Original Clinical Report

Clinical Outcomes in Critically Ill Coronavirus Disease 2019 Patients: A Unique New York City Public Hospital Experience

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Objectives: To explore demographics, comorbidities, transfers, and mortality in critically ill patients with confirmed severe acute respiratory syndrome coronavirus 2.

Design: Retrospective cohort study.

Setting: Data were collected from a large tertiary care public hospital ICU that is part of the largest public healthcare network in the United States.

Patients: One-hundred thirty-seven adult (≥ 18 yr old) ICU patients admitted between March 10, 2020, and April 7, 2020, with follow-up collected through May 18, 2020.

Interventions: None.

Measurements: Demographic, clinical, laboratory, treatment, and outcome data extracted from electronic medical records.

Main Results: The majority of patients were male (99/137; 72.3%) and older than 50 years old (108/137; 78.9%). The most reported ethnicity and race were Hispanic (61/137; 44.5%) and Black (23/137; 16.7%). One-hundred six of 137 patients had at least one comorbidity (77.4%). One-hundred twenty-one of 137 (78.1%) required mechanical ventilation of whom 30 (24.8%) moved to tracheostomy and 46 of 137 (33.6%) required new onset renal replacement therapy. Eighty-two of 137 patients (59.9%) died after a median of 8 days (interquartile range 5–15 d) in the ICU. Male sex had a trend toward a higher hazard of death (hazard ratio, 2.1 [1.1–4.0]) in the multivariable Cox model.

Conclusions: We report a mortality rate of 59.9% in a predominantly Hispanic and Black patient population. A significant association between comorbidities and mortality was not found in multivariable regression, and further research is needed to study factors that impact mortality in critical coronavirus disease 2019 patients. We also describe how a public hospital developed innovative approaches to safely manage a large volume of interhospital transfers and admitted patients.

Key Words: comorbidity; coronavirus disease 2019; healthcare disparities; intensive care; mechanical ventilation; mortality

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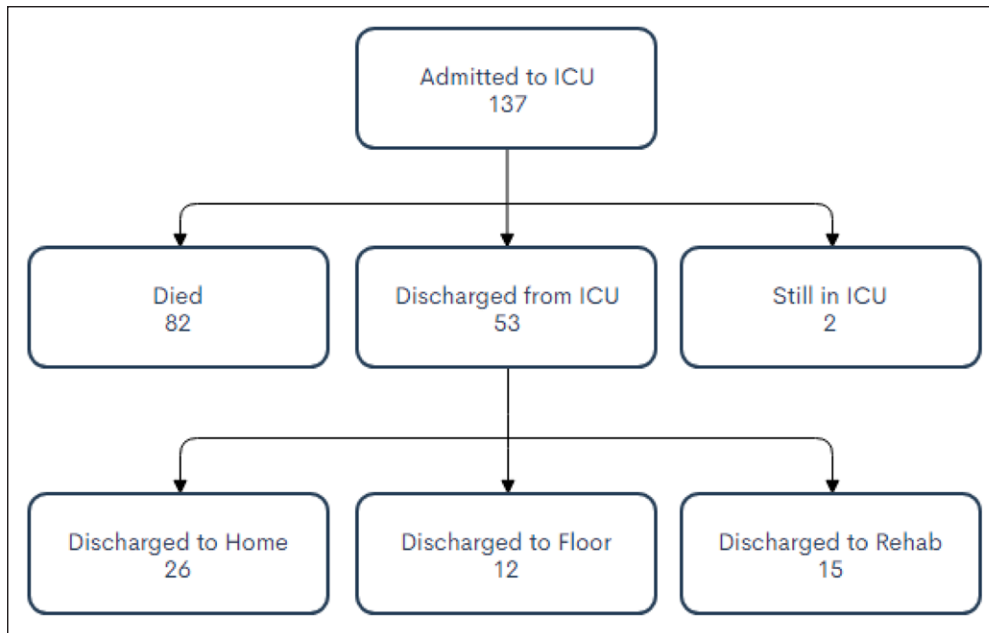[3]Leon H. Charney Division of Cardiology, New York University School of Medicine, New York City, NY.

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Since the first case of coronavirus disease 2019 (COVID-19) was reported in Washington state on January 20, 2020 (1) over 160,000 people have died due to COVID-19 in the United States (2, 3). In New York City (NYC), Black and Hispanic communities have been disproportionately affected by COVID-19, and social and economic factors have been implicated in the incidence and severity of illness (4–7). Black and Hispanic patients have lower rates of health insurance coverage than non-Hispanic White patients and may be more likely to rely on public healthcare resources (7). As the ICU for the primary referral site, and tertiary care center, of the largest public healthcare network in the United States, we share

Figure 1. Flow diagram of included participants. Rehab = rehabilitation facility.

SARS-coronavirus-2 infection was confirmed via positive RT-PCR assay of a nasopharyngeal or oropharyngeal swab. Routine laboratory testing results were recorded at admission to the ICU, including complete blood count, metabolic panel, and inflammatory/injury markers troponin, interleukin (IL)–6, D-dimer, ferritin, C-reactive protein, and procalcitonin.

The primary outcome was ICU mortality at the end of the follow-up period, with patients discharged from the ICU to hospital floors, rehabilitation, or home, considered survivors. Follow-up time was right-censored on May 18, 2020. Secondary outcomes included frequency of mechanical ventilation (MV) and renal failure requiring renal replacement therapy (RRT).

results from our critically ill patients who were predominantly from underserved communities and populations that have been disproportionately impacted by the novel coronavirus (6–10). We explore the outcomes of critically ill COVID-19 patients admitted during the first month of the pandemic in NYC. We explore mortality in critically ill COVID-19 patients in a large public hospital ICU. We also explore the demographics of our patient population, analyze associations between comorbidities and mortality, and describe treatments such as peritoneal dialysis (PD) and tracheostomy that were employed to manage the large volume of interhospital transfers and other admitted patients treated in our ICU.

METHODS

Study Design and Participants

This is a retrospective cohort study of critically ill patients with confirmed COVID-19 by severe acute respiratory syndrome (SARS)–coronavirus-2 reverse transcription-polymerase chain reaction (RT-PCR) admitted to the Bellevue ICU, a large tertiary care public hospital in NYC. Consecutive patients (≥ 18 yr old) admitted to the Bellevue ICU between March 10, 2020, and April 7, 2020, were included. Pregnant women and prisoners were defined as vulnerable populations and excluded from this study as part of the Institutional Review Board (IRB) approval process. The study was approved by the New York University Grossman School of Medicine Institutional Review Board and the NYC Health and Hospitals System to Track and Approve Research (IRB number 20-00447).

Data Collection

Demographic, clinical, laboratory, treatment, and outcome data were extracted from electronic medical records using a predetermined standardized chart review. Data were stored in Research Electronic Data Capture (11, 12). The data for a random sample of 20% of patients were reviewed by the data analysis team to verify accuracy. The rate of disagreement found during verification was 2.31%.

Statistical Analysis

Continuous variables were expressed as medians with interquartile range (IQR), and categorical variables as n (%). We used the Cox proportional hazards model to estimate hazard ratios (HRs) for death. We measured time-to-event in days from the date of ICU admission to the date of death. Seven independent variables were included in the multivariable Cox model considering the total number of deaths in our study to avoid overfitting the model. Sex and age were included, as male sex and older age have been associated with worse clinical outcomes in COVID-19 patients (13, 14). Obesity, hypertension, and diabetes were included as these pre-existing states have been postulated to confer greater risk for more severe disease and poor outcomes (15, 16) D-dimer concentration greater than 1 mg/L at time of ICU admission was included as there is growing evidence for the role of coagulopathy in severe COVID-19 (17–19). Finally, given the strain on the overall hospital system and the high number of patients in our cohort who were transferred from other facilities, we included transfer status in the model. There were 6.5% missing data for D-dimer level and 2.2% for body mass index (BMI). Overall missing data for the model were 8.8%. Data analyses were carried out using R programming language (R Foundation v. 3.6.0; R Project for Statistical Computing, Vienna, Austria).

RESULTS

Between March 10, 2020, and April 7, 2020, 137 patients with confirmed SARS-coronavirus-2 infection were admitted to our ICU. Baseline characteristics are available in **Table 1**. The majority of patients were male (99/137; 72.3%), and the mean age was 59 years (5–70 yr). The most reported ethnicity was Hispanic (61/137; 44.5%). The most reported race was Black or African-American (23/137; 16.7%). Most patients resided in racially and ethnically diverse neighborhoods with the majority of patients from Queens (62/137; 45.3%), Brooklyn (41/137; 29.9%), and Manhattan (24/137; 17.5%). The most common comorbidities

TABLE 1. Patient Characteristics

Demographics and Clinical Characteristics	Study Population (*n* = 137)
Age, yr, median (interquartile range)	59.0 (51.0–70.0)
18–49, *n/N* (%)	29/137 (21.2)
50–64, *n/N* (%)	55/137 (40.1)
≥ 65, *n/N* (%)	53/137 38.7)
Sex, male, *n/N* (%)	99/137 (72.3)
Race and ethnicity[a], *n/N* (%)	
Black or African American	23/137 (16.7)
Asian or Asian American	15/137 (10.9)
American Indian or Alaska native	3/137 (2.2)
White	10/137 (7.3)
Hispanic	61/137 (44.5)
Unknown race or ethnicity	16/137 (11.7)
County, *n/N* (%)	
Brooklyn	41/137 (29.9)
Queens	62/137 (45.3)
Manhattan	24/137 (17.5)
Bronx	9/137 (6.6)
Nassau County	1/137 (0.7)
Smoking status, *n/N* (%)	
Ever smoker	39/137 (28.5)
Never smoker	77/137 (56.2)
Unknown smoking status	21/137 (15.3)
Body mass index (kg/m²), *n/N* (%)	
≥ 30	59/134 (44.0)
≥ 35	32/134 (23.9)
≥ 40	13/134 (9.7)
Comorbidity, *n/N* (%)	
Any	106/137 (77.4)
Hypertension	70/137 (51.1)
Hyperlipidemia	35/137 (25.5)
Diabetes	51/137 (37.2)
Chronic heart disease	19/137 (13.9)
Asthma	11/137 (8.0)
Chronic obstructive pulmonary disease	4/137 (2.9)
Obstructive sleep apnea	56/137 (40.9)
Malignancy	4/137 (2.9)
Chronic kidney disease	20/137 (14.6)

(*Continued*)

TABLE 1. (*Continued*). Patient Characteristics

Demographics and Clinical Characteristics	Study Population (*n* = 137)
Symptoms at hospital presentation[b], *n/N* (%)	
Fever or subjective fever	90/137 (65.7)
Cough	88/137 (64.2)
Diarrhea	24/137 (17.5)
Nausea or vomiting	18/137 (13.1)
Myalgias	27/137 (19.7)
Dyspnea	98/137 (71.5)
Transferred from outside hospital, *n/N* (%)	58/137 (37.4)
Radiologic findings (first chest radiograph in hospital), *n/N* (%)	
Clear	5/137 (3.6)
lobar consolidation	9/137 (6.6)
multifocal/patchy opacity	109/137 (79.6)
Interstitial abnormalities	13/137 (9.5)
Other	14/137 (10.2)
Not performed	3/137 (2.2)

IQR = interquartile range.

were hypertension, obstructive sleep apnea, diabetes, and hyperlipidemia (Table 1). A large proportion of patients (104/134; 77.6%) had obesity. The median time from symptom onset to ICU admission was 7.5 days (5.8–10.3 d). The most common symptoms at admission to the hospital were dyspnea, fever, cough, weakness, and myalgias (Table 1). Twenty-four patients (17.5%) complained of diarrhea, and 18 (13.1%) reported nausea or vomiting. The most common findings on the first chest radiograph in the hospital were multifocal patchy opacities (109/137; 79.6%) (Table 1).

Invasive MV was initiated in 121 of 137 patients (88.3%) (Table 2). Eventually, 30 of 121 (24.8%) underwent tracheostomy (Table 2). The majority of patients were initiated on anticoagulation for prevention or treatment of venous thromboembolism; prophylactic doses were used in 46 of 137 (33.6%) (Table 2) and therapeutic in 84 of 137 (61.3%) (Table 2). New onset RRT was instituted in 46 of 137 patients (33.6%) (Table 2). PD was instituted in 18 of 137 patients (11.6%) (Table 2) and was not associated with increased mortality in patients receiving RRT in univariable analysis (**Table 3**). Veno-venous extracorporeal membrane oxygenation (ECMO) was provided to one of 137 patients.

As of May 18, 2020, 82 of 137 patients (59.9%) had died following a median of 8 days (IQR, 5–15 d) in the ICU. Twenty-six of 137 (19.0%) were discharged home, and 15 of 317 (10.9%) were discharged to a rehabilitation facility. Twelve of 137 (8.8%) were discharged from the ICU and remained on the floor, and two of 137 (1.5%) remained in the ICU (**Fig. 1**). Our ICU accepted 58 critically ill patients in transfer from network hospitals. During the study period, no COVID-19 patients were transferred from our ICU to other hospitals. In the multivariable Cox model, male

TABLE 2. Laboratory Values and Clinical Outcomes

Laboratory Values, Clinical Findings, and Outcomes	Study Population (n = 137)
Laboratory values at ICU admission	
White cell count	
Median (IQR)	10.8 (7.7–13.9)
> 10,000 per mm^3, n/N (%)	75/131 (57.3)
Absolute lymphocyte count	
Median (IQR)	0.9 (0.7–1.3)
< 1 × 10^3/μL, n/N (%)	77/131 (58.8)
Absolute neutrophil count	
Median (IQR)	8.5 (5.9–11.7)
> 7.6 × 10^3/μL, n/N (%)	77/131 (58.8)
Platelet count	
Median (IQR)	236.0 (161.0–296.0)
<150,000 per mm^3, n/N (%)	25/131 (19.1)
Blood urea nitrogen	
Median (IQR)	23.0 (16.0–40.0)
>23 mg/dL, n/N (%)	65/133 (48.9)
Serum creatinine	
Median (IQR)	1.1 (0.8–2.8)
≥ 1.5 mg/dL, n/N (%)	53/133 (39.8)
Alanine aminotransferase	
Median (IQR)	51.0 (32.0–76.0)
> 40 U/L, n/N (%)	79/128 (61.7)
Aspartate aminotransferase	
Median (IQR)	71.0 (53.3–108.5)
> 40 U/L, n/N (%)	112/128 (87.5)
D-dimer	
Median (IQR)	1,582.0 (605.0–3,302.0)
> 1.0 mg/L, n/N (%)	75/128 (58.6)
Ferritin	
Median (IQR)	1,280.0 (741.2–1,743.2)
> 300 ug/mL, n/N (%)	117/123 (95.1)
Troponin	
Median (IQR)	0.1 (0.04–0.60)
> 0.5 ng/mL, n/N (%)	31/110 (28.2)
Lactate dehydrogenase	
Median (IQR)	605.0 (500.0–875.0)
> 225 U/L, n/N (%)	122/125 (97.6)

(*Continued*)

TABLE 2. (*Continued*). Laboratory Values and Clinical Outcomes

Laboratory Values, Clinical Findings, and Outcomes	Study Population (n = 137)
C-reactive protein	
Median (IQR)	199.9 (139.2–278.9)
> 10 mg/dL, n/N (%)	114/129 (88.4)
Procalcitonin	
Median (IQR)	1.4 (0.4–4.8)
≥ 0.5 ng/mL, n/N (%)	63/87 (72.4)
Interleukin-6	
Median (IQR)	215.4 (71.8–785.2)
> 15.5, n/N (%)	58/61 (95.1)
Clinical findings	
Prophylactic anticoagulation initiated, n/N (%)	46/137 (33.6)
Therapeutic anticoagulation initiated, n/N (%)	84/137 (61.3)
Required intubation, n/N (%)	121/137 (78.1)
Time from illness onset to intubation, d, median (IQR)	8.0 (5.0–11.0)
Time from hospital admission to intubation, d, median (IQR)	1.0 (0–4.0)
Pao$_2$/Fio$_2$ ratio at time of intubation, median (IQR)	121.8 (81.3–228.3)
Median positive end-expiratory pressure (at time of first arterial blood gas following intubation), median (IQR)	12.0 (10.0–15.0)
Required tracheostomy, n/N (%)	30/121 (24.8)
Time from intubation to tracheostomy, d, median (IQR)	14.0 (9.8–16.5)
Required new onset RRT, n/N (%)	46/137 (33.6)
Hemodialysis	20/137 (14.6)
Peritoneal dialysis	18/137 (11.6)
Continuous veno-venous therapy	30/137 (19.4)
Time from ICU admission to earliest RRT, d, median (IQR)	5.0 (3.0–8.3)
Time from illness onset to hospital presentation, d, median (IQR)	6.0 (3.0–8.0)
Time from illness onset to ICU admission, d, median (IQR)	7.5 (5.8–10.3)
Outcomes	
Died, n/N (%)	82/137 (59.9)
Duration of ICU stay prior to death, d, median (IQR)	8.0 (5.0–15.3)
Discharged home, n/N (%)	26/137 (19.0)
Discharged to floor, n/N (%)	12/137 (8.8)
Discharged to rehabilitation, n/N (%)	15/137 (10.9)
Still in the ICU, n/N (%)	2/137 (1.5)

IQR = interquartile range, RRT = renal replacement therapy.

sex was associated with increased mortality (HR 1.9 [1.0–3.6]) (Table 3).

DISCUSSION

Demographics, Comorbidities, and Predictors of Severe Disease and Association With Mortality

The majority of our patients were male (72%) and over the age of 50 (79%). Male sex had a trend toward a higher hazard of death in the multivariable model, which is in line with previous findings (20). Differences in behaviors, such as higher smoking rates in men (20, 21), disparities in immune response due to underlying chromosomal differences (22), differential angiotensin-converting enzyme 2 receptor expression or activity (23, 24), and a protective effect of estrogen found in murine models (25) may all help explain why male sex may be associated with increased mortality (10, 13, 14, 16, 21, 26–31).

Of particular interest in the United States and specifically in NYC has been the burden of COVID-19 on Black and Hispanic populations. The racial and ethnic makeup of our study cohort did not match census data detailing racial and ethnic makeup of the catchment areas where our patients were from. According to 2019 Census data, 20.7%, 17.8%, and 33.8% of residents in Queens, Manhattan, and Kings County respectively were Black (32). In our ICU population, which mainly came from these three counties, only 16.7% of our patients were Black. Our prevalence of Black patients was therefore below what would be expected if ICU cases were equal to the makeup of the catchment areas. For Hispanic patients, the opposite was true. Census data from 2019 report 28.2%, 25.6%, and 18.9% of residents in Queens, Manhattan, and Kings County respectively, identified as Hispanic, but our patient population in this cohort was 44.5% Hispanic. In our cohort, patients of Hispanic ethnicity seem to have been disproportionately in need of ICU care compared with what would be expected based on the demographics of the catchment areas.

The burden of comorbid conditions was high with 106 of 137 patients (77.4%) who had at least one comorbid condition. The high frequency of comorbid conditions may be related to the demographics of our study cohort. The patients in our cohort were predominantly Hispanic and Black, and patients from both of these ethnic and racial groups may have higher incidence of certain comorbidities (7, 9, 33). Further, greater COVID-19 mortality has been observed in Hispanic and Black individuals compared with non-Hispanic White individuals in NYC (4).

We did not find that hypertension, diabetes, or obesity were associated with an increase in mortality. This seems at odds with literature that highlights these comorbidities as associated with morbidity and mortality (34–36). However, we hypothesize that the relationship between comorbidities and ICU survival may be more nuanced compared with all COVID-19 admissions. For example, an academic health center network in Georgia reported a higher median BMI in patients who survived versus those who died in their ICUs (37). It may be the case that higher BMI could provide a survival benefit once patients are critically ill (37). Other analyses have observed that hypertension and diabetes are associated with increased mortality, but most data available include all

admissions, and robust ICU specific data are still needed (36, 38). Three quarters of our patients had at least one comorbidity; the lack of patients without comorbidities to make up a comparator arm may also help explain the lack of association between comorbidities and mortality. The lack of association between the studied comorbidities and death could also reflect our small sample size as our cohort consists of the first month of patients admitted to the ICU. Likewise, elevated D-dimer levels have been previously reported as a risk for morbidity and mortality in COVID-19 due to the likely contribution of thromboembolic events (26). Our lack of power could help explain why we did not see a significant association between elevated D-dimer level and mortality in our model.

Mortality Rate

Our ICU mortality rate was 59.9%, which was toward the higher end of sites that have reported mortality figures (13, 14, 16, 26, 28, 30, 37, 39). We hypothesized that our higher ICU mortality rate may in part have been due to our study's longer follow-up period as well as unprecedented levels of patient surge and resultant ICU strain.

The patients who passed away tended to do so fairly quickly, with a median time to death in our cohort of 8 days from ICU admission. The mortality rate did not increase proportionally with time. After 2 weeks, 69 of 137 or 50.4% of patients had passed away; after 4 weeks, 79/137 or 57.7% of patients had passed away; and after 69 days, 82 of 137 or 59.9% of patients had passed away. Our longer follow-up period might explain some smaller differences in mortality rates, but other factors were possibly more impactful.

Our study cohort was taken from the first month of our experience treating COVID-19 and was accompanied by an unprecedented surge of cases. **Supplement 3** (http://links.lww.com/CCX/A286) captures 1 month of descriptive surge levels from March 23 to April 23. By the time, our last study patient was admitted on April 7, the surge level necessitated the utilization of spaces that were engineered into satellite ICUs, such as our endoscopy suite. Available research has observed that mortality risk increases when there are modest increases in ICU strain, and this level of surge and ICU strain was unprecedented in comparison (40). Although our ICU mortality seems high, similar outcomes have been reported from other NYC hospitals (26, 27). Based on our similar time periods, study lengths, and geographic proximity to Petrilli et al (27) and considering the trend toward increased surge level and strain seen at our site during this time period, Petrilli et al (27) may have also faced similar surge conditions, but further research is needed to understand the similarities and differences between the two sites.

Also of interest is a study by Ziehr et al (41) that took place in Boston and is worthy of mention because of the low reported ICU mortality of 16.7%, with only five of 66 patients (7.6%) with undetermined final dispositions (41). Here again strain could also be a factor in increased mortality if ICUs in NYC faced larger surges and worse ICU strain than in Boston. Further research is needed across the board to explore how strong the relationship between surge and mortality might be. This is particularly important research to pursue as COVID-19 cases continue to rise in many other states, and many ICUs may face similar strain that was seen in NYC.

TABLE 3. Factors Associated with ICU Mortality

Factor	Univariable HR (95% CI)	p	Multivariable HR (95% CI)	p
Demographics				
Age, yr	1.02 (1.00–1.04)	0.03		
18–49	0.7 (0.4–1.3)	0.3		
50–64	0.7 (0.5–1.2)	0.2		
≥ 65	1.7 (1.1–2.6)	0.02	1.4 (0.8–2.3)	0.2
Male sex	1.4 (0.8–2.3)	0.2	1.9 (1.0–3.6)	0.06
Transferred	1.3 (0.9–2.0)	0.2	1.2 (0.7–2.0)	0.5
County (reference = Manhattan)				
Queens	0.7 (0.4–1.3)	0.2		
Brooklyn	0.7 (0.4–1.4)	0.4		
Bronx	1.0 (0.4–2.5)	1.0		
Nassau County	0	1.0		
Obesity (body mass index ≥ 30)	0.8 (0.5–1.3)	0.3	0.7 (0.5–1.2)	0.2
History of hypertension	1.0 (0.7–1.6)	0.9	1.0 (0.6–1.8)	0.9
History of diabetes	1.2 (0.8–1.9)	0.4	1.2 (0.7–2.1)	0.6
History of chronic heart disease	1.3 (0.7–2.4)	0.4		
Ever smoked	1.3 (0.8–2.1)	0.3		
Laboratory value				
D-dimer > 1 mg/L	1.3 (0.8–2.0)	0.3	1.0 (0.6–1.7)	1.0
Lactate dehydrogenase > 225 U/L	2.0 (0.3–14.2)	0.5		
Ferritin > 300 ug/mL	0.7 (0.3–1.9)	0.5		
Absolute lymphocyte count < 1 × 10^3/μL	1.2 (0.8–1.9)	0.4		
C-reactive protein >10 mg/dL	0.8 (0.4–1.5)	0.4		
Clinical findings				
Required intubation	4.5 (1.4–14.2)	0.01		
Required tracheostomy	0.3 (0.1–0.7)	0.004		
New onset renal replacement therapy				
Hemodialysis	0.7 (0.4–1.5)	0.4		
Peritoneal dialysis	0.5 (0.3–1.1)	0.1		
Continuous veno-venous therapy	0.6 (0.5–2.5)	0.7		

HR = hazard ratio.

Limited Resources, Creative Solutions, and Avenues for Further Research

As a member of the Regional Ebola and other Special Pathogen Treatment Center for the Department of Health and Human Services Region 2 and as a member of the National Emerging Special Pathogen Training and Education Center, our disaster preparedness plans were extensive. Preparations included expansion of our critical care space, staff, and supplies. As a member of the largest public hospital network in the United States, we used resource sharing across public hospitals to balance patient load from disproportionately affected facilities in Queens and Brooklyn (Table 1). These were hospitals catering to communities that were affected in a disproportionate manner (42). This was done in a coordinated manner, with information regarding institution's ICU capacity being shared in a seamless manner (**Supplement 1**, http://links.lww.com/CCX/A284). Using this level-loading process, we accepted more than 600 patients to our hospital during the months of March and April, including 327 COVID-19 patient transfers of whom 58 were critically ill. Although there was a higher mortality rate in transferred patients (38/58; 65.5%) than locally admitted patients (44/79; 55.6%), Bellevue's ability to serve

as a pressure release valve allowed other hospitals to continue to accept patients.

MV was associated with mortality in univariate analysis, which matched prior reports from China and NYC (28, 43). The association with mortality may be a reflection of the critical state of patients who require MV. Research is required to determine the proper time to intubate and employ MV in COVID-19 patients (44).

The need for RRT was one of our biggest challenges. Initial reports from China noted acute kidney injury (**Supplement 2**, http://links.lww.com/CCX/A285) in only 2.9% of severe COVID-19 cases and did not note strain on RRT resources (14, 45). In our cohort, 46 of 137 patients (33.6%) required new onset RRT. We were constrained by limited availability of nurses trained in hemodialysis or continuous veno-venous therapy and dialysis equipment. To bridge the gap in capacity, a PD program was created. In patients who were initiated on new onset RRT, we did not see a significant association between mortality and use of PD. PD may be a useful treatment when finite resources coincide with increased need for dialysis; however, future studies are needed to explore the safety, efficacy, and utilization of PD in critically ill patients.

In addition to RRT, many of our patients required MV for a prolonged period of time. A team was formed to perform tracheostomies on patients in need of long-term ventilator weaning. Although we found tracheostomy was associated with a decreased hazard of mortality in univariable analysis (HR 0.3 [0.01–0.7]), this result needs to be interpreted cautiously as there was selection bias to perform tracheostomies on patients who were anticipated to survive. Further research is needed to optimize patient selection and ensure provider safety as tracheostomy procedures can be considered super-spreading events (46). To our knowledge, none of the surgeons who performed tracheostomies developed symptoms or positive RT-PCR testing for COVID-19 presumed related to the procedures. The benefits of tracheostomy may outweigh the risks, and novel tracheostomy approaches can help limit the risk of super spreading events (46).

Prior to the COVID-19 pandemic, ECMO capabilities were not available to our ICU patients. Despite the inherent challenges of a pandemic, we recognized that a large volume of patients with severe acute respiratory distress syndrome (ARDS) would present to our ICU and were able to begin a multidisciplinary ECMO program that allowed us to offer this therapy to our patients. This has helped Bellevue establish its presence as an ECMO referral center for severe ARDS for the NYC public health network. As of submission for publication, 28 patients have been transferred for ECMO evaluation. Of these, eight patients were initiated on ECMO; ECMO survival and survival to discharge was 60% and 40%, respectively (47). Despite the circumstances and the low volume of our incipient program, our outcomes have been comparable with the national average (47).

Limitations

Due to the retrospective study design, we had missing data for some of our variables of interest. Additionally, not all laboratory tests were performed in all patients, and we were not able to include biomarkers such as troponin and IL-6 in our analysis. We were unable to report the initial severity of illness of our patients, which limits the interpretation of our findings. Some centers that we received transfers from may have been significantly limited in the critical care interventions that they were able to provide prior to transfer. Additionally, some patients died in the process of transfer and were not included in our cohort. We did not analyze data on treatments given or resource strain for associations with mortality. Finally, our study is limited by our small sample size; with a larger sample size, we may have been able to determine additional associations between patient characteristics and mortality in patients requiring an ICU admission.

CONCLUSIONS

We report a mortality rate of 59.9% for a large NYC public health hospital ICU in a predominantly Hispanic and Black patient population. In line with previous findings, male sex had a trend toward a higher hazard of death in multivariable analysis. Reported ICU mortality rates are subject to limitations based on study design such as length of available follow-up. ICU Mortality may be related to ICU strain but further research is needed to elucidate possible relationships.

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