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Syndromic Surveillance of 167 COVID-19 Patients in a Tertiary Hospital, Riyadh, Saudi Arabia

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Abstract

Background: *The Coronavirus Disease 19 (COVID-19) that emerged in China in late December 2019 has rapidly evolved into a pandemic, placing health systems and economies worldwide under unprecedented burdens. The objective of this study is to evaluate clinical characteristics for hospitalized COVID-19 patients in a large tertiary hospital in Saudi Arabia.*

Methods: *The study setting was King Fahad Medical City, a 1200-bed tertiary hospital, in Riyadh, Saudi Arabia; it included all RT-PCR confirmed COVID-19 cases, occurring between May 1 and June 13, 2020. Clinical and demographic data were retrieved from electronic health records and analyzed.*

Results: *One hundred and sixty-seven patients were included; all but three were managed in the ICU. Male patients, (n=148; 88.6%) had a median age of 54; IQR of 16 (0-94), and SD =15.78 compared with female with a median age of 57; IQR of 24 (28-75) and SD =15.15. The median age for survivors (n= 144; 86.2%) was 53; IQR 16 (0-88), and SD 15.35. The mean age between survivors and non-survivors was statistically significant; p = 0.029. Patients with comorbidities (n= 84; 50.3%) had a median age of 59.60; IQR, 19 (0-88); and SD of 17.50. The mean age between patients with and without comorbidities was statistically significant; p = 0.012.*

Conclusion: *In this cohort of hospitalized COVID-19 patients, younger patients are less likely to have comorbidities irrespective of gender. Further, younger patients are likely to survive COVID-19 than older patients.*

Keywords: *COVID-19, SARS COV2, mortality, Survivals, Non-survivals, Comorbidities, risk factors, biomarkers, Saudi Arabia*

Introduction:

In late December 2019, the World Health Organization (WHO) was notified of a cluster of respiratory illnesses observed in Wuhan, China **[**1**]**. In January 2020, the causal pathogen was identified to be a newly emerged beta coronavirus similar to severe acute respiratory syndrome Coronavirus (SARS CoV) and Middle East respiratory syndrome Coronavirus (MERS CoV); the latter remains endemic in Saudi Arabia.

Genetically, it is more closely related to SARS CoV (79%) than MERS CoV (50%) **[**2**]**. It was named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS COV2) **[**3**]** and the disease Coronavirus Disease 19 (COVID-19) **[**4**]**. The COVID-19 is similar to SARS and MERS: they all present with acute respiratory distress syndrome (ARDS). Yet, SARS COV2 infected persons can be asymptomatic, mild, or severe. Infected individuals present with fever, dry cough, dyspnea, sore throat, headache, and pneumonia about five to six days post-infection **[**2**]**. Although transmission is thought to be droplet-mediated, there persist debates as to the possibility of aerosol-mediated airborne transmission. Currently, there are no approved vaccines or therapies **[**2**]**.

Consequently, early case detection and management coupled with public health surveillance remain essential to mitigate the spread and impact of COVID-19. However, SARS COV2 has proven to be more infectious than SARS and MERS. By March 2020, its global spread compelled the World Health Organization to declare COVID-19 a pandemic **[**2**]**. As of August 9, 2020, Saudi Arabia has conducted 3,745,562 tests and has confirmed 287,262 cases of which 250,440 recovered with 3,130 associated deaths **[**5**]**. Riyadh has the highest number of confirmed COVID-19 cases in the country at 54,029 **[**5**]**.

Killerby et al. **[**6**]** demonstrated that being male, black, smoking, having cancer, and diabetic was associated with hospitalization in 220 COVID-19 patients from Atlanta, Georgia in the US. Other similar studies suggested that advanced age and comorbidities, such as hypertension, diabetes, cancer, and respiratory illnesses are risk factors for COVID-19 **[**6, 21-27**]**. There is a paucity of data on the clinical characteristics of COVID-19 at the patient level in the Middle East. A recent retrospective study in Saudi Arabia analyzed aggregated national surveillance data **[**7**]** while in Oman workers have published the results of a limited case series (n=63) study **[**8**]**.

Therefore, the purpose of this study is to investigate the baseline clinical characteristics and outcomes of COVID-19 patients in a tertiary hospital in Riyadh, Saudi Arabia.

Methods

Study population

The study was carried out at King Fahad Medical City (KFMC), Riyadh, a 1200-bed tertiary referral hospital in Riyadh, Saudi Arabia**.** All hospitalized laboratory-confirmed real-time polymerase chain reaction (RT-PCR) COVID-19 positive patients were retrospectively included in the study between May 1 and June 13, 2020. Nasopharyngeal swabs from patients were tested for the presence of SARS-COV-2 using real-time RT-PCR. This study was approved as an exempted study by the institutional review board of King Fahad Medical City under IRB #20-332.

Data collection

The patient's baseline clinical characteristics, demographics, symptoms, comorbidities, chest radiographic, and laboratory findings were collected from electronic medical records into Excel (Microsoft Seattle), de-identified, and cleaned. The collected data were organized in excel by two clinicians (OA and MT) and data entries were revalidated by two clinical epidemiologists, OA and SF for consistency and accuracy.

Laboratory and Radiographic Studies

Four pediatric COVID-19 were separated from the initial laboratory findings because of the different criteria for laboratory ranges for the pediatric population. Baseline laboratory values were collected, which included routine hematology, biochemistry, ferritin, C-reactive protein (CRP), and lactate dehydrogenase (LDH). Further, high-sensitivity cardiac troponin I and D-dimer were collected for some of the patients on admission. However, depending on the attending physicians, some of the laboratory values were not investigated at the time of admission to the emergency room. Baseline chest radiographs were requested on a case-by-case basis by the attending physician.

Definition

Acute respiratory distress syndrome (ARDS) was defined according to the Berlin definition as the ratio of partial pressure of oxygen to fractioned of inspired oxygen ≤ 300 mm Hg **[**9**]** or as documented in the patient's medical history by the physician. Successful extubation was defined as a patient not needing reintubation after removal of endotracheal tube for 72 hours **[**10**]**. Acute kidney injury was defined using the clinical practice guidelines for Kidney Disease: Improving Global Outcomes (KDIGO) **[**11**]**. The cardiac injury was classified by correlating with high sensitivity serum Troponin I levels that are higher than the 99th percentile of the upper limit **[**12**]**.

Statistical analysis

Descriptive statistics were used for continuous variables in respect to median, mean, interquartile range (IQR), and standard deviation (SD). Age was used as a continuous variable for ethnicity, gender, survivals, non-survivals, presence or absence of comorbidities. The median was used as descriptive for the age distribution because it is the most robust statistic because of the presence of outliers (n=4; pediatric patients) in the sample size. Baseline laboratory values at the time of admission to the emergency room were presented as continuous variables in respect to median, IQR, and SD. Categorical variables, such as symptoms, patients with or without comorbidities, and chest radiographic findings

were presented as proportions and percentiles. Independent t-test was used to compare mean age in determining the level of significance among groups (i.e., Saudis vs. non-Saudis; Female vs. males; survivors vs. non-survivals; comorbidities vs. without comorbidities; males with comorbidities vs. females with comorbidities; males without comorbidities vs. females without comorbidities; male survivors vs. female survivors; and male non-survivors vs. female non-survivors). Confidence intervals (CI) were set at 95% across groups. Two-sided *P* values < 0.05 among age groups were classified as statistically significant. All data were analyzed using the statistical package SPSS version 26 (IBM).

Results

Table 1: Demography and baseline Characteristics of Hospitalized COVID-19 at Presentation

Demographic Characteristics by Age	**Frequency (%); N = 167**	**Median (years)**	**IQR**	**SD**	***P* value**
Saudis	51 (30.5)	61.00	27.00 (0-94)	20.85	
Non-Saudis	112 (67.1)	53.00	13.00 (0-76)	11.71	0.332
Unknown	4 (2.3)	50.50	60.00 (0-73)	32.05	
Female	19 (11.4)	57.00	24.00 (28-75)	15.15	
Male	148 (88.6)	54.00	16.00 (0-94)	15.78	0.441
Survivors	144 (86.2)	53.00	16.00 (0-88)	15.35	
Non-Survivors	23 (13.8)	61.00	25.00 (30-94)	16.23	**0.029***
Comorbidities	84 (50.3)	59.50	19.00 (0-88)	17.50	
Without comorbidities	83 (49.7)	50.00	12.00 (0-94)	13.02	**0.012***
Gender					
Females with comorbidity	15 (78.9)	64.00	19.00 (28-75)	14.63	
Male with comorbidity	69 (46.6)	59.00	16.00 (0-98)	18.03	0.388
Females without comorbidity	4 (21.1)	46.50	13.00 (30-47)	8.35	
Male without comorbidity	79 (53.4)	51.00	13.00 (0-94)	13.12	0.139

Female Survivors	16 (11.1)	59.50	23.00 (28-73)	14.36	
Male Survivors	128 (86.5)	53.00	16.00 (0-88)	15.42	0.177
Female non-survivors	3 (15.8)	40.00	NA (36-75)	21.46	
Male non-survivors	20 (13.5)	61.50	18.00 (30-94)	15.40	0.443
Survivors	**n = 144**				
Female	16 (11.1)				
Male	128 (88.90)				
Non-survivors	**n =23**				
Female	3 (13)				
Male	20 (87)				
No of Comorbidities	**n=84**				
Female	15 (17.9)				
Male	69/84 (82.1)				
Without comorbidities	**n =83**				
Female	4 (4.8)				
Male	79 (95.2)				
Survivors by ethnicity	**n = 144**				
Saudis	42 (29.2)				
Non-Saudis	98 (68.1)				
Unknown	4 (2.8)				
Non-survivors by ethnicity	**n = 23**				
Saudis	9 (39.1)				
Non-Saudis	14 (60.9)				
Unknown	NA				

Survivors with comorbidity by ethnicity	**n = 67**
Saudis	27 (40.3)
Non-Saudis	37 (55.2)
Unknown	3 (4.5)
Survivors without comorbidity by ethnicity	**n = 77**
Saudis	15 (19.5)
Non-Saudis	61 (79.2)
Unknown	1 (1.3)
Non-survivors with comorbidities by ethnicity	**n =17**
Saudis	7 (41.2)
Non-Saudis	10 (58.8)
Unknown	NA
Non-survivors without comorbidity by ethnicity	**n = 6**
Saudis	2 (33.3)
Non-Saudis	4 (66.7)
Unknown	NA

NA=Not applicable, IQR=Interquartile range, SD=Standard deviation

Demography and baseline characteristics

A total of 167 RT-PCR confirmed COVID-19 patients were included in the study. Table 1 summarizes their demographic profiles (age, sex, and ethnicity) and baseline characteristics (survivals, non-survivals, patients with or without comorbidities). The median age was included in the study because it was the most robust parameter to deal with the variation in age from 0 to 98 years. Males (n=148;

88.6%), median, IQR (range); standard deviation (SD); median age of 54 years [IQR, 16 (0-94), SD=15.78] were in the majority compared with females (n=19; 11.4%), median age of 57 years [(IQR, 24 (28-75), SD=15.15]. The mean age between the male and female was not statistically significant with *a P-value* = 0.441. Of the 167 patients, n=51 (30.5%) were Saudis, median age of 61 years (IQR, 27 [0-94], SD = 20.85) compared with non-Saudis with a median age of 53 years (IQR, 13 [0-76], SD = 11.71). The mean age between Saudis and non-Saudis was not statistically significant with a *P-value* = 0.332. The difference in age of eight years may be indicative of the younger expatriate population working in Saudi Arabia.

Table 2: Clinical Symptoms on admission, comorbidities, and chest radiograph findings

Clinical Characteristics **Symptoms on admission**	**Frequency (%); N =167**				
Shortness of breath	164 (98.2)				
Tachypnea	163 (98.2)				
Desaturation	163 (98.2)				
Cough	100 (59.9)				
Fever	83 (49.7)				
Chest pain	3 (1.8)				
Gasping	3 (1.8)				
Sore throat	2 (1.2)				
Decrease level of consciousness	2 (1.2)				
Diarrhea	2 (1.2)				
Cyanosis	1 (0.6)				
Tachycardia	1 (0.6)				
Hemoptysis	1 (0.6)				
Epigastric pain	1 (0.6)				
Palpitations	1 (0.6)				
		Counts			

Comorbidities	**Frequency (%); n = 84**	**Median= 2.00**	**IQR =2 (1-5)**	**SD =1.02**	**P value =N/A**
Diabetes Mellitus	60 (71.4)				
Hypertension	53 (63.1)				
Ischemic Heart Disease	9 (7.1)				
Heart Failure	5 (6)				
Bronchial Asthma	4 (4.8)				
Chronic Kidney Disease	4 (4.8)				
Diabetic Ketoacidosis	3 (3.6)				
End-stage renal disease	3 (3.6)				
Hepatitis C	2 (2.4)				
Chronic Obstructive Pulmonary Disease	2 (2.4)				
Dyslipidemia	2 (2.4)				
Benign Prostatic hyperplasia	2 (2.4)				
Seizures	2 (2.4)				
Renal Transplantation	1 (1.2)				
Pulmonary hypertension	1 (1.2)				
Right leg amputation	1 (1.2)				
Leukemia	1 (1.2)				
Diffuse large B-cell lymphoma	1 (1.2)				
Atrial ventricular septal defect	1 (1.2)				
Global development delay	1 (1.2)				
Pregnancy	1 (1.2)				
Cerebral vascular disease	3 (3.6)				
Aortic Stenosis	1 (1.2)				

HIV	1 (1.2)				
Polycythemia	1 (1.2)				
Atrial fibrillation	1 (1.2)				
Endometrial Cancer	1 (1.2)				
Down Syndrome	1 (1.2)				
Chest radiograph findings	**Frequency (%);N=167**				
Ground glass appearance + Air Bronchograms	88 (52.7)				
Pulmonary Infiltrates	67 (40.1)				
Normal	5 (3)				
Airway Collapse	3 (1.8)				
Pneumothorax	1 (0.6)				

NA =Not Applicable; IQR =Interquartile range

Of the total study population, n=144 (86.2%) survived with a median *age* of 53 years [IQR, 16 (0-88), SD =15.35] compared with non-survivals with a median age of 61 years [IQR, 25 (30-94), SD =16.23]. The mean age between survivors and non-survivors was statistically significant with a *P-value* = 0.029. More than half (50.3%) of the study population have one or more comorbidities [Table 2; median =2, IQR; 2 (1-5), SD = 1.02] with a median age of 59.60 years [IQR, 19 (0-88), SD =17.50] compared with patients without comorbidities with a median age of 50 years [IQR, 12 (0-94), SD =13.02]. The mean age between patients with comorbidities and those patients without comorbidities was statistically significant with a *P-value* = 0.012.

Male patients with comorbidities was n=69 (46.6%) with a median age of 59 years [IQR, 16 (0-98), SD =18.03] compared with female patients (n=15; 78.9%) with a median age of 64 years [IQR, 19(28-75), SD =14.63]. The mean age between male and female patients with comorbidities was not statistically significant with a *P-value* = 0.388. Male patients without comorbidities was n=79 (53.4%) with a median age of 51 years [IQR, 13 (0-94), SD = 13.12] compared with female patients without comorbidities (n=4; 21.1%) with a median age of 46.50 years [IQR, 13 (30-47), SD =8.35]. The younger age difference may be suggestive of the smaller sample size of the female population in the study period. The mean age between males and females without comorbidities was not statistically significant with a *P-value* = 0.139.

Male non-survivors were n=20 (13.5%) with a median age of 61.50 years [IQR, 18 (30-94), SD = 15.40] compared with female non-survivors (n=3; 15.8%) with a median age of 40 years (range, 36-75; SD = 21.46). The age difference of more than 20 years may not have been representative of the study population because there were only three non-survivors for the female population; and the mean age between male and female non-survivors was not statistically significant with a *P-value* = 0.443.

Clinical symptoms on admission, comorbidities, and chest radiograph findings Table 2 summarizes the clinical symptoms, comorbidities, and chest radiographic findings at the time of admission to the emergency room. Most of the symptoms (n=163; 98.2%) at presentation were shortness of breath, tachypnea, and desaturation, which was followed by cough (n=100; 59.9%) and fever (n=83; 49.7%). Frequent comorbidities at presentation was diabetes mellitus (n=60; 71.4%) and hypertension (n=53; 63.1%) with both comorbidities occurring together or in isolation. More than half (n=88; 52.7%) of the chest radiograph showed ground glass appearance with air-bronchograms and pulmonary infiltrates (n=67; 40.1%).

Interventions, complications, and clinical outcomes

Table 3: Interventions, complications, and outcomes in hospitalized Patients

Intervention	**Frequency (%); N=167**
Mechanical Ventilation -Intubated on admission -Transferred from other facility while intubated	28 (16.8) 15 (9) 13 (7.8)
Oxygen Therapy	136/167 (81.4)
Room Air	2 (1.2)
ECMO	2 (1.2)
CRRT	5 (3)
Complications	**Frequency (%);N=167**
ARDS	164 (98.2)
Acute Kidney Injury	5 (3) *

Cardiac Injury	1 (0.6)
Pulmonary Embolus	2 (1.2)
Pneumothorax (right side)	1 (0.6)
Urinary tract infection	1 (0.6)
Death	23 (13.8)
Outcomes	**Frequency (%);n=28**
Extubations	14/28 (50)

Table 3 summarizes the interventions, complications, and clinical outcomes. The majority of the COVID-19 patients (n=136; 81.4%) were treated with oxygen therapy. Fifteen (9%) of these patients were mechanically ventilated on admission while 13 (7.8%) were received mechanically-ventilated from other hospitals. Of the 167 COVID-19 patients, n=164 (98.2%) presented with acute respiratory distress syndrome (ARDS). Few of these patients were treated with advanced interventions, such as extracorporeal membrane oxygenation (n=2; 1.2%) and continuous renal replacement therapy (n=5; 3%) at the time of admission to the emergency room. Of the 28 (16.8%) who were mechanically ventilated, 14 (50%) were successfully extubated during the study period.

Laboratory findings

Table 4: Initial Laboratory Results of Patients Hospitalized with COVID-19

Laboratory Results	**Median**	**IQR**	**n/N (%)**	**Reference ranges**
Age (20-94, years old)				
White blood cell count, *10^9/L	8.77	5.23 (1.34-35.42)	157/163 (96.3)	3.9-11
Red blood cell count, *10^12/L	4.92	0.66 (1.82-6.47)	157/163 (96.3)	4.5-6.0
Neutrophils, *10^9/L	5.65	5.00 (2.00-20.00)	54/163 (33.1)	1.35-7.50

Lymphocyte, *10^9/L	0.92	1.00 (0-3)	159/163 (97.5)	1.5-4.3
Hemoglobin, g/dL	13.85	2.57 (5.5-18.6)	156/163 (95.7)	13.5-18.00
Platelet count, *10^9/L	232.00	115.50 (49-826)	157/163 (96.3)	155-435
Prothrombin time, s	14.30	3.00 (11-32)	127/163 (77.9)	9.7-12.6
Activated Partial Thromboplastin time, s	30.90	4.98 (24-60.40)	124/163 (76.1)	25.3-38.3
Alanine aminotransferase, U/L	46.00	41 (7-543)	99/163 (60.7)	0-55
Aspartate aminotransferase, U/L	52.00	48 (13-284)	29/163 (17.8)	0-32
Albumin (plasma), g/L	36.10	5.90 (22.50-43.40)	65/163 (40)	35-52
Total bilirubin, µmol/L	10.10	9.40 (3.3-25.40)	59/163 (36.2)	3-20
Creatinine, µmol/L	89.00	50 (30-2016)	158/163 (96.9)	64-104
Urea (plasma), mmol/L	5.70	4.75 (1.60-52.90)	157/163 (96.3)	3-9.2
Lactate (plasma), mmol/L	2.12	1.89 (0.89-14.80)	54/163 (33.1)	0.5-2.2
Troponin I (plasma), ng/L	14.40	45.25 (<4-6771.40)	130/163 (79.8)	0-34.2
Lactate dehydrogenase, U/L	657.00	297 (372-1047)	17/163 (10.4)	125-220
Alkaline Phosphate, U/L	75.00	46 (32-375)	109/163 (66.9)	40-150

D-Dimer, ug/L	1.82	2.27 (0.50-32.59)	22/163 (13.5)	0-0.5
Ferritin (serum), ug/L	1354.60	1820.90 (402.70-7734.70)	17/163 (10.4)	22-275
C reactive protein (highly sensitive), mg/L	119.50	121.20 (3.83-479)	98/163 (60.1)	1-3
Infant subset (n=4)				
Age (0-1, year old)				
White blood cell count, *10^9/L	12.41	NA (11.21-16.24)	3/4 (75)	6-18
Red blood cell count, *10^12/L	4.89	NA (2.7-5.37)	3/4 (75)	4.1-5.3
Neutrophils, *10^9/L	Median and IQR does not apply, only one patient neutrophil =13.12 *10^9/L			1-6
Lymphocyte, *10^9/L	1.71	NA (1.21-1.95)	3/4 (75)	4-12
Hemoglobin, g/dL	16.80	NA (14.5-17.7)	3/4 (75)	11.1-14.1
Platelet count, *10^9/L	323.00	NA (256-346)	3/4 (75)	200-550
Prothrombin time, s	18.00	NA (13.40-20.20)	3/4 (75)	9.7-12.6
Activated Partial Thromboplastin time, s	32.00	NA (30.30-32.70)	3/4 (75)	25.3-38.3
Alanine aminotransferase, U/L	16.00	NA (14-1420)	3/4 (75)	30-65
Albumin (plasma), g/L	35.00	NA (31.70-35.90)	3/4 (75)	38-51
Total bilirubin, µmol/L	84.60	NA (6.20-161.10)	3/4 (75)	2-17
Creatinine, µmol/L	75.00	NA (52.00-263.00)	3/4 (75)	71-115
Urea (plasma), mmol/L	5.20	NA (1.80-34.70)	3/4 (75)	2.5-6.4
Lactate (plasma), mmol/L	4.80	NA (3.02-11.20)	3/4 (75)	1.1-2.2
Troponin I (plasma), ng/L	256.20	NA (10.40-263.50)	3/4 (75)	0-34.2
C reactive protein (highly sensitive), mg/L	179.00	NA (109-333)	3/4 (75)	0-5.99

Alkaline Phosphate, U/L	179	NA (74-181)	3/4 (75)	50-136
Lactate dehydrogenase (LDH), U/L	Median and IQR does not apply here as only 1 of the 4 had these biomarkers captured. All were extremely high; LDH= 513 U/I, D-Dimer=6.88 ug/L, and Ferritin=2151.10 ug/I.			100 - 190
D-Dimer, ug/L				0-0.5
Ferritin (serum), ug/L				22-275

NA = Not applicable, * = multiplication, ^ = exponential

Table 4 summarizes baseline laboratory values. Of note, there are huge dispersions in some values because of outliers (extreme values); although, normal median values were maintained. Notably, outliers are observed in white blood cell counts, neutrophils, platelet counts, alanine aminotransferase, creatinine, urea, high sensitivity Troponin I, and alkaline phosphate. The presence of these outliers in some patients is suggestive of infective processes, thrombocytosis, pancreatic, kidney, liver, and cardiac involvement. However, initial laboratory values were high for some patients. Lymphopenia (159; 97.5%) was reported in most patients [median, IQR (range), 0.92*10^9/L, 1*10^9/L (0-3)]. Biomarkers of infective and inflammatory processes were high, such as C-reactive protein (CRP), D-dimer, and ferritin in the study population. The CRP (n=98; 60.1%) median was 119.50 mg/l and IQR of 121.20 mg/l (3.83-479); D-dimer (n=22; 13.5%) median was 1.82 ug/l and IQR of 2.27 ug/l (0.50-32.59); and ferritin (n=17; 10.4%) median was 1354.60 ug/l and IQR of 1820.90 ug/l (402.70-7734.70).

The coagulation profile, such as the prothrombin time (n=127; 77.9%) median was 14.30 seconds (s) was extended with an IQR of 3s (11-32) and activated partial thromboplastin time (n=124; 76.1%) median was 30.90s and IQR of 4.98s (24-60.40). Lactate dehydrogenase (LDH), a marker of tissue damage, was elevated in the study population with a median of 657.00 U/l and IQR of 297 U/l (372-1047). In addition, in the pediatric population (n=4), elevated values were shown in total bilirubin, Troponin I, CRP, and Alkaline phosphate. The low sample size of the pediatric population may best be explained by the angiotensin-converting enzyme 2 (ACE2) protein. ACE2 plays a key role in the transmission of SARS-COV 2 in the adult population; however, ACE2 is not as profuse in the lower respiratory tract of children **[**13**]**.

Discussion

This study investigates clinical characteristics and outcomes of COVID-19 patients during a surge crisis in a tertiary hospital, which represents the largest hospital in Saudi Arabia. To our knowledge, there are no studies that have explored COVID-19 clinical characteristics during a surge crisis in Saudi Arabia. Our study adds to the body of knowledge by exploring the demographic variables, clinical characteristics,

comorbidities, symptoms, and laboratory findings at the time of admission to the emergency room before hospitalization.

Of note, almost 98.2% (n=164) of the case-patients presented at the emergency room with tachypnea, desaturation, and shortness of breath, which includes cough (59.9%) and fever 49.7%). Similar findings have already been reported elsewhere **[**14, 23-24**]**. Interestingly, more than 50% of the subjects had abnormal chest radiographic findings characterized by diffused bilateral opacification, air bronchograms (suggestive of infective and inflammatory processes) with pneumonic changes, and ground glass appearance, which further corroborates other similar investigations **[**22-23**]**.

The median age of 57 years among female case-patients irrespective of ethnicity was similar to that of African-American females (57.5 years) in another study **[**14**]**. Guan et al. **[**15**]** have already concluded a similar finding when they reported a mean age of 48.9 years among 686 COVID-19 confirmed positive Asian females. Although these findings may not be generalizable, it does provide some insights into the clinical management and outcomes of COVID-19 among different ethnicities: there is evidence associating poor outcomes, including mortality with being black, Asian, or another minority group **[**16**]**.

The mean age of survivors was 53.3 years compared with 60.6 years for non-survivors, which is statistically significant (P = 0.029). This adds to the body of knowledge **[**7**]** that younger age is protective for surviving COVID-19; this addition however comes from the Middle East with various ethnicities involved. Further, a recent study has already corroborated our study that having comorbidities and old age (≥65 years) is associated with death in COVID-19 patients **[**17**]**.

By comparison, the median ages for patients with and without comorbidities were 59.50 and 50 years, respectively. Of the 51 Saudi patients, 42 (29.2%) survived; 9 (39.1%) did not survive; and 7 (41.2%) of these nine case patients had one or more comorbidities. The observation that having comorbidities was strongly associated with non-survival among our Saudi case-patients corroborates our earlier experiences with MERS **[**18**]** and, more recently, that of others with COVID-19 **[**6, 19-21**]**. It adds to the growing body of knowledge that comorbidity is a risk factor for COVID-19 patients **[**22-28**]**. Indeed, 17 (73.9%) of the 23 non-survivors had one or more comorbidities. Of note, 84 (50.3%) of our case-patients had one or more [Median, IQR (range); 2, 2 (1-5)**]** of the following comorbidities: diabetes mellitus (71.4%), hypertension (63.1%), ischemic heart disease (7.1%) or combination of these comorbidities. The Saudi subset of our study population had a median age of 61 years and IQR of 27 years (0-94): this may be related to the improved life expectancy enjoyed in the Kingdom following years of continuously enhanced health care delivery and modernization. From a public health perspective, it provides additional data supporting the preventive intervention measures targeting the elderly.

Although our study population did not have “thromboembolic and hemorrhagic” **[**29**]** crisis (except in some few outlier cases) that is customary with most COVID-19 patients, the initial prothrombin time was slightly extended with a median of 14.30 s with an IQR of 3 s (11-32) while activated partial

thromboplastin time remained within normal limits at the time of presentation to the emergency room. This result may be attributable to the initial routine monitoring and prophylaxis treatment of abnormal coagulation profiles (n=127) of subjects in the study population at the time of presentation to the emergency room. Given the clinical effectiveness of thromboprophylaxis management, about 97.5% (n=159) were presented with lymphopenia at the time of presentation to the emergency room with median lymphocytes of 0.92*10^9/L and IQR of 1 *10^9/L (0-3). Lymphopenia is synonymous with COVID-19 patients and has already been reported as an important biomarker for predicting the severity of illness **[**29**]**. Similar to other studies **[**29, 31-34**]** that inflammatory and tissue biomarkers, such as C-reactive protein (CRP), D-dimer, LDH, and ferritin are prognostic indicators of interleukin and cytokine storm and disease progression in COVID-19 patients. Indeed, CRP (n=98), D-dimer (n=22), LDH (n=17), and ferritin (n=17) were significantly elevated in our study population at the time of presentation to the emergency room. Similar to this study, "extrapulmonary" **[**35**]** multi-system organ characterizations as indicated in some laboratory values, such as mild thromboembolic, kidney, liver, hepatic, and cardiac involvements were seen in our patient population. This finding is further evidence that the initial evaluation of extrapulmonary involvement, such as inflammatory and tissue biomarkers should be an important assessment, diagnostic, and prognostic indicator in the management of COVID-19 patients.

This study is not without limitations. Firstly, it is a hospital-based study and results may not be representative of the community or nationwide epidemiological picture of COVID-19. Secondly, as it was a hospital-based study of critically ill patients, epidemiologic surveillance data, such as travel history, contact history, time of symptoms onset, and length of stay to discharge were not available when the study was conducted. Lastly, all confirmed positive PCR patients were included in the study period; however, clinical characteristics, treatment response time, physiology, and viral shedding for pediatric and adult populations are often expressed differently.

Conclusion

The research team proposes some recommendations for future public health research. Targeted prevention strategies, such as community-based testing, early intervention, diagnosis, surveillance, and treatments of the older population with comorbidities. Biomarkers, such as lymphocytes, coagulation, liver, kidney, and hepatic profiles can serve as an early diagnostic tool for COVID-19 patients. Further, prognostic indicators, such as CRP, LDH, D-dimer, and ferritin can be used as a biomarker for severity and clinical outcomes for survivals and non-survivals for infected patients. Creating a clinical analytics center of excellence to capture population health data for early surveillance and prevention strategies would create an atmosphere in which comorbidity risks can be managed effectively.

The use of information technology, such as clinical decision support systems that interface with all the hospitals in the Kingdom would further afford clinicians to work in an integrated health system, creating

early clinical epidemiological and surveillance tracking systems for infected individuals to mitigate risks associated with COVID-19 infection.

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