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Characteristics and Outcomes of 21 Critically Ill Patients With COVID-19 in Washington State

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the disease it causes, coronavirus disease 2019 (COVID-19), is an emerging health threat.[1] Until February 2020, most cases were described in non-US health systems.[2,3] One of the first deaths in the US was reported at Evergreen Hospital in Kirkland, Washington. Over the following weeks, multiple cases of COVID-19 were identified in the surrounding community and treated at Evergreen Hospital. Most were attributed to US transmission, and the majority were linked to exposures at a skilled nursing facility.

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Audio

In this case series, we describe the clinical presentation, characteristics, and outcomes of incident cases of COVID-19 admitted to the intensive care unit (ICU) at Evergreen Hospital to inform other clinicians treating critically ill patients with COVID-19.

Methods | Patients with confirmed SARS-CoV-2 infection (positive result by polymerase chain reaction testing of a nasopharyngeal sample) admitted to the ICU at Evergreen Hospital between February 20, 2020, and March 5, 2020, were included. Evergreen Hospital is a 318-bed public hospital with a 20-bed ICU serving approximately 850 000 residents of King and Snohomish counties in Washington State.

Prior to data collection, a waiver was obtained from the Evergreen Healthcare institutional review board. Deidentified patient data were collected and analyzed using Stata version 15.1 (StataCorp). Laboratory testing was reviewed at ICU admission and on day 5. Chest radiographs were reviewed by an intensivist and a radiologist. Patient outcome data were evaluated after 5 or more days of ICU care or at the time of death. No analysis for statistical significance was performed given the descriptive nature of the study.

Results | A total of 21 cases were included (mean age, 70 years [range, 43-92 years]; 52% male). Comorbidities were identified in 18 cases (86%), with chronic kidney disease and congestive heart failure being the most common. Initial symptoms included shortness of breath (76%), fever (52%), and cough (48%) (**Table 1**). The mean onset of symptoms prior to presenting to the hospital was 3.5 days, and 17 patients (81%) were admitted to the ICU less than 24 hours after hospital admission.

Table 1. Baseline Characteristics of 21 Patients With Coronavirus Disease 2019 at Presentation to the Intensive Care Unit

Baseline characteristics	No. (%) of patients[a]	Reference range
Preadmission comorbidities		
Asthma	2 (9.1)	
Chronic obstructive pulmonary disease	7 (33.3)	
Congestive heart failure	9 (42.9)	
Diabetes	7 (33.3)	
Rheumatologic disease	1 (4.8)	
Obstructive sleep apnea	6 (28.6)	
Chronic kidney disease	10 (47.6)	
End-stage kidney disease	2 (9.5)	
History of solid organ transplant	2 (9.5)	
Cirrhosis	1 (4.8)	
Immunosuppression[b]	3 (14.3)	
Total with ≥1 comorbidity	18 (85.7)	
Admission symptoms		
Cough	11 (47.6)	
Shortness of breath	17 (76.2)	
Fever[c]	11 (52.4)	
Temperature (range), °C	37.6 (35.3-39.2)	
Admission chest radiograph findings[d]		
Bilateral reticular nodular opacities	11 (52.4)	
Ground-glass opacities	10 (47.6)	
Pleural effusion	6 (28.6)	
Peribronchial thickening	5 (23.8)	
Pleural effusion	5 (23.8)	
Focal consolidation	4 (19.0)	
Pulmonary edema	2 (9.5)	
Venous congestion	1 (4.8)	
Atelectasis	1 (4.8)	
Clear	1 (4.8)	
Admission laboratory measures, mean (range)[a]		
White blood cell count, /μL	9365 (2890-16 900)	4000-11 000
Absolute lymphocyte count, /μL	889 (200-2390)	1000-3400
Hemoglobin, g/dL	11.4 (8.0-13.7)	11.2-15.7
Platelet count, $\times 10^3$/μL	215 (52-395)	182-369
Sodium, mmol/L	137 (125-148)	135-145
Creatinine, mg/dL	1.45 (0.1-4.5)	0.6-1.2
Total bilirubin, mg/dL	0.6 (0.2-1.1)	0-1.5
Alkaline phosphatase, U/L	80 (41-164)	31-120
Aspartate aminotransferase, U/L[e]	273 (14-4432)	5-40
Alanine aminotransferase, U/L[e]	108 (11-1414)	5-50
Creatinine kinase, U/L	95 (45-1290)	21-215
Venous lactate, mmol/L	1.8 (0.8-4.9)	<1.9
Had troponin level >0.3 ng/mL, No. (%)	3 (14.0)	
Brain-type natriuretic peptide, pg/mL	4720 (69-33 423)	<450
Procalcitonin, ng/mL	1.8 (0.12-9.56)	0.15-2.0
Underwent bronchoalveolar lavage, No. (%)	7 (33.0)	

(continued)

Table 1. Baseline Characteristics of 21 Patients With Coronavirus Disease 2019 at Presentation to the Intensive Care Unit

Baseline characteristics	No. (%) of patients[a]	Reference range
After undergoing bronchoalveolar lavage		
White blood cell count, /μL	515 (174-1222)	0-5
Polymorphonuclear neutrophils, %	41.0 (13-77)	
Lymphocytes, %	32.0 (4-90)	
Monocytes, %	39.0 (12-72)	

SI conversion factors: To convert absolute lymphocyte count and white blood cell count to $\times 10^9$/L, multiply by 0.001; alanine aminotransferase, alkaline phosphatase, aspartate aminotransferase, and creatinine kinase to μkat/L, multiply by 0.0167; creatinine to μmol/L, multiply by 76.25; total bilirubin to μmol/L, multiply by 17.104; venous lactate to mg/dL, divide by 0.111.

[a] Unless otherwise indicated.

[b] Defined as outpatient prescription of greater than 10 mg/d of prednisone or an equivalent, use of chemotherapy, or use of nonsteroidal immunosuppressive agents for solid organ transplant or for an autoimmune disease.

[c] Defined as a temperature of greater than 38.0 °C.

[d] Reviewed independently by a chest radiologist and a pulmonary physician.

[e] One patient with a very high admission aspartate aminotransferase and admission alanine aminotransferase skewed the distribution and mean values. At admission the median aspartate aminotransferase level was 34 U/L and the median alanine aminotransferase was 26.5 U/L.

An abnormal chest radiograph was observed in 20 patients (95%) at admission. The most common findings on initial radiograph were bilateral reticular nodular opacities (11 patients [52%]) and ground-glass opacities (10 [48%]). By 72 hours, 18 patients (86%) had bilateral reticular nodular opacities and 14 (67%) had evidence of ground-glass opacities. The mean white blood cell count was 9365 μL at admission and 14 patients (67%) had a white blood cell count in the normal range. Fourteen patients (67%) had an absolute lymphocyte count of less than 1000 cells/μL. Liver function tests were abnormal in 8 patients (38%) at admission (Table 1).

Mechanical ventilation was initiated in 15 patients (71%) (**Table 2**). Acute respiratory distress syndrome (ARDS) was observed in 15 of 15 patients (100%) requiring mechanical ventilation and 8 of 15 (53%) developed severe ARDS by 72 hours. Although most patients did not present with evidence of shock, vasopressors were used for 14 patients (67%) during the illness. Cardiomyopathy developed in 7 patients (33%). As of March 17, 2020, mortality was 67% and 24% of patients have remained critically ill and 9.5% have been discharged from the ICU.

Discussion | This study represents the first description of critically ill patients infected with SARS-CoV-2 in the US. These patients had a high rate of ARDS and a high risk of death, similar to published data from China.[2] However, this case series adds insight into the presentation and early outcomes in this population and demonstrates poor short-term outcomes among patients requiring mechanical ventilation.

It is unclear whether the high rate of cardiomyopathy in this case series reflects a direct cardiac complication of SARS-CoV-2 infection or resulted from overwhelming critical illness. Others have described cardiomyopathy in COVID-19, and further research may better characterize this risk.[4,5]

Table 2. Clinical Measures During the Course of Illness and Outcomes of 21 Critically Ill Patients With Coronavirus Disease 2019

	No. (%) of patients[a]
Clinical measures	
Acute respiratory distress syndrome (ARDS)[b]	
None	1 (4.8)
Mild	2 (9.5)
Moderate	6 (28.6)
Severe	12 (57.1)
Ratio of arterial oxygen concentration to the fraction of inspired oxygen (range)	
At admission to ICU	169 (69-492)
At nadir	108 (58-247)
Use of noninvasive positive pressure ventilation	4 (19.0)
Use of high-flow oxygen therapy >15 L/min	1 (4.8)
Required mechanical ventilation	15 (71.0)
Among patients requiring intubation for mechanical ventilation	
Hospital days prior to intubation, mean (range), d	1.5 (0-12)
Use of prone positioning for ARDS	8 (50.0)
Use of inhaled epoprostenol for ARDS	5 (31.3)
Use of vasopressors	14 (67.0)
Absolute lymphocyte count at nadir (range), /μL	525 (180-1100)
Evidence of co-infection[c]	
Bacterial	1 (4.8)
Viral	3 (14.3)
Acute kidney failure[d]	4 (19.1)
Cardiomyopathy[e]	7 (33.3)
Acute hepatic injury[f]	3 (14.3)
Seizures	1 (4.8)
Length of follow-up, mean (range), d	5.2 (1-10)
Outcomes	
Died	11 (52.4)
Survived to transfer out of ICU	2 (9.5)
Remains critically ill and requires mechanical ventilation	8 (38.1)
Length of follow-up for those who survived or remain critically ill, mean (range), d	7.5 (5-10)

Abbreviation: ICU, intensive care unit.

SI conversion factor: To convert absolute lymphocyte count to $\times 10^9$/L, multiply by 0.001.

[a] Unless otherwise indicated.

[b] Definition and severity according to the Berlin Criteria.

[c] One patient developed pseudomonas (bacteremia). Two patients tested positive for influenza A and 1 patient tested positive for parainfluenza type 3.

[d] Defined by criteria from the Kidney Disease Improving Global Outcomes and the International Society of Nephrology.

[e] Defined as evidence of a globally decreased left ventricular systolic function on transthoracic echocardiogram in addition to clinical signs of cardiogenic shock, an elevation in level of creatinine kinase or troponin I, or a decrease in central venous oxygen saturation (<70%) without a past history of systolic dysfunction.

[f] Defined as an alanine aminotransferase or aspartate aminotransferase level greater than 3 times the upper limit of normal.

The limitations of this study include the small number of patients from a single center, that the study population included older residents of skilled nursing facilities, and it is likely not to be broadly applicable to other patients with critical illness. However, this study provides some initial experiences regarding the characteristics of COVID-19 in patients with critical illness in the US and emphasizes the need to limit exposure of nursing home residents to SARS-CoV-2.

Matt Arentz, MD
Eric Yim, MD
Lindy Klaff, MD
Sharukh Lokhandwala, MD, MSc
Francis X. Riedo, MD
Maria Chong, MD
Melissa Lee, MD

Author Affiliations: Department of Global Health, University of Washington, Seattle (Arentz); Evergreen Healthcare, Kirkland, Washington (Yim, Klaff, Lokhandwala, Riedo, Lee); Radia Inc, Lynwood, Washington (Chong).

Corresponding Author: Matthew Arentz, MD, Department of Global Health, University of Washington, 325 Ninth Ave, Seattle, WA 98104 (marentz@uw.edu).

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Concept and design: Arentz.
Acquisition, analysis, or interpretation of data: Arentz, Yim, Klaff, Lokhandwala, Riedo, Chong, Lee.
Drafting of the manuscript: Arentz, Chong.
Critical revision of the manuscript for important intellectual content: Arentz, Yim, Klaff, Lokhandwala, Riedo, Lee.
Statistical analysis: Arentz, Chong.
Administrative, technical, or material support: Riedo.

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Quality Measure Development and Associated Spending by the Centers for Medicare & Medicaid Services

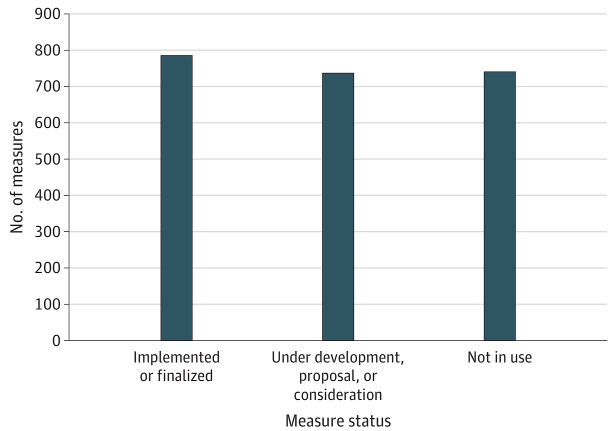
In the US, the Centers for Medicare & Medicaid Services (CMS) is increasingly tying reimbursement to the value of care, resulting in the rapid proliferation of quality measures to evaluate clinician and health system performance. Quality measurement can improve patient care, but there is growing concern that many measures may not be meaningful and that the administrative and financial burden placed on clinicians to report quality measures is substantial.[1-3] Less is known about the current landscape of CMS quality measures and the magnitude of spending on measure development. Understanding this landscape is important for efforts that aim to enhance the value of quality measurement and improvement.

Therefore, this study aimed to answer 3 questions. First, how many quality measures are currently available in the inventory of the CMS? Second, how many of these measures are used in CMS programs, are under development or consideration, or are not in use? Third, how much has the CMS invested in the development of quality measures?

Methods | The publicly available CMS Inventory Tool, which includes a compilation of CMS quality measures, was reviewed as of December 2019 to determine the percentage of measures that (1) had been implemented or finalized for use in a CMS program, (2) were under development, proposal, or consideration for use, or (3) were not in use. We also characterized the domains of quality assessed by measures that have been implemented or finalized in CMS programs.

Data from USAspending.gov were used to quantify federal spending on measure development and maintenance. We identified Measure and Instrument Development and Support contracts that were awarded to organizations by the CMS from 2008 to 2018, and estimated total spending in 2018 US dollars by adjusting total contract amounts for inflation.

Figure 1. Status of Quality Measures Developed for the Centers for Medicare & Medicaid Services (CMS)



The current status of quality measures was determined based on definitions provided by the CMS Inventory Tool. *Implemented or finalized* indicates measures that are currently used within a CMS incentive, reimbursement, or performance program or finalized per federal rule for use in a CMS program. *Under development, proposal, or consideration* indicates measures that are currently being developed for eventual use in a CMS program, have been introduced in a published proposed rule for potential use in a CMS program if eventually finalized in the federal rulemaking process, or have been submitted to the prerulemaking process and accepted for consideration by a CMS program. *Not in use* indicates measures that were introduced in a published proposed rule but were not finalized for use in a CMS program, submitted but not accepted by a CMS program through the prerulemaking process, removed from a CMS program via federal rule and are no longer implemented, or are no longer being developed for use in a CMS program or initiative.