. https://doi.org/10.1016/j.nmni.2021.100838

[21] Cummings MJ, Baldwin MR, Abrams D, Jacobson SD, Meyer BJ, Balough EM, Aaron JG, Claassen J, Rabbani LE, Hastie J, Hochman BR, Salazar-Schicchi J, Yip NH, Brodie D, O'Donnell MR. Epidemiology, clinical course, and outcomes of critically ill adults with COVID-19 in New York City: a prospective cohort study. Lancet 2020;395:1763-70. https://doi.org/10.1101/2020.04.15.20067157

[22] Halvatsiotis P, Kotanidou A, Tzannis K, Jahaj E, Magira E, Theodorakopoulou M, Konstandopoulou G, Gkeka E, Pourzitaki C, Kapravelos N, Papoti S, Sileli M, Gogos C, Velissaris D, Markou N, Stefanatou E, Vlachogianni G, Aimoniotou E, Komnos A, Zafeiridis T, Koulouvaris P, Armaganidis A, Bamias A, Dimopoulos G. Demographic and clinical features of critically ill patients with COVID-19 in Greece: the burden of diabetes and obesity. Diabetes Res Clin Pract 2020;166:108331. https://doi.org/10.1016/j.diabres.2020.108331

[23] Poussardin C, Oulehri W, Isner ME, Mertes PM, Collange O. In-ICU COVID-19 patients' characteristics for an estimation in post-ICU rehabilitation care requirement. Anaesth Crit Care Pain Med 2020;39:479-80. https://doi.org/10.1016/j.accpm.2020.06.002

[24] National guidelines on clinical management of coronavirus disease 2019 (Covid-19): government of the people's Republic of Bangladesh; 2020. Available at: https://dghs.gov.bd/index.php/bd/publication/guideline (accessed on 21/09/2020).

[25] Ranieri VM, Rubenfeld GD, Thompson BT, Ferguson ND, Caldwell E, Fan E, Camporota L, Slutsky AS. Acute respiratory distress

syndrome: the Berlin Definition. JAMA 2012;307:2526-33. https://doi.org/10.1001/jama.2012.5669

[26] Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, Bellomo R, Bernard GR, Chiche J-D, Coopersmith CM, Hotchkiss RS, Levy MM, Marshall JC, Martin GS, Opal SM, Rubenfeld GD, van der Poll T, Vincent J-L, Angus DC. The third international consensus definitions for Sepsis and Septic shock (Sepsis-3). JAMA 2016;315(8):801-10. https://doi.org/10.1001/jama.2016.0287

[27] Grasselli G, Zangrillo A, Zanella A, Antonelli M, Cabrini L, Castelli A, Cereda D, Coluccello A, Foti G, Fumagalli R, Iotti G, Latronico N, Lorini L, Merler S, Natalini G, Piatti A, Ranieri MV, Scandroglio AM, Storti E, Cecconi M, Pesenti A, Network ftC-LI. Baseline Characteristics and Outcomes of 1591 Patients Infected With SARS-CoV-2 Admitted to ICUs of the Lombardy Region, Italy. JAMA 2020;323:1574-81. https://doi.org/10.1001/jama.2020.5394

[28] Bhatraju PK, Ghassemieh BJ, Nichols M, Kim R, Jerome KR, Nalla AK, Greninger AL, Pipavath S, Wurfel MM, Evans L, Kritek PA, West TE, Luks A, Gerbino A, Dale CR, Goldman JD, O'Mahony S, Mikacenic C. Covid-19 in critically ill patients in the seattle region - case series. N Engl J Med 2020;382:2012-22. https://doi.org/10.1056/NEJMoa2004500

[29] Yu Y, Xu D, Fu S, Zhang J, Yang X, Xu L, Xu J, Wu Y, Huang C, Ouyang Y, Yang L, Fang M, Xiao H, Ma J, Zhu W, Hu S, Hu Q, Ding D, Hu M, Zhu G, Xu W, Guo J, Xu J, Yuan H, Zhang B, Yu Z, Chen D, Yuan S, Shang Y. Patients with COVID-19 in 19 ICUs in Wuhan, China: a cross-sectional study. Critical care 2020;24:219. https://doi.org/10.1186/s13054-020-02939-x

[30] Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, Consortium atNC-R. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with covid-19 in the New York city area. JAMA 2020;323:2052-9. https://doi.org/10.1001/jama.2020.6775

[31] Rahman MS, Akter S, Abe SK, Islam MR, Mondal MNI, Rahman JAMS, Rahman MM. Awareness, treatment, and control of diabetes in Bangladesh: a nationwide population-based study. Plos one 2015;10:e0118365. https://doi.org/10.1371/journal.pone.0118365

[32] Antonicelli L, Tontini C, Manzotti G, Ronchi L, Vaghi A, Bini F, Scartabellati A, Menzella F, De Michele F, Musarra A, Micheletto C, Bilò MB. Severe asthma in adults does not significantly affect the outcome of COVID-19 disease: results from the Italian Severe Asthma Registry. Allergy 2020;76:902-5. https://doi.org/10.1111/all.14558

[33] Demoule A, Vieillard Baron A, Darmon M, Beurton A, Géri G, Voiriot G, Dupont T, Zafrani L, Girodias L, Labbé V, Dres M, Fartoukh M, Azoulay E. High-flow nasal cannula in critically III patients with severe COVID-19. Am J Respir Crit Care Med 2020;202:1039-42. https://doi.org/10.1164/rccm.202005-2007LE

[34] Beitler JR, Mittel AM, Kallet R, Kacmarek R, Hess D, Branson R, Olson M, Garcia I, Powell B, Wang DS, Hastie J, Panzer O, Brodie D, Hill LL, Thompson BT. Ventilator sharing during an acute shortage caused by the COVID-19 pandemic. Am J Respir Crit Care Med 2020;202:600-4. https://doi.org/10.1164/rccm.202005-1586LE

[35] Kesici S, Yavuz S, Bayrakci B. Get rid of the bad first: Therapeutic plasma exchange with convalescent plasma for severe COVID-19. Proc Natl Acad Sci USA 2020;117:12526-7. https://doi.org/10.1016/j.ijid.2020.10.085

[36] Stebbing J, Phelan A, Griffin I, Tucker C, Oechsle O, Smith D, Richardson P. COVID-19: combining antiviral and anti-inflammatory treatments. Lancet Infect Dis 2020;20:400-2. https://doi.org/10.1016/S1473-3099(20)30132-8

[37] Irie K, Nakagawa A, Fujita H, Tamura R, Eto M, Ikesue H, Muroi N, Tomii K, Hashida T. Pharmacokinetics of Favipiravir in critically ill patients with COVID-19. Clin Transl Sci 2020;13:880-5. https://doi.org/10.1111/cts.12827

[38] Aschenbrenner DS. Remdesivir receives emergency use authorization for severely ill patients with ovid-19. AJN The American Journal of Nursing 2020;120(7). https://doi.org/10.1097/01.NAJ.0000688196.83625.b1

[39] Lamb YN. Remdesivir: first approval. Drugs 2020;80:1355-63. https://doi.org/10.1007/s40265-020-01378-w

[40] Wu C, Chen X, Cai Y, Xia Ja, Zhou X, Xu S, Huang H, Zhang L, Zhou X, Du C, Zhang Y, Song J, Wang S, Chao Y, Yang Z, Xu J, Zhou X, Chen D, Xiong W, Xu L, Zhou F, Jiang J, Bai C, Zheng J, Song Y. Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in Wuhan, China. JAMA 2020;180:934-43. https://doi.org/10.1001/jamainternmed.2020.0994

[41] Ledford H. Coronavirus breakthrough: dexamethasone is first drug shown to save lives. Nature 2020;582:469. https://doi.org/10.1038/d41586-020-01824-5

[42] IDF. IDF SEA members: the International Diabetes Federation (IDF) 2020. Available at: https://idf.org/our-network/regions-members/south-east-asia/members/93-bangladesh.html (accessed on 27/08/2020).

[43] Díaz-Guio DA, Villamil-Gómez WE, Dajud L, Pérez-Díaz CE, Bonilla-Aldana DK, Mondragon-Cardona A, Cardona-Ospina JA, Gómez JF, Rodríguez-Morales AJ. Will the Colombian intensive care units collapse due to the COVID-19 pandemic? Travel Med Infect Dis 2020:101746. https://doi.org/10.1016/j.tmaid.2020.101746

[44] Fang L, Karakiulakis G, Roth M. Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? Lancet Respire Med 2020;8:e21. https://doi.org/10.1016/S2213-2600(20)30116-8

[45] Nichols BE, Jamieson L, Zhang SRC, Rao GA, Silal S, Pulliam JRC, Sanne I, Meyer-Rath G. The role of remdesivir in South Africa: preventing COVID-19 deaths through increasing ICU capacity. Clinical infectious diseases 2020;ciaa937. https://doi.org/10.1093/cid/ciaa937

[46] Kabir FH. Only 399 ICU beds amid virus spike 2020. Available at: https://thefinancialexpress.com.bd/health/only-399-icu-beds-amid-virus-spike-1591415722 (accessed on 11/08/2020).

[47] McCarthy N. The countries with the most critical care beds per capita. Statista 2020. Available at: https://www.statista.com/chart/21105/number-of-critical-care-beds-per-100000-inhabitants/?fbclid=IwAR0vCHkxUSc70U3hO3LEPl5gRTpnfKO2cEfDHCIyrTIlUo2_ZrI2ioIBVHQ (accessed on 11/08/2020).

Correspondence: Ayan Saha, Disease Biology and Molecular Epidemiology Research Group, Chattogram, Bangladesh - E-mail: ayan.saha.bd@gmail.com - ayan.saha@unsw.edu.au

Supplementary data

Supplementary Fig. 1. The number of COVID-19 ICU beds available for every 10,000 inhabitants of Bangladesh and other countries worse affected by COVID-19. USA, United States of America; UK, United Kingdom [9, 14, 42-47].