

# Clinical characteristics and outcomes of critically ill patients with COVID-19 in Northeast Ohio: low mortality and length of stay

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**Background:** Published coronavirus disease 2019 (COVID-19) reports suggest higher mortality with increasing age and comorbidities. Our study describes the clinical characteristics and outcomes for all intensive care unit (ICU) patients admitted across the Cleveland Clinic enterprise, a 10-hospital health care system in Northeast Ohio, serving more than 2.7 million people.

**Methods:** We analyzed the quality data registry for clinical characteristics and outcomes of all COVID-19-confirmed ICU admissions. Differences in outcomes from other health care systems and published cohorts from other parts of the world were delineated.

**Results:** Across our health care system, 495 COVID-19 patients were admitted from March 15 to June 1, 2020. Mean patient age was 67.3 years, 206 (41.6%) were females, and 289 (58.4%) were males. Mean Acute Physiology Score was 45.3, and mean Acute Physiology and Chronic Health Evaluation III score was 60.5. In total, 215 patients (43.3%) were intubated for a mean duration of 9.2 days. Mean ICU and hospital length of stay were 7.4 and 13.9 days, respectively, while mean ICU and hospital mortality rates were 18.4% and 23.8%.

**Conclusions:** Our health care system cohort is the fourth largest to be reported. Lower ICU and hospital mortality and length of stay were seen compared to most other published reports. Better preparedness and state-level control of the surge in COVID-19 infections are likely the reasons for these better outcomes. Future research is needed to further delineate differences in mortality and length of stay across health care systems and over time.

**Key words:** cohort; COVID-19; critical illness; hospital mortality; intensive care unit; mechanical ventilation; pandemic

## INTRODUCTION

Coronavirus disease 2019 (COVID-19) has spread across the globe, causing more than a half million deaths to date [1]. The first COVID-19 death in Ohio was reported on March 1, 2020, and it has affected more than 89,626 people up to July 31, with more than 10,678 hospitalizations and 3,442 deaths across the state [2]. Studies from different countries pointed to higher mortality with increasing age and comorbidities [3,4]. Prior published results focused on overall hospitalized patients [3,4] or critically ill patients [5-13]. Our current study describes

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the clinical characteristics and outcomes of all intensive care unit (ICU) patients admitted across the Cleveland Clinic enterprise, a 10-hospital health care system in Northeast Ohio with more than 60% of the market share, serving more than 2.7 million people. Through our study, we tried to explain differences in outcomes from other health care systems and published cohorts from other parts of the world.

## MATERIALS AND METHODS

We analyzed the Cleveland Clinic health care system quality data registry for clinical characteristics and outcomes for all COVID-19-confirmed ICU admissions from March 15 to June 1, 2020. Data were compiled on June 29 to allow a 28-day assessment of outcomes in all patients. Table 1 summarizes demographics, clinical characteristics, and outcomes data. Before finalizing this report, we gathered available preliminary outcome data as of July 25, 2020 from all 10 hospital ICU cohorts since March. COVID-19 diagnosis was based on a positive polymerase chain reaction of a nasopharyngeal swab. We collected demographics, clinical characteristics, laboratory values at admission, ICU admission sources, admission Acute Physiology Score (APS), Acute Physiology And Chronic Health Evaluation III (APACHE III) score, hospital and ICU length of stay (LOS), hospital and ICU mortality, and duration of mechanical ventilation. The Institutional Review Board at the Cleveland Clinic approved this study (No. 20-418) and waived the need for patient informed consent. A review of other published reports on critically ill patients with COVID-19, available from the United States, Canada, Italy, the United Kingdom, and China was performed, with a focus on differences in baseline characteristics and outcomes over time. Chi-square test was used for statistical analysis and comparisons of mortality and mechanical ventilator ratios.

## RESULTS

Across our health care system ICUs, 495 patients were admitted for severe COVID-19 infection from March 15 to June 1, 2020 (Table 1). Mean age was 67.3 years, 206 (41.6%) were females, and 289 (58.4%) were males. The majority of patients (54.9%) was Caucasian, and 192 (38.3%) were African American. In addition, 176 (33.7%) were admitted from emergency rooms, and 228 (46.1%) transferred from medical or surgical wards to the ICU. Median BMI was 29.7 kg/m<sup>2</sup>, 177 patients (35.8%) were diabetic, and 64 (12.9%) met the criteria for severe sepsis or septic shock. Mean APS was 45.3, and mean

### KEY MESSAGES

- Better preparedness and state-level control of the surge in coronavirus disease 2019 (COVID-19) infections are the most plausible explanations for the lower mortality and length of stay in our cohort.

APACHE III score was 60.5. There were 215 patients on mechanical ventilation (43.3%) for a mean duration of 9.2 days. Of those 215 intubated patients, 24 underwent tracheostomy and were discharged on mechanical ventilation to a nursing home with ventilator capacity or to a long-term acute care hospital (11.16%). Mean ICU and hospital LOS values were 7.4 and 13.9 days, respectively, and ICU and hospital mortality rates were 18.4% and 23.8%. Mean C-reactive protein on admission was 13.5 mg/dl, mean D-dimer was 4,163.2 ng/ml, mean ferritin was 2,306.5 ng/ml, mean fibrinogen was 565.5 mg/dl, mean hemoglobin A1c was 7.9%, mean interleukin-6 was 116.0 pg/ml, and mean triglycerides was 210.7 mg/dl (Table 2). Our reported cohort contained no cases of catheter-associated urinary tract infection, no cases of ventilator-acquired pneumonia, and one case of fungal central line-associated blood stream infection.

## DISCUSSION

A review of the literature revealed several published cohorts and case series reports on demographics, clinical characteristics, and outcomes of COVID-19 patients as early as February 2020 from Wuhan, China [4]; March 2020 from Tongji Hospital also in Wuhan, China [10], Seattle and Washington state in the United States [6,12], and from the Lombardy region in Italy [5]; May 2020 from Vancouver, Canada [8]; a 65-center cohort study in the United States published July 2020 [7]; and the United Kingdom's Intensive Care National Audit and Research Center report on critically ill COVID-19 patients as of July 31, 2020 [13].

Our cohort of 495 patients is the fourth largest to be reported. Median age was 68 years, with a predominantly male population at 58.4% and elevated cohort mean BMI of 31.7 kg/m<sup>2</sup>. These results are similar to all prior reported demographics, supporting older age, male sex, and elevated BMI as risk factors for critical illness and adverse outcomes of COVID-19 infection. Diabetic patients whether type 1 or type 2 representing 35.8% of the ICU COVID-19 population is consistent with findings from Vancouver, Canada [8]; Seattle, WA [6]; and

**Table 1.** Demographics, clinical characteristics, and outcomes data

Variable	Cleveland Clinic, Northeast Ohio, United States (data as of 6/20)	Intensive Care National Audit and Research Center, United Kingdom [14] (data as of 7/31)	Multi-center cohort study of 65 centers across the United States [7] (data as of 6/4)	Vancouver, Canada [8] (data as of 5/5)	Lombardy Region, Italy [5] (data as of 3/25)	Washington State, United States [12] (data as of 3/10)	Seattle, WA, United States [6] (data as of 3/23)	Tongji, Wuhan, China [10] (data as of 3/23)	Wuhan, China [4] (data as of 2/23)
Number	495	10,624	2,215	117	1,591	21	24	344	52
Age (yr)	Mean ± SD, 67.3 ± 13.7; median (range), 68 (22.0–102.0)	Mean ± SD, 58.8 ± 12.7; 60	60.5 (14.5)	Median, 69	Median (range), 63 (14–100)	Median (range), 70 (43–92)	Mean ± SD, 64 ± 18	Median (range), 64 (52–72)	Mean ± SD, 59.7 ± 13.3
Sex									
Male	289 (58.4)	7,458 (70.2)	1,436 (64.8)	79 (67.5)	1,304 (82)	11 (52)	15 (63)	179 (52)	35 (67)
Female	206 (41.6)	3,159 (29.8)	779 (35.2)	38 (32.5)	287 (18)	10 (48)	9 (37)	165 (48)	17 (33)
ICU admission source									
ER	167 (33.7)								
Medical unit	228 (46.1)								
Transfer from another hospital	100 (20.2)								
Race									
White	272 (54.9)	6,765 (66.2)	837 (37.8)						
African American/Black	192 (38.8)	981 (9.6)	669 (30.2)						
Asian/Pacific	4 (0.8)	1,593 (15.6)	133 (6.0)						
Other/multiracial	16 (3.2)	690 (6.8)	576 (26)						
Unknown	11 (2.2)	Hispanic, 445 (20.1)							
BMI (kg/m <sup>2</sup> )	Mean ± SD, 1.7 ± 12.4; median (range), 29.7 (14.6–220.8)	Median (range), 30.5 (26.6–32.2)	Median, 28				Mean ± SD, 33.2 ± 7.2		
Diabetes mellitus									
Yes	177 (35.8)		861 (38.8)	36 (30.8)	180 (17)	7 (33.3)	14 (58)	64 (18.6)	9 (17)
No	318 (64.2)		1,354 (61.2)	81 (69.2)	111 (73)	14 (66.6)	10 (42)	280 (18.4)	43 (83)
Sepsis									
Yes	64 (12.9)								
No	431 (87.1)								

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**Table 1.** Continued

Variable	Cleveland Clinic, Northeast Ohio, United States (data as of 6/20)	Intensive Care National Audit and Research Center, United Kingdom [14] (data as of 7/31)	Multi-center cohort study of 65 centers across the United States [7] (data as of 6/4)	Vancouver, Canada [8] (data as of 5/5)	Lombardy Region, Italy [5] (data as of 3/25)	Washington State, United States [12] (data as of 3/10)	Seattle, WA, United States [6] (data as of 3/23)	Tongji, Wuhan, China [10] (data as of 3/23)	Wuhan, China [4] (data as of 2/23)
APS	Mean ± SD, 45.3 ± 24.7; median (range), 41.0 (4.0–164.0)								
APACHE III score	Mean ± SD, 60.5 ± 26.7; median (range), 57.0 (11.0–179.0)								
On mechanical ventilation									
Yes	215 (43.4)	6,090 (58.8), P < 0.0001	1,859 (83.9), P < 0.0001	74 (63.2), P = 0.0001	1,150 (88), P < 0.0001	15 (71), P = 0.0128	18 (75), P = 0.0024	100 (29.1), P < 0.0001	22 (42), P = 0.8464
No	280 (56.6)	4,534 (41.2)	356 (16.1)	43 (36.8)	441 (12)	6 (29)	6 (25)	244 (70.9)	30 (58)
Duration of mechanical ventilation	n = 243; mean ± SD, 9.2 ± 8.0; median (range), 7.0 (0.1–46.1)		n = 1,859; median (range), 11 (7–14)	n = 74; median (range), 13.5 (8–22)			n = 18; median (range), 10 (7–12)		
ICU LOS	Mean ± SD, 7.4 ± 7.9; median (range), 4.4 (0.1–46.9)		Median, 9	Median, 9	Median, 9		Median, 9		
Hospital LOS	Mean ± SD, 13.9 ± 9.1; median (range), 12.6 (0.1–49.5)		Median, 18	Median, 18			Median, 12		
ICU discharge status									
Dead	91 (18.4)	4,109 (38.7), P < 0.0001		18 (15.4), P = 0.4461	405 (26), P = 0.0006	11 (52.4), P = 0.0001	12 (50), P = 0.0002		
Alive	404 (81.6)	6,515 (61.3)	71 (60.7)	71 (60.7)	1,186 (74)	10 (47.6)	12 (50)		
Hospital discharge status									
Dead	118 (23.8)	4,405 (41.5), P < 0.0001	875 (39.5), P < 0.0001					133 (38.7), P < 0.0001	32 (61.5), P < 0.0001
Alive	377 (76.2)	6,219 (5.805)	1,340 (60.5)					211 (61.3)	20 (38.5)

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**Table 1.** Continued

Variable	Cleveland Clinic, Northeast Ohio, United States (data as of 6/20)	Intensive Care National Audit and Research Center, United Kingdom [14] (data as of 7/31)	Multi-center cohort study of 65 centers across the United States [7] (data as of 6/4)	Vancouver, Canada [8] (data as of 5/5)	Lombardy Region, Italy [5] (data as of 3/25)	Washington State, United States [12] (data as of 3/10)	Seattle, WA, United States [6] (data as of 3/23)	Tongji, Wuhan, China [10] (data as of 3/23)	Wuhan, China [4] (data as of 2/23)
Discharged with tracheostomy on mechanical ventilation to nursing home or LTACH									
Yes									
No									

Values are presented as number (%) unless otherwise indicated.

SD: standard deviation; ICU: intensive care unit; ER: emergency room; BMI: body mass index; APS: Acute Physiology Score; APACHE: Acute Physiology And Chronic Health Evaluation; LOS: length of stay; LTACH: long-term acute care hospital.

Washington state [12], as well as a multi-center cohort study across 65 centers in the United States [7]. This percentage is significantly higher than the 9.4% reported by the Center for Disease Control and Prevention Diabetes Center in Northeast Ohio, the 9.7% reported by the State of Ohio, and the 9.1% reported by the United States [15]. This confirms diabetic comorbidity to be associated with adverse outcomes including critical illness and ICU admission in COVID-19 patients.

The invasive mechanical ventilation rate in our cohort was 43.4%, similar to that reported from Wuhan, China [4,10]. However, this result was significantly lower than all other reports of mechanical ventilator usage in critically ill patients: 63.2% in Vancouver, Canada and up to 83.9% in a multi-center cohort study of 65 centers in the United States [5-8,12,13] (Table 1). Our reported ICU mortality of 18.4% and hospital mortality of 23.8% were significantly lower than those of most other cohorts except that from Vancouver, Canada [8] (Table 1). In addition, our median ICU LOS of 4.4 days was significantly shorter than that of 9 days from Lombardy, Vancouver, and Seattle [5,8,12] (Table 1). When an updated outcome summary from our health care system cohort was requested on August 7, ICU mortality had decreased from 18.4% to 17% and LOS from 7.4 to 6.6 days, while hospital mortality and LOS decreased from 23.8% to 21% and from 13.9 to 12.33 days, respectively, compared to the outcome data reported at the end of June.

A recent systematic review and meta-analysis of ICU mortality in COVID-19 patients reported a 41.6% mortality rate across all studies, with no significant effect of geographical location. However, a meta-regression by month of publication revealed a significant reduction in ICU mortality over time [11]. All studies reported an ICU COVID-19 mortality higher than the 4.4% [14] to 21.4% [13] mortality reported for those with non-COVID-19 viral and community-acquired pneumonia, and all were higher than our cohort ICU mortality of 18.4%.

All data published or reported, including ours, were preliminary and incomplete, representing up to 28 days post ICU admission. Consequently, all reported mortality and LOS are likely underestimated. Although unable to compare admission acuity across cohorts and case series as APS and APACHE III scores were rarely reported, several factors can explain our lower mortality and LOS. First, the state of Ohio enacted early social distancing measures, school closures, and a “stay at home” order prevented a surge in COVID-19 infection and in ICU and hospital bed utilization. These measures allowed proper time for all health care systems to prepare, and none was overwhelmed with COVID-19 patients as was seen in

**Table 2.** Laboratory test results on admission of COVID-19 patients admitted to an intensive care unit

Variable	Value
<b>CRP (mg/dl)</b>	
Number	386
Mean ± SD	13.5 ± 9.2
Median	12.2
Q1, Q3	5.9, 18.8
Range	0.1–48.3
<b>D-dimer (ng/ml)</b>	
Number	330
Mean ± SD	4,163.2 ± 7,648.1
Median	1,520.0
Q1, Q3	850.0, 3,340.0
Range	3.9–35,200.0
<b>Ferritin (ng/ml)</b>	
Number	381
Mean ± SD	2,306.5 ± 9,306.1
Median	843.6
Q1, Q3	447.0, 1,633.0
Range	30.9–100,000.0
<b>Fibrinogen (mg/dl)</b>	
Number	213
Mean ± SD	565.5 ± 179.5
Median	563.0
Q1, Q3	437.0, 703.0
Range	86.0–860.0
<b>HbA1c (%)</b>	
Number	69
Mean ± SD	7.9 ± 2.5
Median	7.1
Q1, Q3	6.1, 8.7
Range	5.0–14.4
<b>Interleukin-6 (pg/ml)</b>	
Number	205
Mean ± SD	116.0 ± 204.8
Median	49.0
Q1, Q3	14.0, 120.5
Range	2.2–1,602.7
<b>Troponin T</b>	
Number	260
Mean ± SD	0.1 ± 0.2
Median	0
Q1, Q3	0.0, 0.0
Range	0.0–2.0

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**Table 2.** Continued

Variable	Value
<b>Triglycerides (mg/dl)</b>	
Number	321
Mean ± SD	210.7 ± 379.0
Median	137
Q1, Q3	103.0, 203.0
Range	9.0–4,425.0

COVID-19: coronavirus disease 2019; CRP: C-reactive protein; SD: standard deviation; HbA1c: hemoglobin A1c.

other states such as New York and other countries such as Italy. In addition, we found a significantly lower rate of mechanical ventilation of 43.4% compared to most other cohorts and a lower median 7.0-day duration of mechanical ventilation compared to the 10 to 13.5 days reported in other studies [6,7,8]. Our planning and strict protocol-based best practice daily spontaneous breathing trial and sedation weaning also likely contributed to the result differences. Finally, as mentioned above, the date of data collection in June could have played a role in the observed reduction in ICU mortality since the start of the pandemic [11]. The main limitations of our study are the retrospective nature and use of data from a single health care system, which might restrict generalizability. However, this single system comprised 10 hospitals across Northeast Ohio, serving 2.7 million people.

Our analysis of outcome data from more than 495 ICU patients with a 28-day follow-up is the fourth largest to be reported. Lower ICU and hospital LOS and mortality were noted compared to most other published cohorts and case series across the globe. Better preparedness and state-level control of preventive measures seem to be the most plausible explanations for the lower mortality and LOS. Future study should determine if the lower rate of mechanical ventilation use and shorter duration on mechanical ventilation played a role.

Future research is needed to further explain the higher mortality of COVID-19 viral pneumonia compared to other viral and community-acquired pneumonias and to explain differences in mortality and LOS at national and international levels across health care systems and over time.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

## AUTHOR CONTRIBUTIONS

Conceptualization: FAF. Data curation: FAF, MAJ, SK, LG, RB. Formal analysis: FAF, SK, XW, XH. Methodology: FAF. Project administration: FAF. Visualization: FAF. Writing—original draft: FAF, SK. Writing—review & editing: FAF, MAJ.

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