




Critical Care Among Disadvantaged Minority Groups Made Equitable: Trends Throughout the COVID-19 Pandemic

Diana Cristina Lopez¹ · Georgina Whelan¹ · Lisa Kojima¹ · Samyukta Dore¹ · Saloni Lad¹ · Dominique Tucker¹ · Emily Abramczyk¹ · Omar Mehkri² · Xiaozhen Han³ · Xiaofeng Wang³ · Ana Monica Yepes-Rios⁴ · Abhijit Duggal² 

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Abstract

Background US racial and ethnic minorities have well-established elevated rates of comorbidities, which, compounded with healthcare access inequity, often lead to worse health outcomes. In the current COVID-19 pandemic, it is important to understand existing disparities in minority groups' critical care outcomes and mechanisms behind these—topics that have yet to be well-explored.

Objective Assess for disparities in racial and ethnic minority groups' COVID-19 critical care outcomes.

Design Retrospective cohort study.

Participants A total of 2125 adult patients who tested positive for COVID-19 via RT-PCR between March and December 2020 and required ICU admission at the Cleveland Clinic Hospital Systems were included.

Main Measures Primary outcomes were mortality and hospital length of stay. Cohort-wide analysis and subgroup analyses by pandemic wave were performed. Multivariable logistic regression models were built to study the associations between mortality and covariates.

Key Results While crude mortality was increased in White as compared to Black patients (37.5% vs. 30.5%, respectively; $p = 0.002$), no significant differences were appraised after adjustment or across pandemic waves. Although median hospital length of stay was comparable between these groups, ICU stay was significantly different (4.4 vs. 3.4, $p = 0.003$). Mortality and median hospital and ICU length of stay did not differ significantly between Hispanic and non-Hispanic patients. Neither race nor ethnicity was associated with mortality due to COVID-19, although APACHE score, CKD, malignant neoplasms, antibiotic use, vasopressor requirement, and age were.

Conclusions We found no significant differences in mortality or hospital length of stay between different races and ethnicities. In a pandemic-influenced critical care setting that operated outside conditions of ICU strain and implemented standardized protocol enabling equitable resource distribution, disparities in outcomes often seen among racial and ethnic minority groups were successfully mitigated.

Keywords Critical care · ICU strain · COVID-19 · Social disparities of health · Racial and ethnic inequality

Diana Cristina Lopez and Georgina Whelan Shared first authorship.

Diana Cristina Lopez and Georgina Whelan contributed equally to this work.

✉ Abhijit Duggal
duggala2@ccf.org

¹ Cleveland Clinic Lerner College of Medicine of Case Western Reserve University, Cleveland, OH, USA

² Department of Critical Care, Respiratory Institute, Cleveland Clinic, 9500 Euclid Avenue, OH 44195 Cleveland, USA

Introduction

COVID-19 has put significant strain on healthcare systems, with a high proportion of patients admitted to the ICU requiring mechanical ventilation. Studies of past and current

³ Department of Quantitative Health Sciences, Cleveland Clinic, Cleveland, OH, USA

⁴ Department of Internal Medicine, Cleveland Clinic, Cleveland, OH, USA

pandemics have shown that minority groups and individuals of low socioeconomic status are disproportionately affected due to barriers of access to prevention and care [1]. US racial and ethnic minority populations are known to have higher rates of comorbidities, which, when coupled with gaps in access to healthcare, have led to worse outcomes when compared to those of their White counterparts [2, 3]. These existing health disparities are compounded by situations that increase the demand and resource depletion of a healthcare system, such as a global pandemic. Studies of past pandemics, such as the 2008 H1N1 Influenza, have highlighted important disparities in exposure, susceptibility to disease, and access to care [4]. These barriers include an increased risk of being exposed to communicable diseases, increased susceptibility to illness due to pre-existing medical comorbidities, and limited access to testing and care [4].

Analysis of the COVID-19 pandemic has demonstrated this alarming trend, such as within New York City and other urban centers, where the Black community and other communities of color have been particularly affected by the pandemic [5]. These risks may be further compounded by the fact that minority groups and individuals of low socioeconomic status are more likely to have decreased access to timely intervention, an inability to undergo social distancing due to work-related demands, language barriers, and larger household sizes. Altogether, these factors could hinder individuals of disadvantaged communities from seeking medical attention, testing, and treatment, contributing to poorer outcomes [6].

The effects of COVID-19 on the health outcomes of racial and ethnic minority groups are still incompletely understood, especially within the critical care setting. Long-term mitigation of these disparities will require an assessment of the differences in COVID-19 ICU outcomes between patients who identify as Black, Hispanic, and non-Hispanic White. By identifying whether race and/or ethnicity is associated with inequalities in critical care management of COVID-19 within the Northeastern Ohio community, we hope to inform guidelines for nationwide providers to help mitigate disparities among vulnerable populations in the setting of severe disease and high acuity care. Similar to other recent data, we hypothesized that patients who identify as Black or Hispanic in Cleveland, OH, may be more susceptible to poor COVID-19 outcomes following ICU admission, including increased length of stay and increased mortality rates, as compared to non-Hispanic White patients.

Methods

Cleveland Clinic COVID-19 Research Registry

This was a retrospective cohort study utilizing the Cleveland Clinic COVID-19 ICU Registry, which compiles

clinical data obtained from the electronic medical record of all patients admitted to a Cleveland Clinic Healthcare System ICU for the treatment of COVID-19. The study was approved by the Cleveland Clinic Institutional Review Board #20–404. Patients enrolled in the COVID-19 Cleveland Clinic Registry tested positive for the SARS-CoV-2 virus via RT-PCR. The registry includes data on patient demographics, comorbidities, risk factors for contracting COVID-19 and experiencing a more severe disease course, intubation status, medications used in the treatment of COVID-19, duration of follow-up, and COVID-19 outcomes, such as length of hospital and ICU stay and mortality. The severity of illness was quantified by using the APACHE score.

Subjects

A total of 2125 adults over the age of 18 years admitted to a Cleveland Clinic ICUs in Northeastern Ohio for the treatment of COVID-19 between March and December 2020 were included in this analysis (Fig. 1). Apart from age, no other exclusion criteria were applied. Three waves of COVID-19 patients were independently studied, with each wave defined as March to June, July to September, and October to December, respectively. Within race, individuals self-identified as Black, White, or other, which includes Asian, Native Hawaiian, Pacific Islander, American Indian, Alaskan Native, or multiracial. Patients were also identified as being of either Hispanic or non-Hispanic ethnicity.

Primary and Secondary Outcomes

Our primary outcome was incidence of mortality, either during hospital admission or within the 90-day follow-up period thereafter. Our secondary outcomes were length of hospital and ICU stay.

Data Analysis

An overall analysis was performed on the entire cohort in addition to subgroup analyses for each pandemic wave, as defined above. Descriptive statistics were used to characterize the patient cohort. Patient information was described using median (25th–75th percentile) for all continuous variables and counts and percentages for all categorical variables. Wilcoxon rank sum test or Kruskal–Wallis test was used to compare differences between groups for continuous variables, and Fisher's exact test or chi-square test was applied for categorical variables. Multivariable logistic regression models were built to study the associations between the mortality outcome and pre-specified variables. Variables included in the regression model were comorbidities that were hypothesized to affect disease severity and factors important to ICU

and COVID-19 care. In the case of missing values, only complete cases were analyzed. The analyses were two-tailed and were performed at a significance level of 0.05. SAS 9.4 software (SAS Institute, Cary, NC) was used for all analyses. For analyses based on race, a Bonferroni correction was used for multiple comparisons, with a significance level of $0.05/3 = 0.017$ being considered significant.

Results

Characteristics of COVID-19–positive patients based on race

A total of 2125 patients tested positive for COVID-19 between March and December 2020 and required an intensive care unit (ICU) admission during their hospital course. Among the 2108 patients included in the race analysis

(17 were excluded for missing data) (Fig. 1), 41.8% were female, 33% identified as Black, and 6.7% identified as being of non-White or non-Black race (Table 1). The Black cohort was younger than the White cohort (66 vs. 71 years, $p < 0.001$). Black patients had a significantly higher prevalence of asthma (26.3% vs. 20.4%, $p = 0.003$), CKD (48.6% vs. 36.7%, $p < 0.001$), and diabetes (68.1% vs. 56.0%, $p < 0.001$) as compared to White patients. Additionally, Black patients had a lower prevalence of malignant neoplasms (37.3 vs. 45.0%, $p = 0.001$). There were no significant differences between Black and White patients for chronic cardiac disease, COPD, CAD, dementia, HTN, hematological malignancies, solid organ and bone marrow transplants, malnutrition, liver disease, and immunodeficiencies. Median APACHE score, a predictor of ICU mortality, was 54 and 55 for Black and White patients, respectively ($p = 0.40$). For comparisons between Black, White, and other populations, see Supplementary Table 1.

Table 1 Patient baseline characteristics based on race (White vs. Black)

Variable	Overall (N=1,967)	Black (N=699)	White (N=1,268)	p value
Demographics				
Age	69.0[59.0,78.0]	66.0[55.0,75.0]	71.0[61.0,79.0]	< 0.001 ^b
Female	830(42.2)	315(45.1)	515(40.6)	0.056 ^c
Comorbidities				
COPD	712(36.2)	251(35.9)	461(36.4)	0.84 ^c
Asthma	443(22.5)	184(26.3)	259(20.4)	0.003 ^c
Diabetes	1,186(60.3)	476(68.1)	710(56.0)	< 0.001 ^c
HTN	1,772(90.1)	644(92.1)	1,128(89.0)	0.024 ^c
CAD	408(20.7)	149(21.3)	259(20.4)	0.64 ^c
Chronic cardiac disease	1,393(70.8)	490(70.1)	903(71.2)	0.60 ^c
CKD	805(40.9)	340(48.6)	465(36.7)	< 0.001 ^c
Liver disease	431(21.9)	165(23.6)	266(21.0)	0.18 ^c
Malignant neoplasm	831(42.2)	261(37.3)	570(45.0)	0.001 ^c
Immunodeficiency	27(1.4)	7(1.0)	20(1.6)	0.29 ^c
AIDS (HIV)	20(1.0)	10(1.4)	10(0.79)	0.17 ^c
Solid organ or bone marrow transplant	106(5.4)	38(5.4)	68(5.4)	0.94 ^c
Malnutrition	1,336(67.9)	468(67.0)	868(68.5)	0.49 ^c
Smoking				
Current smoker	158(8.2)	84(12.3)	74(6.0)	< 0.001 ^c
Former smoker	912(47.4)	291(42.7)	621(50.0)	
Severity of illness				
APACHE score	55.0[40.0,74.0]	54.0[38.0,75.0]	55.0[42.0,72.0]	0.40 ^b
Wave				
1	415 (21.1)	169 (24.2)	246 (19.4)	0.0003 [†]
2	374 (19.0)	157 (22.5)	217 (17.1)	
3	1178 (59.9)	373 (53.4)	805 (63.5)	

*Statistics presented as mean \pm SD, median [P25, P75], median (min, max) or N (column %)

[†]p values: a = ANOVA, b = Kruskal–Wallis test, c = Pearson's chi-square test, d = Fisher's exact test

[‡]p value < 0.017 was considered significant due to Bonferroni correction

Characteristics of COVID-19–Positive Patients Based on Ethnicity

Among the 2064 patients included in the ethnicity analysis (61 were excluded for missing data) (Fig. 1), 4.3% of individuals identified as Hispanic (Table 2). As compared to non-Hispanic patients, Hispanic patients within this cohort had a significantly lower prevalence of chronic cardiac disease (52.8% vs. 71.2%, $p < 0.001$), CKD (20.2% vs. 41.5%, $p < 0.001$), COPD (23.6% vs. 36.3%, $p = 0.015$), HTN (80.9% vs. 89.9%, $p = 0.007$), and malignant neoplasms (29.2% vs. 41.8%, $p = 0.019$). However, Hispanic patients had a significantly higher prevalence of liver disease (32.6% vs. 22.2%, $p = 0.022$). No significant differences were observed in the prevalence of asthma, CAD, diabetes, solid organ and BM transplant, malnutrition, HIV, and immunodeficiency disorders between groups. The mean APACHE score was significantly lower for Hispanic patients (49 vs. 55, $p = 0.037$), suggesting that

the predicted ICU mortality at admission was higher for non-Hispanic patients within this cohort.

Interventions Required During ICU Admission by Race and Ethnicity

A similar percentage of patients within the Black and White groups required intubation during their ICU course (41.9% vs. 42.7%, respectively, $p > 0.05$); among those intubated, the mean intubation times were comparable (7.0 vs. 8.2 days) (Table 3). Additionally, vasopressor requirements in the ICU were not significantly different between Black and White patients (51.2% vs. 53.5% respectively, $p > 0.05$). Dexamethasone, which has been studied as a potential therapeutic for COVID-19, was prescribed significantly more frequently in White than Black patients (69.6% vs. 64.2%, $p = 0.014$). Other COVID-19 therapeutics employed include lopinavir, ritonavir, remdesivir, hydroxychloroquine, and tocilizumab. A similar percentage of patients in each category received these medications, with the

Table 2 Patient baseline characteristics based on ethnicity

Variable	Overall (N=2,064)	Hispanic (N=89)	Non-Hispanic (N=1,975)	p-value
Demographics				
Age	69.0[59.0,78.0]	60.0[48.0,72.0]	69.0[59.0,78.0]	< 0.001^b
Female	868(42.1)	35(39.3)	833(42.2)	0.59 ^c
Comorbidities				
COPD	737(35.7)	21(23.6)	716(36.3)	0.015^c
Asthma	470(22.8)	24(27.0)	446(22.6)	0.33 ^c
Diabetes	1,259(61.0)	63(70.8)	1,196(60.6)	0.053 ^c
HTN	1,848(89.5)	72(80.9)	1,776(89.9)	0.007^c
CAD	422(20.4)	12(13.5)	410(20.8)	0.096 ^c
Chronic cardiac disease	1,453(70.4)	47(52.8)	1,406(71.2)	< 0.001^c
CKD	838(40.6)	18(20.2)	820(41.5)	< 0.001^c
Liver disease	467(22.6)	29(32.6)	438(22.2)	0.022^c
Malignant neoplasm	851(41.2)	26(29.2)	825(41.8)	0.019^c
Immunodeficiency	28(1.4)	0(0.0)	28(1.4)	0.63 ^d
AIDS (HIV)	22(1.1)	3(3.4)	19(0.96)	0.07 ^d
Solid organ or bone marrow transplant	115(5.6)	6(6.7)	109(5.5)	0.62 ^c
Malnutrition	1,393(67.5)	55(61.8)	1,338(67.7)	0.24 ^c
Smoking				0.002^c
Current Smoker	160(7.9)	4(4.7)	156(8.1)	
Former smoker	946(46.9)	27(31.4)	919(47.6)	
Severity of illness				
APACHE score	54.0[39.0,73.0]	49.0[35.0,69.0]	55.0[39.0,74.0]	0.037^b
Wave				
1	436 (21.1)	25 (28.1)	411 (20.8)	0.1770 ¹
2	405 (19.6)	19 (21.3)	386 (19.5)	
3	1223 (59.3)	45 (50.6)	1178 (59.6)	

*Statistics presented as mean \pm SD, median [P25, P75], median (min, max), or N (column %)

[†]p values: a = ANOVA, b = Kruskal–Wallis test, c = Pearson's chi-square test, d = Fisher's exact test

Table 3 ICU therapies based on race (White vs. Black)

	Overall (<i>N</i> =1,967) Statistics	Black (<i>N</i> =699) Statistics	White (<i>N</i> =1,268) Statistics	<i>p</i> value
Days intubated	7.8[3.1,14.6]	7.0[2.7,13.7]	8.2[3.5,14.9]	0.074 ^b
Intubated	834(42.4)	293(41.9)	541(42.7)	0.7478 ^c
Dexamethasone	1,320(67.7)	442(64.2)	878(69.6)	0.014^c
Methylprednisolone	283(14.5)	74(10.7)	209(16.6)	< 0.001^c
Prednisone	199(10.2)	64(9.3)	135(10.7)	0.33 ^c
Epinephrine	369(18.9)	139(20.2)	230(18.2)	0.29 ^c
Norepinephrine	906(46.4)	306(44.4)	600(47.5)	0.19 ^c
Phenylephrine	698(35.8)	256(37.2)	442(35.0)	0.35 ^c
Vasopressin	11(0.56)	5(0.73)	6(0.48)	0.53 ^d
Remdesivir	105(5.4)	50(7.3)	55(4.4)	0.007^c
Hydroxychloroquine	170(8.7)	65(9.4)	105(8.3)	0.40 ^c
Lopinavir-ritonavir	10(0.51)	3(0.44)	7(0.55)	> 0.99 ^d
Tocilizumab	144(7.4)	41(6.0)	103(8.2)	0.074 ^c
Antibiotics	1,760(90.2)	606(88.0)	1,154(91.4)	0.013^c
Vasopressor use	1037(52.7)	358(51.2)	679(53.5)	0.321 ^c

*Statistics presented as mean ± SD, median [P25, P75], median (min, max), or N (column %)

[†]*p* values: a = ANOVA, b = Kruskal–Wallis test, c = Pearson's chi-square test, d = Fisher's exact test

[‡]*p* value < 0.017 was considered significant due to Bonferroni correction

exception of remdesivir, which was more frequently administered to Black as compared to White patients (7.3% vs. 4.4%, $p=0.007$). For comparisons between Black, White, and other populations, see Supplementary Table 2.

Corresponding trends were appreciated when comparing Hispanic to non-Hispanic patients (Table 4). 37.1% vs. 42.4% Hispanic and non-Hispanic patients required intubation with a median time of 11 vs. 7.8 days, respectively

($p=0.27$). Vasopressor requirements were comparable between ethnicities, although fewer Hispanic patients received dexamethasone as compared to non-Hispanic patients (51.7% vs. 67.9%, $p=0.001$). More Hispanic patients were prescribed hydroxychloroquine (14.6% vs. 8.5%, $p=0.045$) and lopinavir/ritonavir (3.4% vs. 0.4%, $p<0.001$), although the use of remdesivir and tocilizumab was not significantly different.

Table 4 ICU therapies based on ethnicity

	Overall (<i>N</i> =2,064)	Hispanic (<i>N</i> =89)	Non-Hispanic (<i>N</i> =1,975)	<i>p</i> value
Days intubated	7.8[3.2,14.6]	11.0[3.9,16.8]	7.8[3.2,14.5]	0.27 ^b
Intubated	870(42.2)	33(37.1)	837(42.4)	0.3218 ^c
Dexamethasone	1,375(67.2)	46(51.7)	1,329(67.9)	0.001^c
Methylprednisolone	296(14.5)	7(7.9)	289(14.8)	0.070 ^c
Prednisone	209(10.2)	9(10.1)	200(10.2)	0.98 ^c
Epinephrine	383(18.7)	11(12.4)	372(19.0)	0.12 ^c
Norepinephrine	943(46.1)	37(41.6)	906(46.3)	0.38 ^c
Phenylephrine	725(35.4)	26(29.2)	699(35.7)	0.21 ^c
Vasopressin	12(0.59)	0(0.0)	12(0.61)	> 0.99 ^d
Remdesivir	115(5.6)	6(6.7)	109(5.6)	0.64 ^c
Hydroxychloroquine	179(8.7)	13(14.6)	166(8.5)	0.045 ^c
Lopinavir-ritonavir	10(0.49)	3(3.4)	7(0.36)	< 0.001^d
Tocilizumab	161(7.9)	10(11.2)	151(7.7)	0.23 ^c
Antibiotics	1,843(90.0)	81(91.0)	1,762(90.0)	0.75 ^c
Vasopressor	1077(52.2)	42(47.2)	1035(52.4)	0.335 ^c

*Statistics presented as mean ± SD, median [P25, P75], median (min, max), or N (column %)

[†]*p* values: a = ANOVA, b = Kruskal–Wallis test, c = Pearson's chi-square test, d = Fisher's exact test

Table 5 Patient outcomes based on race

	Overall (<i>N</i> =1,967)	Black (<i>N</i> =699)	White (<i>N</i> =1,268)	<i>p</i> value
LOS in ICU	4.0[1.6,10.1]	3.4[1.4,8.8]	4.4[1.7,10.5]	0.003^b
LOS in Hospital	11.0[6.5,18.2]	10.6[6.0,17.9]	11.5[6.7,18.5]	0.056 ^b
Dead	688(35.0)	213(30.5)	475(37.5)	0.002^c

*Statistics presented as Mean ± SD, Median [P25, P75], Median (min, max) or N (column %)

[†]*p* values: a = ANOVA, b = Kruskal–Wallis test, c = Pearson's chi-square test, d = Fisher's exact test

[‡]*p* value < 0.017 was considered significant due to Bonferroni correction

[§]LOS = length of stay

Table 6 Patient outcomes based on ethnicity

	Overall (<i>N</i> =2,064)	Hispanic (<i>N</i> =89)	Non-Hispanic (<i>N</i> =1,975)	<i>p</i> value
LOS in ICU	4.0[1.6,10.1]	3.9[1.4,9.9]	4.0[1.6,10.1]	0.72 ^b
LOS in hospital	11.0[6.5,18.3]	10.8[5.9,16.3]	11.0[6.5,18.4]	0.25 ^b
Dead	708(34.3)	24(27.0)	684(34.6)	0.14 ^c

*Statistics presented as mean ± SD, median [P25, P75], median (min, max), or N (column %)

[†]*p* values: a = ANOVA, b = Kruskal–Wallis test, c = Pearson's chi-square test, d = Fisher's exact test

[‡]LOS = length of stay

Outcomes of COVID-19–Positive Patients Based on Race and Ethnicity

Mortality was seen in a higher proportion of White patients as compared to Black patients admitted to the ICU (37.5% vs. 30.5%, respectively; $p = 0.002$). The median length of hospital stay was similar between Black and White patients (10.6 vs. 11.5 days, $p = 0.056$). However, the median length of ICU stay was statistically different between the two groups (3.4 vs. 4.4 days, $p = 0.003$) (Table 5; Fig. 2). For comparisons between Black, White, and other populations, see Supplementary Table 3. Mortality was not significantly different between Hispanic and non-Hispanic patients (27.0% vs. 34.6%, $p = 0.14$). The median hospital and ICU LOS were similar between ethnicities (10.8 vs. 11.0 days in the hospital; 3.9 and 4.0 days in the ICU) (Table 6; Fig. 3).

Mortality rate across the 3 waves of the pandemic remained stable (Table 7). Table 8 demonstrates odds ratios for variables analyzed in the logistic regression model for mortality based on race with White patients serving as the reference group. Race was not found to be associated with mortality (OR (Black vs. White) = 0.83, 95% CI = 0.65 to 1.05). Factors that statistically affected mortality include APACHE score at ICU admission (OR = 1.02; 95% CI = 1.01 to 1.02), CKD (OR = 1.34; 95% CI = 1.05 to 1.71), malignant neoplasms (OR = 1.28, 95% CI = 1.03 to 1.59), antibiotic use (OR = 1.69, 95% CI = 1.04 to 2.73), vasopressor requirement (OR = 3.97; 95% CI = 3.12 to 5.05), and age (OR = 1.06, 95% CI = 1.04 to 1.07).

Comparable trends were observed in the logistic regression model for mortality based on ethnicity (Table 9). While ethnicity was not associated with mortality (OR = 1.23,

Table 7 Mortality across the 3 waves of the pandemic

	Alive (<i>N</i> =1393)	Dead (<i>N</i> =732)	Total (<i>N</i> =2125)	<i>p</i> value
Wave				0.0691 ¹
1	296 (66.7%)	148 (33.3%)	444 (20.9%)	
2	285 (69.9%)	123 (30.1%)	408 (19.2%)	
3	812 (63.8%)	461 (36.2%)	1273 (59.9%)	

*Statistics presented as N (row%)

95% CI = 0.70 to 2.15), APACHE score (OR = 1.02, 95% CI = 1.01 to 1.02), CKD (OR = 1.32, 95% CI = 1.03 to 1.70), malignant neoplasms (OR = 1.28, 95% CI = 1.03 to 1.60), antibiotic use (OR = 1.75, 95% CI = 1.07 to 2.86), vasopressor requirement (OR = 3.82, 95% CI = 3.0 to 4.86), and age (OR = 1.06, 95% CI = 1.05 to 1.07) were associated with the primary outcome. The same analysis was performed for each of the waves during this pandemic. Race and ethnicity were not associated with mortality in any of the waves (Supplementary Table 4a–c, 5a–c).

Discussion

We found race and ethnicity were not associated with mortality in our cohort of COVID-19–positive ICU patients despite pre-ICU pathophysiologic differences and underlying comorbidities among the populations. However, underlying comorbidities including CKD and malignant neoplasms, as well as the severity of disease, as measured by the APACHE score, were independently associated with mortality. ICU care across race and ethnicity was similar

Table 8 Logistic regression for mortality (race)

Odds ratio estimates				
Variable	Point estimate	95% Wald confidence limits	<i>p</i> values	
Race (Black vs White)	0.828	0.651 1.052	0.1230	
Race (other vs White)	1.062	0.671 1.683	0.7967	
APACHE	1.016	1.011 1.020	<.0001	
CKD	1.339	1.048 1.710	0.0195	
Dialysis	0.912	0.664 1.252	0.5672	
Diabetes	0.809	0.644 1.017	0.0691	
HTN	0.834	0.546 1.272	0.3993	
COPD	1.029	0.815 1.298	0.8128	
Liver disease	1.170	0.905 1.513	0.2312	
Smoking history Current smoker vs. others	1.346	0.863 2.100	0.1897	
Smoking history Former smoker vs. others	1.150	0.913 1.449	0.2338	
Malignant neoplasm	1.279	1.028 1.593	0.0275	
Stroke	1.089	0.858 1.382	0.4857	
Antibiotics	1.685	1.039 2.734	0.0346	
Methylprednisolone	1.115	0.829 1.498	0.4718	
Tocilizumab	1.174	0.803 1.717	0.4087	
Vasopressor use	3.970	3.119 5.052	<.0001	
Age	1.055	1.044 1.065	<.0001	

*Statistics presented as odds ratio (OR)

†*p* values is used to test whether the OR is equal to 1

‡*p* value < 0.05 was considered significant

regarding intubation, vasopressor use, and antiviral use, although dexamethasone use was found to be significantly greater in the White and Non-Hispanic groups. Additionally, mortality rates did not change throughout each phase of the COVID-19 pandemic and remained similar between racial and ethnic groups.

In a critical care setting free of the negative effects of ICU strain and inequitable resource distribution, which are consequences often associated with increased pandemic healthcare demand, this work demonstrates that equitable healthcare may be achieved, via a standardized approach, especially for patients of traditionally disadvantaged racial and ethnic minorities. With the COVID-19 pandemic, the nation has seen new challenges to system surge capacity, in response to which hospitals have implemented common operational and structural changes [7]. One study showed that of the 45 surveyed sites, nearly all implemented incident command activation changes, initially canceled elective procedures, 49% expanded ward capacity, 63% expanded ICU capacity, and some added providers to match elevated demand [7]. Within such a taxed environment, innovative protocols that allow for standardization of critical care are

Table 9 Logistic regression for mortality (ethnicity)

Odds ratio estimates				
Variable	Point estimate	95% Wald confidence limits	<i>p</i> value	
Ethnicity	1.227	0.702 2.147	0.4725	
APACHE	1.015	1.011 1.020	<.0001	
CKD	1.323	1.033 1.694	0.0266	
Dialysis	0.913	0.665 1.255	0.5769	
Diabetes	0.795	0.632 1.000	0.0504	
HTN	0.815	0.529 1.256	0.3538	
COPD	1.025	0.811 1.296	0.8361	
Liver disease	1.150	0.888 1.489	0.2896	
Smoking history Current smoker vs. others	1.298	0.831 2.028	0.2512	
Smoking history Former smoker vs. others	1.139	0.903 1.436	0.2733	
Malignant Neoplasm	1.282	1.028 1.598	0.0273	
Stroke	1.054	0.829 1.340	0.6660	
Antibiotics	1.747	1.069 2.855	0.0261	
Methylprednisolone	1.175	0.874 1.579	0.2849	
Tocilizumab	1.172	0.796 1.726	0.4201	
Vasopressor use	3.817	2.995 4.864	<.0001	
Age	1.056	1.046 1.067	<.0001	

*Statistics presented as odds ratio (OR)

†*p* values is used to test whether the OR is equal to 1

‡*p* value < 0.05 was considered significant

integral to patient survival, as demonstrated by our study. We coordinated our ICUs' surge capacity response across our network, and with even resource distribution and adequate surge planning, this study demonstrated no difference in mortality or length of stay outcomes by race or ethnicity. Our institution's success was gleaned in part by employing surge capacity principles based on those published during 2014 for the care of the critically ill and injured during pandemics [8]. The WHO utilized the 2014 Ebola scare to develop a series of recommendations for disaster preparedness, which was adapted at our institution to devise what is termed an "all hazards" approach, consisting of ten general principles, to emergency management [9]. Some examples of this approach include taking action before a disaster is imminent, facilitating creative solutions, prioritizing the safety and well-being of hospital employees, emphasizing collaboration, anticipating resource needs, and planning for recovery [9]. Implementing this multifaceted plan was crucial to our hospital system's effective COVID-19 response [9]. Throughout the pandemic, it has also become increasingly clear that limiting system overload is vital to decreasing the disease mortality burden. For instance, Janke et al.

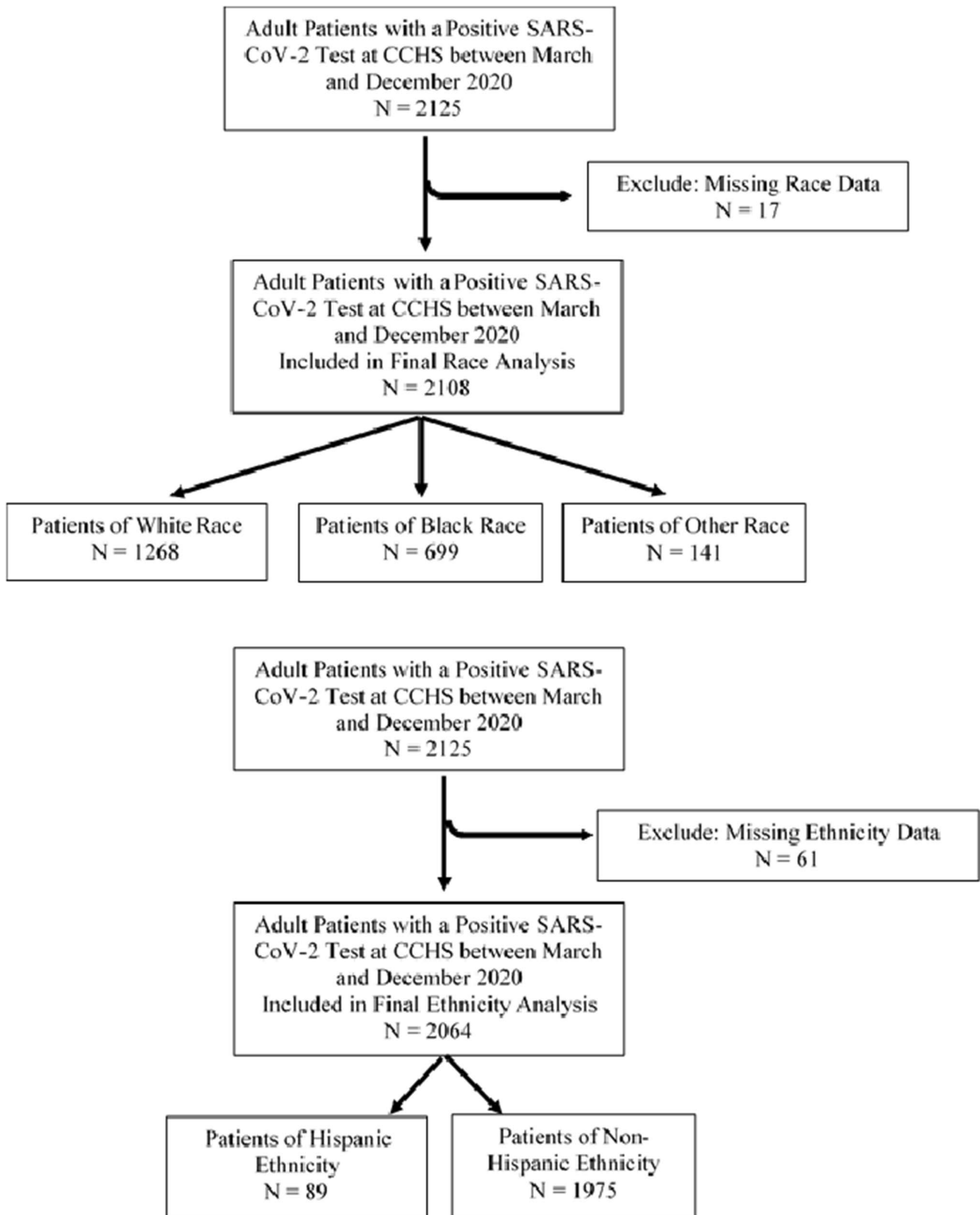


Fig. 1 Flow chart of patients included in final analysis

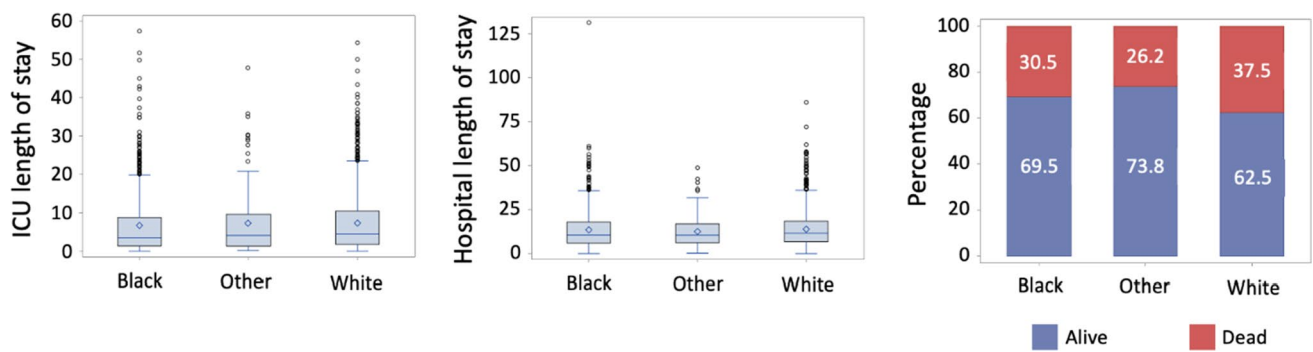


Fig. 2 Hospital LOS, ICU LOS, and Mortality based on race

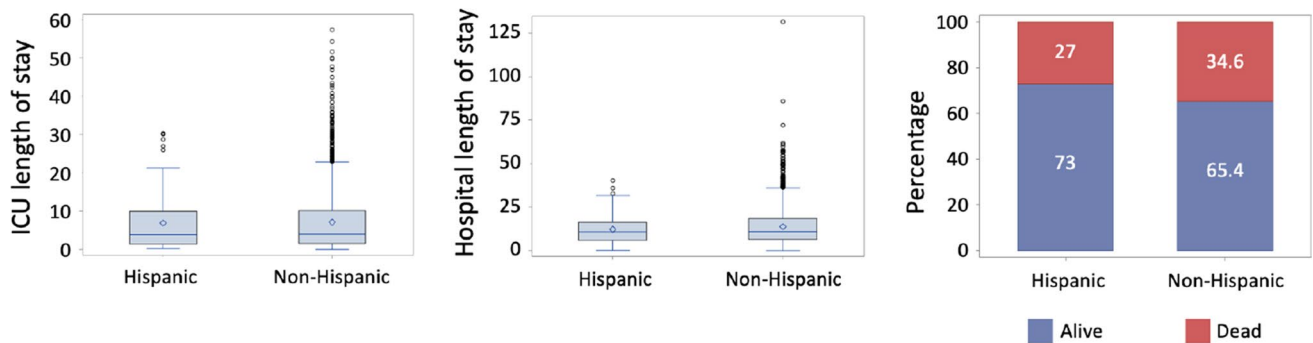


Fig. 3 Hospital LOS, ICU LOS, and Mortality based on ethnicity

demonstrated that restricted resource availability, quantified by areas with fewer ICU unit beds, nurses, and general medicine/surgical beds per COVID-19 case, was associated with statistically significant greater mortality incidence in April 2020 [10]. Similarly, Bravata et al. studied 8516 COVID-19 positive US Veterans Administration patients at 88 federal hospitals during the pandemic's height and demonstrated that ICU strain, defined by combined ICU load and demand, is associated with worse outcomes, including increased mortality [11]. They also concluded that when hospital, and specifically critical care, capacity is optimized during periods outside of acute resource strain, patients receive better quality and more standardized care, allowing for minimal opportunity for disparities between patients [11, 12]. Such a conclusion is reassuring, as it implies that, apart from non-modifiable variables associated with greater disease mortality, such as age and comorbidities, there are factors over which the medical community has control, including the ways in which institutional preparation and resource allocation are managed.

Early pandemic reports demonstrated a disproportionately high disease and mortality incidence among Black and Hispanic patients as compared with White patients diagnosed with COVID-19 [13]. For example, in June 2020, the CDC reported that 33% of COVID-19 cases were reported

in Hispanic individuals and 22% in Black individuals despite Hispanic and Black individuals accounting only for 18% and 13% of the US population, respectively [14]. Recently, Asch et al. showed that Black patients hospitalized with COVID-19 had 11% higher odds of death, as compared to White patients even following adjustment for sociodemographic characteristics between groups. Importantly, this group found that the higher mortality among Black patients can be explained in large part by having received treatment at hospitals that care for a disproportionate number of Black patients, suggesting that hospital segregation and inequitable distribution of resources are contributing to outcome disparities [15]. On the other hand, Yehia et al. reported that hospital mortality was not higher in Black patients as compared to White patients diagnosed with COVID-19, citing mortality rates of 23.1% in hospitalized White patients and 19.2% in hospitalized Black patients within a cohort of 11,210 individuals [16], an encouraging finding dissimilar to previous literature reports but concurrent with that of this current study.

The strengths of this study are manifold. This study successfully evaluated the overall outcomes of a large number of COVID-19 patients over the course of 9 months and, moreover, more granularly analyzed this cohort by each pandemic wave to ensure no major differences in survival

or ICU care existed among them. The patients in this study were those cared for within the Cleveland Clinic system, which includes a quaternary referral center, two tertiary centers, and six community hospitals, thus incorporating a wide variety of levels of care. Additionally, the study looked at outcomes in a critical care setting outside of that impacted by strain and limitation of resources, thus enabling a better understanding of the impact of the disease itself based on ethnicity and race.

There are several limitations to this study. First, outcomes of COVID-19 were limited to mortality and length of stay and did not investigate other lasting disease consequences such as dyspnea, cognitive changes, and symptom recovery. Second, the decreased rate of comorbidities in Hispanic as compared to non-Hispanic patients seen here, which contrasts what has traditionally been reported in the literature, suggests that this cohort may not be representative of the greater Hispanic population. Third, although the impact of racial and ethnic minority status was studied, implications of socioeconomic determinants of health and geographic factors on outcomes following critical care for COVID-19 should be further investigated in future studies.

Although we did not see a significant impact of racial and ethnic disparities on healthcare outcomes in the context of COVID-19 within Cleveland Clinic's ICUs during a circumscribed snippet in time, this should not be taken to imply that health disparities have ceased to exist. On the contrary, the conversation surrounding such pervasive inequalities and actions that should be taken to begin correcting these is precisely what we seek to incite with this work. As a tertiary and quaternary care referral center, the Cleveland Clinic's practice patterns may limit the generalizability of the findings discussed in this article. A pandemic forces hospital systems facing resource scarcity to maximize the benefits of treatment and to prioritize the allocation of resources to patients with an increased chance of survival [17, 18]. Furthermore, prior studies have shown that resource-limited hospitals and those with higher proportions of complications serve minority patients at significantly higher rates [19, 20]. In our own study, Black and Hispanic patients possessed more comorbidities at presentation than White patients. Thus, it stands to reason that in a resource-limited health system, individuals with increased rates of comorbidities, a group likely to include those of the Black race, Hispanic ethnicity, and other minorities, may not be prioritized as large-scale decisions are made to maximize utilization of scarce resources. This strategy inevitably leads to the provision of suboptimal and inequitable care to people of color. However, armed with this knowledge, we hope that our findings serve as initial evidence that we, as healthcare providers and organizations, can begin to decrease health inequality with an intentional approach to offering uniform excellent care.

This study provides a longitudinal view of a single center's standardized critical care response to the COVID-19 pandemic. Patients, particularly those of disadvantaged racial and ethnic minority groups, are most vulnerable to disparities in care when their local healthcare systems have surpassed capacity and are increasingly resource strained. To improve upon the provision of equitable critical care within this pandemic and future scenarios of increased healthcare demand, it is important to proactively implement protocols that mitigate strain on ICUs, standardize care, and enable equitable resource distribution.

Conclusion

In this cohort of COVID-19–positive patients admitted to the ICU within the Cleveland Clinic healthcare system, neither race nor ethnicity was significantly associated with increased mortality or hospital and ICU length of stay. When not operating under critical care strain, consistent and standardized care can help translate into equitable outcomes in all individuals, including those of racial and ethnic minorities, thus benefiting traditionally disadvantaged populations.

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Author Contribution Daniel Moussa and Ryan Zhang contributed to the manuscript by assisting with the review of the Electronic Health Record.

Data Availability The dataset analyzed for the current study is available from the corresponding author on reasonable request.

Declarations

Ethics Approval The study was approved by the Cleveland Clinic Institutional Review Board #20–404.

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