Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Characteristics of mechanically ventilated patients with COVID-19 and persons under investigation negative for COVID-19 at an academic medical center: A retrospective cross-sectional pilot study

There is a paucity of literature investigating the characteristics and outcomes of critically ill and mechanically ventilated patients with COVID-19 and those suspicious for COVID-19 (known as Persons Under Investigation, PUIs) in the United States [1–4]. Current guidelines for ventilator management and adjunct therapies of mechanically ventilated COVID-19 patients are not well-defined [5]. A retrospective review was conducted of patients with COVID-19 (positive RT-PCR test) and PUIs[1] negative for COVID-19 who were admitted and required mechanical ventilation at a large, tertiary, academic center in Los Angeles from 2/27/20 to 4/6/20 (24 days minimum follow-up). This study was approved by Cedars-Sinai Medical Center's Institutional Review Board.

There were 37 patients identified (72.9% COVID-19 patients, $n = 19$). The sample was 81.1% male, mean age was 62.7 ± 19.7 years, and 62.2% had hypertension (Table 1). Nearly 82.0% of COVID-19 patients were placed on high-flow nasal cannula (HFNC) prior to intubation; 40.0% of COVID-19 negative patients were placed on BiPAP/CPAP before admission to the ED so BIPAP/CPAP was

Table 1
Characteristics in mechanically ventilated patients with COVID-19 and Persons Under Investigation negative for COVID-19[a].

	All patients ($N = 37$)	COVID-19 patients ($N = 27$)	COVID-19 negative patients ($N = 10$)	*P* value
Age, years, mean (SD)	62.7 (19.7)	66.7 (12.8)	51.9 (30.0)	0.04
Age ≥ 65 years, *n* (%)	21 (56.8)	16 (59.3)	5 (50.0)	0.61
Male, *n* (%)	30 (81.1)	22 (81.5)	8 (80.0)	0.92
BMI, mean (SD)	27.6 (7.7)	28.2 (7.7)	25.8 (7.8)	0.41
Obese BMI ≥ 30, *n* (%)	13 (35.1)	10 (37.0)	3 (30.0)	0.69
Preadmission comorbidities				
Coronary artery disease, *n* (%)	10 (27.0)	6 (22.2)	4 (40.0)	0.28
Cerebral vascular disease, *n* (%)	5 (13.5)	4 (14.8)	1 (10.0)	0.70
Chronic kidney disease, *n* (%)	9 (24.3)	7 (25.9)	2 (20.0)	0.71
COPD, *n* (%)	8 (21.6)	5 (18.5)	3 (30.0)	0.45
Diabetes, *n* (%)	14 (37.8)	9 (33.3)	5 (50.0)	0.35
Dialysis, *n* (%)	3 (8.1)	2 (7.4)	1 (10.0)	0.80
HIV, *n* (%)	1 (2.7)	1 (3.7)	0 (0.0)	0.54
Hypertension, *n* (%)	23 (62.2)	15 (55.6)	8 (80.0)	0.17
Malignancy, *n* (%)	5 (13.5)	4 (14.8)	1 (10.0)	0.70
Total with ≥1 co-morbidity, *n* (%)	28 (75.7)	19 (70.4)	9 (90.0)	0.22
Admission vitals				
Heart rate, beats per min, mean (SD)	97.5 (20.3)	92.8 (18.1)	110.2 (21.2)	0.02
Systolic blood pressure, mean (SD)	131.8 (27.3)	128.7 (26.2)	140.3 (30.0)	0.26
Respiratory rate, breaths per min, mean (SD)	24.1 (7.4)	22.6 (6.8)	27.9 (8.2)	0.06
Temperature ≥ 38° C, *n* (%)	13 (35.1)	11 (40.7)	2 (20.0)	0.24
Abnormal chest x-ray, *n* (%)	32 (86.5)	25 (92.6)	7 (70.0)	0.08
Respiratory viral panel (excluding COVID-19), positive, *n* (%)	1 (2.7)	1 (3.7)	0 (0.0)	0.54
Treatment prior to intubation				
Non-rebreather mask, *n* (%)	7 (18.9)	5 (18.5)	2 (20.0)	0.92
High-flow nasal cannula, *n* (%)	22 (59.5)	22 (81.5)	0 (0.0)	< 0.01
BiPAP/CPAP, *n* (%)	5 (13.5)	1 (3.7)	4 (40.0)	< 0.01
APACHE IV, mean (SD)	33.9 (25.9)	30.6 (26.0)	43.0 (24.4)	0.20

Abbreviations: APACHE, acute physiology and chronic health evaluation; BiPAP, bilevel positive airway pressure; BMI, body mass index; COPD, Chronic obstructive pulmonary disease; CPAP, continuous positive airway pressure; HIV, Human immunodeficiency virus; PBW, predicted body weight.

[a] Persons Under Investigation negative for COVID-19 are patients suspicious for COVID-19 with a negative RT-PCR test, referred to as COVID-19 negative patients.

[1] PUIs included patients admitted to our COVID-19-designated units with the following admission criteria: 1) Presence of new-onset fever, cough, shortness of breath (SOB), altered mental status, infiltrates on imaging without alternate explanation of symptoms for high to moderate clinical suspicion of COVID-19; 2) Presence of new-onset fever, cough, SOB, AMS, no new infiltrates on CXR or CT with an alternate explanation of symptoms for low clinical suspicion of COVID-19; and 3) a subsequent negative RT-PCR test.

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Table 2
Outcomes, ventilation management, and adjunct therapies in mechanically ventilated patients with COVID-19 and Persons Under Investigation negative for COVID-19[a].

	All patients (*N* = 37)	COVID-19 patients (*N* = 27)	COVID-19 negative patients (*N* = 10)	*P* value
ARDS after initial intubation, *n* (%)	31 (83.8)	24 (88.9)	7 (70.0)	0.63
Mild, *n* (%)	9 (24.3)	6 (22.2)	3 (30.0)	
Moderate, *n* (%)	15 (40.6)	12 (44.4)	3 (30.0)	
Severe, *n* (%)	7 (18.9)	6 (22.2)	1 (10.0)	
PaO2/FiO2 after initial intubation				0.44
201–300, *n* (%)	10 (27.0)	6 (22.2)	4 (40.0)	
101–200, *n* (%)	18 (48.6)	14 (51.9)	4 (40.0)	
≤100, *n* (%)	7 (18.9)	6 (22.2)	1 (10.0)	
Intubations in ICU, *n* (%)	25 (67.6)	25 (92.6)	0 (0.0)	< 0.01
Initial VT				0.53
6–8 ml/kg PBW, *n* (%)	31 (83.8)	22 (81.5)	9 (90.0)	
4–6 ml/kg PBW, *n* (%)	6 (16.2)	5 (18.5)	1 (10.0)	
Initial PEEP				< 0.01
≤5 cm H2O, *n* (%)	10 (27.0)	1 (3.7)	9 (90.0)	
> 5 cm H20, *n* (%)	27 (73.0)	26 (96.3)	1 (10.0)	
Vasopressor requirement, *n* (%)	34 (91.9)	25 (92.6)	9 (90.0)	0.80
Prone position, *n* (%)	16 (43.2)	16 (59.3)	0 (0.0)	< 0.01
Neuromuscular blockade[b], *n* (%)	18 (48.6)	18 (66.7)	0 (0.0)	< 0.01
Days on NMB, median (IQR)	0.0 (0.0–6.0)	4.0 (0.0–6.0)	0.0 (0.0–0.0)	< 0.01
Inhaled nitric oxide, *n* (%)	8 (21.6)	8 (29.6)	0 (0.0)	0.05
CRRT, *n* (%)	7 (18.9)	5 (18.5)	2 (20.0)	0.92
iHD, *n* (%)	7 (18.9)	5 (18.5)	2 (290.)	0.92
Days from admission to intubation, median (IQR)	1.6 (0.1–3.5)	2.1 (0.6–3.7)	0.0 (0.0–1.4)	0.44
Days on ventilator, median (IQR)	9.3 (4.4–14.9)	10.0 (6.3–15.5)	4.4 (2.4–12.5)	0.19
Hospital LOS, days, median (IQR)	23.3 (12.7–30.5)	26.5 (14.0–32.0)	12.7 (8.7–24.5)	0.05
ICU LOS, days, median (IQR)	12.0 (6.6–17.9)	13.7 (7.8–13.7)	5.8 (4.0–13.8)	0.08
Extubated, alive, *n* (%)	28 (75.7)	21 (77.8)	7 (70.0)	0.62
Discharged, alive, *n* (%)	28 (75.7)	20 (74.1)	8 (80.0)	0.71
Remain in hospital, *n* (%)	7 (18.9)	6 (22.2)	1 (10.0)	0.40
Died, *n* (%)	4 (10.8)	3 (11.1)	1 (10.0)	0.92
Died, age ≥ 65 years, *n* (%)	3 (8.1)	2 (7.4)	1 (10.0)	0.68

Abbreviations: ARDS, acute respiratory distress syndrome (defined by the Berlin criteria)[21]; CRRT, continuous renal replacement therapy; iHD, intermittent hemodialysis; LOS, length of stay; Neuromuscular blockade, NMB; PEEP, positive end-expiratory pressure; VT, tidal volume.

[a] Persons Under Investigation negative for COVID-19 are patients suspicious for COVID-19 with a negative RT-PCR test, referred to as COVID-19 negative patients.

[b] Cisatracurium was the NMB of choice (vecuronium was used in one patient).

continued before intubation. The median time from admission to mechanical ventilation was 2.1 (0.6–3.7) days for COVID-19 patients and 0.0 (0.0–1.4) days for negative patients. COVID-19 patients (59.3%) underwent proning, neuromuscular blockade (NMB) was administered in 66.7% of patients for a median of 4.0 (0.0–6.0) days, and 39% were started on inhaled nitric oxide (iNO). COVID-19 patients were mechanically ventilated for a median of 10.0 (6.3–15.5) days, and 4.4 (2.4–12.5) days for COVID-19 negative patients. Relatedly, COVID-19 patients were in the ICU for a median of 13.7 (7.8–13.7) days and in the hospital for a median of 26.5 (14.0–32.0) days. The majority of COVID-19 (77.8%) and COVID-19 negative patients (70.0%) were extubated. The mortality rate was 11.1%, and 10.0% for COVID-19 and negative patients, respectively (Table 2).

Our patient population was similar to other cases series in Washington and New York in terms of demographics and comorbidities, but had fewer critically ill patients. Our population had lower proportions of patients with obesity, patients with more than one co-morbidity, and patients with severe ARDS [1–4]. Most of our COVID-19 patients were placed on HFNC before intubation, which may have led to a longer time from admission to mechanical ventilation [2,3]. Adjunct therapies during mechanical ventilation (proning, NMB, and iNO) were utilized more frequently in our COVID-19 patients compared to other studies [2]. Our institution established an aggressive proning protocol for mechanically ventilated patients with ARDS for less than 36 h (16 h prone, 8 h supine).

Compared to other studies, our COVID-19 patients had longer ventilator days despite aggressive extubation strategies in the ICU (77.8% extubated with a median of 10 ventilator days in our study vs. 33% extubated with a median of 10 ventilator days in the Seattle study) [2,3]. They also had a longer hospital LOS. This suggests that the hypoxic respiratory failure due to COVID-19 may require prolonged mechanical ventilation before extubation and a protracted recovery after ICU discharge. Altered mental status from propofol and fentanyl infusions (context-sensitive half time) could also have played a role. Furthermore, the proportion of our patients discharged alive (74.1%) was more than four-fold that of other cities including New York (3.3% and 17.7%), Seattle (17%), and Wuhan, China (5%). Finally, our mortality rate (11.1%) was much lower than the mortality rates in New York (24.5% and 14.7%) and Seattle (37.5%) [1,2,4,5]. This preliminary data suggests our COVID-19 patients had better outcomes which may be attributed to a less critically ill patient population, earlier presentation to the hospital before respiratory failure, aggressive proning strategies and NMB use, COVID-19-designated resources/personnel, and a hospital system that is not over capacity. Given our small sample size and underpowered study, future multi-center longitudinal studies based on patient population differences and treatment modalities are needed.

Disclosures

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Declaration of competing interest

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