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Racial Differences in a Detroit, MI, ICU Population of Coronavirus Disease 2019 Patients

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OBJECTIVES: To investigate the potential influence of racial differences in outcomes of patients infected by coronavirus disease 2019-positive patients who require intensive care in an urban hospital.

DESIGN: Retrospective cohort study.

SETTING: Henry Ford Health System Multidisciplinary ICU, a total of 156 beds spread throughout the hospital in Detroit, MI.

PATIENTS: We obtained data from the electronic medical record of all adult severe acute respiratory syndrome coronavirus-2-positive patients managed in the ICU of Henry Ford Hospital in Detroit, MI, between March 13, 2020, and July 31, 2020. Included patients were divided into two groups: people of color (including Black, Asian, Hispanic/Latino, and Arab) and White.

INTERVENTIONS: None.

MEASUREMENTS AND MAIN RESULTS: A total of 365 patients were evaluated: 219 were Black (60.0%), 129 were White (35.3%), two were Asian (0.6%), eight were Hispanic/Latino (2.2%), and seven were Arab (1.9%). People of color were younger (62.8 vs 67.1; $p = 0.007$), with equal distribution of sex. People of color had less coronary artery disease (34 [14.4%] vs 35 [27.1%]; $p = 0.003$) and less self-reported use of regular alcohol consumption (50 [21.2%] vs 12 [9.3%]; $p = 0.004$) than Whites, with no differences in diabetes (125 [53.0%] vs 66 [51.2%]; $p = 0.742$), hypertension (188 [79.7%] vs 99 [76.8%]; $p = 0.516$), congestive heart failure (41 [17.4%] vs 32 [24.8%]; $p = 0.090$), or chronic kidney disease (123 [54.1%] vs 55 [42.6%]; $p = 0.083$).

There was no difference in ICU length of stay between people of color (18 d [CI, 7–47 d]) and Whites (18 d [CI, 6–48 d]; $p = 0.$ 0.979). Neither frequency (72.5% vs 71.3%; $p =$ ns) nor median time to mechanical ventilation between people of color (9 d [CI, 6–15 d]) and Whites (10 d [CI, 5–16 d]; $p = 0.733$) was different. Overall, 188 patients (51.5 %) died in the hospital. The 28-day mortality was lower in people of color (107/236; 45.3%) versus Whites (73/129; 56.6%) (adjusted odds ratio 0.60; $p = 0.034$), and there was an increased median survival time in people of color (20 d) versus Whites (13.5 d; hazard ratio 0.62; $p = 0.002$). The inhospital mortality was lower in people of color versus White, but the difference was not statistically significant (113 [47.9%] vs 75 [58.1%], respectively; $p = 0.061$). Finally, there was no significant difference in days of symptoms prior to admission, frequency of presenting symptoms, or frequency or severity of acute respiratory distress syndrome between the two groups.

CONCLUSIONS: In critically ill patients infected with coronavirus disease 2019, people of color had a lower 28-day mortality than Whites with no

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DOI: 10.1097/CCM.0000000000004735

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difference in hospital mortality, ICU length of stay, or rates of intubation. These findings are contrary to previously held beliefs surrounding the pandemic.

KEY WORDS: acute respiratory distress syndrome; coronavirus disease 2019; critical care; length of stay; mechanical ventilation; race

In December 2019, the novel, severe acute respiratory syndrome coronavirus 2 caused an outbreak of severe respiratory infections in Wuhan, China. This infection is currently identified as coronavirus disease 2019 (COVID-19).

In the United States, the total number of cases as of August 27, 2020, exceeded 5.7 million people (1); of these, approximately 99,200 were in Michigan (2). Of all the counties in Michigan, Wayne County (which contains Detroit) has the largest absolute number of cases.

The literature has identified certain risk factors associated with a poorer prognosis in patients infected with COVID-19 (3–6). Although the medical literature is mixed with regard to racial disparities in other disease types (7–12), recent data suggest that there are racial differences in patients with COVID-19 (13, 14). However, it remains unclear whether these findings are applicable to an ICU population of patients. We sought to characterize the cohort of COVID-19-positive patients admitted to the ICU in our hospital, with attention to whether there are racial differences in ICU length of stay (LOS) and other outcomes.

MATERIALS AND METHODS

Henry Ford Hospital, a tertiary-care hospital serving the racially diverse, metropolitan Detroit region, as of August 31, 2020, has admitted 1,832 patients diagnosed with COVID-19 (15). Henry Ford Hospital consists of a 156-bed ICU and 68 dedicated medical ICU beds with additional specialized surgical, cardiac, and neuroscience ICUs that occasionally serve as overflow for medical patients. As the surge progressed, these ICUs were employed systematically to accommodate all COVID-19 patients. ICU admissions represent approximately one-third of admissions at our hospital and is the site of most hospital deaths from COVID-19 (4, 5). We performed a single-center retrospective cohort analysis among adult patients (age > 18 yr old) admitted to the ICU at a large urban teaching hospital.

Consecutive patients with laboratory-confirmed COVID-19 diagnosed using quantitative reverse transcriptase-polymerase chain reaction and managed in the ICU between March 13, 2020, and July 31, 2020, were included in the study. Patients who were clinically suspected of having COVID-19 but who ultimately tested negative were excluded. For patients admitted to the ICU greater than one time, the initial admission was exclusively evaluated in our study. The primary outcomes were ICU LOS and need for mechanical ventilation during the ICU stay and inhospital and 28-day mortality.

Race and ethnicity in the electronic health record are self-reported. We binarized to "people of color" (POC; Black, Arab, Hispanic/Latino, and Asian) or "White" (Caucasian).

Acute respiratory distress syndrome (ARDS) was defined according to the Berlin Criteria (16); mild ARDS is defined as a Pao_2/Fio_2 ratio of 200–300, moderate ARDS as a Pao_2/Fio_2 ratio of 100–200, and severe ARDS as a Pao_2/Fio_2 ratio of less than 100.

All analyses were performed with the STATA software, Version 16.1 (Stata Corp, College Station, TX).

Continuous variables were compared using the Student *t* test or the Kruskal-Wallis rank-sum test in the cases of nonnormally distributed variables and expressed, respectively, as means ± SD or median and interquartile range. Categorical variables were expressed as percentages and analyzed using a chi-square test.

We used univariate logistic regression to identify independent risk factors for need for mechanical ventilation and mortality. Cox proportional hazards model was used for estimating survival time. The variables used in all these analyses included race/ethnicity, sex, median income by zip code, body mass index, chronic obstructive pulmonary disease, asthma, obstructive sleep apnea/obesity hypoventilation syndrome, home oxygen use, diabetes mellitus, coronary artery disease, congestive heart failure, chronic kidney disease, end-stage renal disease, smoking status, venous thromboembolic disease, alcohol abuse, drug abuse, HIV status, outpatient medications (immunosuppressives, aspirin, systemic and inhaled corticosteroid, 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors, angiotensin converting enzyme inhibitor, angiotensin receptor blocker, nonsteroidal anti-inflammatory drug, and anticoagulant), and inpatient administration

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of steroids and hydroxychloroquine. Variables with a p value of less than or equal to 0.1 were included in the multivariate regression models.

For survival analysis, time to intubation was measured from the onset of symptoms prior to hospital presentation. For 28-day mortality, time to death was measured from day of admission. For patients never intubated, censored dates included time of ICU discharge or death. The validity of the proportionality assumption was verified by the Schoenfeld test. Median ICU LOS was calculated using Kaplan-Meier estimates and death was considered as a censored event.

This study was approved with waiver of informed consent by the Institutional Review Board of Henry Ford Hospital, Detroit, MI (13739).

RESULTS

Of the 365 patients admitted to the ICU during the study period, 219 (60.0%) were Black, 129 (35.3%) were White, two (0.6%) were Asian, eight (2.2%) were Hispanic/Latino, and seven (1.9%) were Arab. Because of the low numbers in several ethnicities, this study focused on two groups: POC (Black, Asian, Hispanic/Latino, and Arab) and White.

Sex was equally distributed between the groups. POC were younger than Whites (62.8 vs 67.1, respectively; $p = 0.007$). POC had less coronary artery disease than Whites (34 [14.4%] vs 35 [27.1%]; $p = 0.003$) and less self-reported use of regular alcohol consumption (50 [21.2%] vs 12 [9.3%]; $p = 0.004$). There was no difference in median income by zip code of residence. Overall, 279 patients (76.4%) received steroids during the hospitalization (**Table 1**).

Of the 365 patients, 255 (69.9%) had ARDS. Of these patients, 23 (9.0%) had mild disease, 96 (37.6%) had moderate disease, and 136 (53.3%) had severe disease. The number of patients with ARDS and severity of disease was similar between the two groups (**Fig. 1**).

The number of days of symptoms prior to presentation to the hospital was similar in POC and Whites (5 [CI, 3–7] vs 4 [CI, 2–7]; $p = 0.140$). The presenting symptoms (constitutional, respiratory, and GI) were also similar between the groups (data not shown).

Overall, in our cohort, the median ICU LOS was 18 days (CI, 7–47 d). After adjusting for confounders and censoring deaths in the ICU, there was no difference in ICU LOS between POC (18 d [CI, 7–47] d) and Whites (18 d [CI, 6–48 d]; $p = 0.979$).

TABLE 1.
Clinical Baseline Characteristics of Patients

Characteristic	Persons of Color ($n = 236$)	White ($n = 129$)	p
Age	62.8 ± 15.3	67.1 ± 13.6	0.007
Male	131 (55.5)	74 (57.4)	0.733
Comorbid conditions			
Chronic obstructive pulmonary disease	43 (18.2)	24 (18.6)	0.928
Asthma	20 (8.5)	10 (7.8)	0.810
Obstructive sleep apnea/obesity hypoventilation syndrome	31 (13.1)	14 (10.9)	0.526
Hypertension	188 (79.7)	99 (76.8)	0.516
Diabetes	125 (53.0)	66 (51.2)	0.742
Coronary artery disease	34 (14.4)	35 (27.1)	0.003
Congestive heart failure	41 (17.4)	32 (24.8)	0.090
Chronic kidney disease	123 (52.1)	55 (42.6)	0.083
Cirrhosis	2 (0.9)	0 (0)	0.294
Deep vein thrombosis history	15 (6.4)	4 (3.1)	0.178
Smoking history			
Never	156 (66.1)	79 (61.2)	0.241
Active	3 (1.3)	0 (0)	
Ex	77 (32.7)	50 (38.8)	
Alcohol use	50 (21.2)	12 (9.3)	0.004
Outpatient medications			
Aspirin	82 (34.8)	51 (39.5)	0.363
Statin	104 (44.1)	63 (48.8)	0.382
Angiotensin-converting enzyme inhibitor	57 (24.2)	36 (27.9)	0.431
Angiotensin-receptor blocker	42 (17.8)	17 (13.2)	0.252
Nonsteroidal anti-inflammatory drugs	35 (14.8)	8 (6.2)	0.015
Immunosuppressive	21 (8.9)	12 (9.3)	0.898
Anticoagulation	34 (14.6)	32 (24.8)	0.016

(*Continued*)

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TABLE 1. (*Continued*).
Clinical Baseline Characteristics of Patients

Characteristic	Persons of Color (*n* = 236)	White (*n* = 129)	*p*
Steroids, per oral	16 (6.8)	4 (3.1)	0.140
Steroids, inhaled	24 (10.2)	11 (8.5)	0.610
Inpatient medications			
Steroids	173 (73.3)	106 (82.2)	0.056
Hydroxychloroquine	175 (74.2)	109 (84.5)	0.023
Home oxygen	14 (5.9)	10 (7.8)	0.503
Median income, by zip code (95% CI)	$32,118 (25,078–47,433)	$33,029 (26,164–54,021)	0.221

Values are mean ± SD or *n* (%), unless otherwise indicated.

TABLE 2.
Predictors for Invasive Mechanical Ventilation

Factor	Adjusted OR (95% CI)	*p*
Persons of color	1.08 (0.65–1.80)	0.760
Male	1.82 (1.11–2.97)	0.017
Age ≥ 65 yr old	2.10 (1.28–3.44)	0.003
Systemic steroid use upon presentation	6.39 (0.82–50.05)	0.077
Chronic kidney disease	1.67 (1.01–2.77)	0.045
Smoking	1.52 (0.90–2.58)	0.119
Income	1.00 (1.00–1.00)	0.083

OR = odds ratio.

During the study period, 263 of 365 patients required invasive mechanical ventilation (72.1%) at some time during their ICU stay. The frequency of mechanical ventilation was similar in POC (171 [72.5%]) and Whites (92 [71.3%]) ($p = 0.817$) (**Table 2**). The median time from symptom onset to intubation was similar for POC (9 d [CI, 6–15 d]) and Whites (10 d [CI, 5–16 d]; adjusted hazard ratio 0.954 [CI, 0.726–1.25]; $p = 0.733$) (**Fig. 2A**).

Overall, 180 patients (49.3%) died within 28 days of admission and 188 patients (51.5 %) died in the hospital. The 28-day mortality was lower in POC (107/236; 45.3%) than in Whites (73/129; 56.6%) (odds ratio 0.636 [CI, 0.412–0.98]; $p = 0.040$). This difference remained significant after adjusting for confounders. There was a similar trend with inhospital mortality, but the difference was not statistically significant after adjusting for confounders (**Table 3**). Of the nine patients who died in the hospital after day 28, seven were POC and two were White. Survival time was longer in POC than Whites (**Fig. 2***B*; hazard ratio 0.627 [$p = 0.010$]). After adjusting for confounders, this difference remained significant (**Fig. 2***C*; **Supplemental Table 1**, Supplemental Digital Content 1, http://links.lww.com/CCM/F990). All deaths in the ICU occurred during the index ICU admission. Seven patients (2%) were readmitted to the ICU during their hospitalization, all of whom survived to hospital discharge.

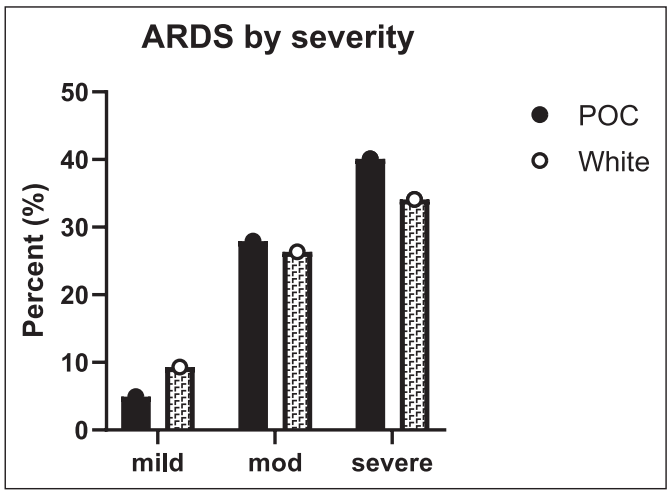

Figure 1. Distribution of acute respiratory distress syndrome (ARDS) by severity for people of color (POC) (*black dot*) and Whites (*white dot*). Percent is of total patients with ARDS. Mild: Pao_2/Fio_2 200–300, moderate: 100–200, severe: < 100. *p* value for whole group is nonsignificant.

DISCUSSION

Detroit's racial/ethnic profile includes 79% African-American, 10% Caucasian, 8% Hispanic/Latino, and 2% Asian (17). In our study, approximately 63% of patients were POC. This is consistent with the community representation of Detroit but does differ significantly from U.S. data (18).

Our study sought to identify whether race led to important differences in outcomes. We found a 28-day mortality benefit for POC versus Whites; however, there were no differences in hospital mortality, ICU LOS, or need for mechanical ventilation in a cohort of

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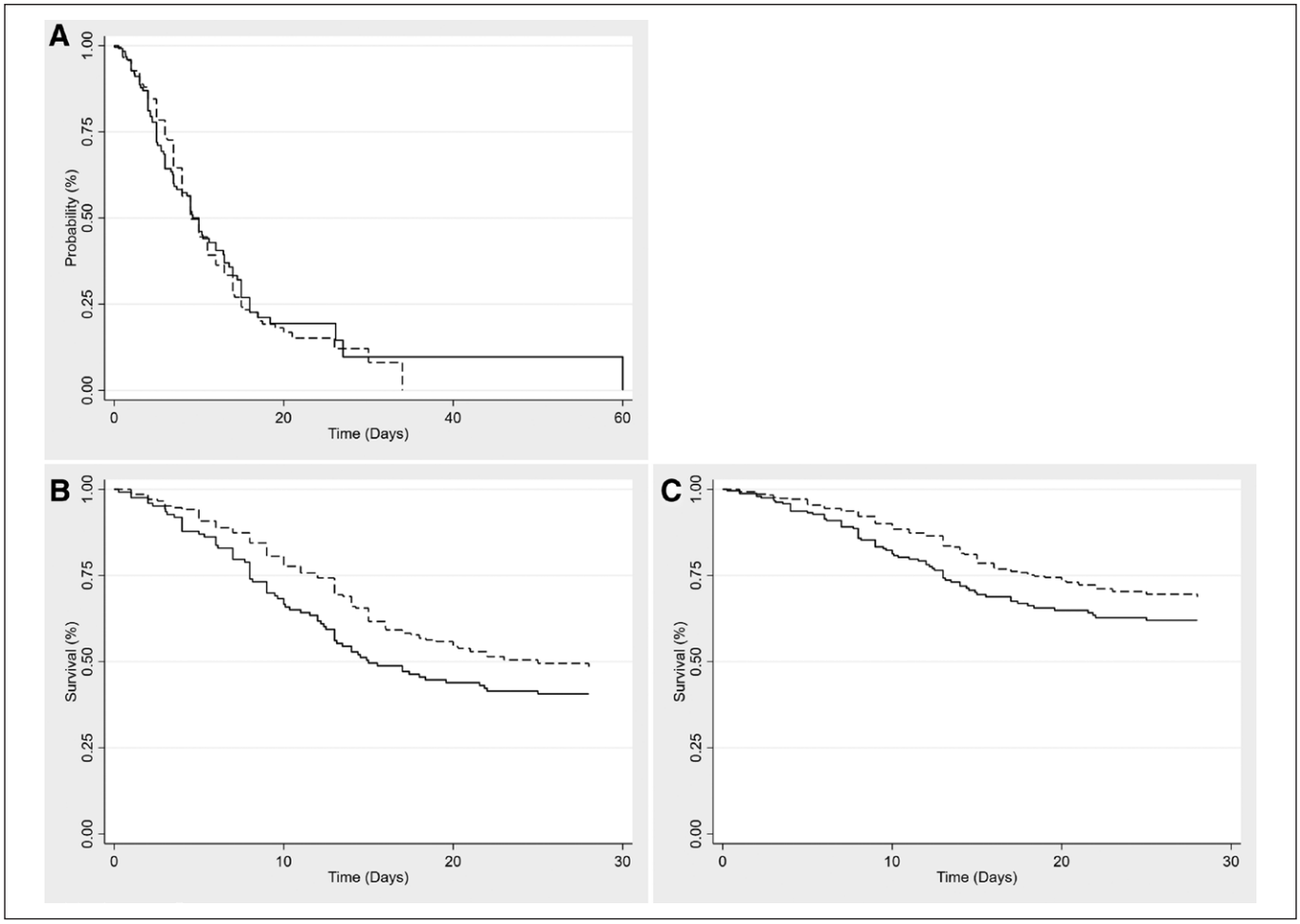

Figure 2. (**A**) Probability of requiring mechanical ventilation from time of symptoms onset to ICU discharge (p = nonsignificant). The probability of survival within 28 days was significant in both the unadjusted (**B**) and adjusted (**C**) models ($p = 0.002$). *Solid line* represents people of color and *dashed line* represents Whites.

COVID-19-positive patients admitted to an ICU. We observed a shortened survival among White patients (after adjusting for confounders) with COVID-19 admitted to the ICU. Importantly, our study was limited to an ICU cohort; as such, we did not evaluate whether there were racial differences in becoming clinically symptomatic or critically ill if infected with COVID-19 (19).

The literature is mixed as to whether racial disparities determine clinically significant outcomes in the ICU. In an older study, Williams et al (20) found a shorter ICU LOS for African-American patients, in contrast to our findings. Conversely, Higgins et al (21) showed no racial differences in ICU LOS. Although no differences in ICU LOS existed between the groups in our study, the overall median ICU LOS in this cohort is similar to other studies in patients with ARDS (22, 23).

The literature is also inconsistent with regard to the need for mechanical ventilation among different racial groups. Nanchal et al (24) found an increased rate of mechanical ventilation in African-Americans when compared with White patients with asthma. In ARDS patients, there were no differences between the rates of intubation among the different racial/ethnic groups (25).

We found a decreased 28-day mortality in POC compared with Whites. This effect remained significant after controlling for important confounders including age and common comorbidities. These results seemingly conflict with prior literature that showed either no mortality difference (9, 20, 26) or worsening (27) in survival among African-American patients. One plausible explanation for this finding is that POC deaths were delayed. Of the nine patients who died in the hospital after 28 days, seven were POC. This could explain the contradictory observation of a lack of inhospital mortality difference despite the 28-day mortality benefit. Furthermore, we did observe significantly longer time to death in the POC group.

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TABLE 3.
Predictors of Mortality

Factor	Inhospital Mortality		28-d Mortality	
	Adjusted OR (95% CI)	*p*	Adjusted OR (95% CI)	*p*
Persons of color	0.64 (0.40–1.03)	0.069	0.60 (0.37–0.96)	0.034
Age ≥ 65 yr old	2.42 (1.53–3.81)	< 0.001	2.21 (1.40–3.49)	< 0.001
Chronic kidney injury	1.63 (1.03–2.60)	0.039	2.01 (1.27–3.19)	0.003
Congestive heart failure	1.08 (0.58–2.02)	0.805	1.05 (0.57–1.94)	0.876
Coronary artery disease	2.17 (1.15–4.07)	0.016	1.65 (0.89–3.06)	0.109
Chronic obstructive pulmonary disease	1.30 (0.71–2.39)	0.399	1.40 (0.76–2.58)	0.280
Outpatient systemic steroids	2.75 (0.93–8.12)	0.066	NA	NA
Inpatient steroids	0.68 (0.40–1.16)	0.152	0.60 (0.36–1.01)	0.058
Ever smoker	NA	NA	1.11 (0.69–1.78)	0.659

OR = odds ratio, NA = not applicable in final model.

We note that our cohort of patients is exclusively individuals admitted to an ICU. Racial disparities in the community may be differentiated by unique social and economic factors that may not be crucial after a patient is admitted to a protocol-driven ICU. Although the protocolized nature of care in the ICU may help mitigate some of these social and economic factors, cultural influences can still significantly contribute to specific clinical outcomes. The longer survival time observed in POC might be explained by POC requesting more critical care resources and life support than Whites (28). Furthermore, POC are less likely to withhold or withdraw care than Whites (29). Finally, POC tend to use palliative care resources less frequently than Whites (30, 31).

The overall mortality in our entire cohort was nearly 50%. In patients admitted to an ICU with COVID-19, reported mortality ranges from 8% to 67% (32). Although many of the individual studies had small numbers of patients, the combined mortality was 25%. One explanation for our high mortality rate may be the high proportion of mechanical ventilation and ARDS in our cohort. Almost three-quarters of our patients required mechanical ventilation. Similarly, 70% of our patients had ARDS with approximately 55% of those having severe disease, with a Pao_2/Fio_2 ratio of less than 100. As such, our cohort represents a very sick population of patients with a novel disease. In addition, our mortality rate is similar to other reported cohorts of patients with ARDS (33).

Despite recent evidence that inhospital use of systemic steroids improves survival in patients with COVID-19-associated ARDS (34–36), we did not find steroids to be a significant predictor of mortality. This was likely because more than three-fourths of patients analyzed in our study received steroids due the early initiation of protocolized care. Additionally, steroid use was less likely to be a confounder in our study, because while Whites received slightly more steroids than POC, the observed survival and mortality advantage favored POC.

There are a few important limitations in our study. First, this is a single-center study performed in a large, urban, tertiary-care hospital. We do not know if these results are applicable in other settings. Detroit is a predominantly African-American community, and our patient population reflects this finding. One of the advantages of our study being a single-center study is that we provide identical resources and protocols for all patients regardless of race.

Our results could conceivably be biased if there was a difference in time to presentation between the groups. Indeed, prior studies in African-American patients with acute coronary syndromes have shown this pattern (37). However, our data show equivalent time to presentation for both groups to our institution.

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Another potential limitation is that the definition of POC and White can be subjective. Our data were self-reported, which can often be inaccurate and might skew data (38). However, this is a very common way to document and collect racial/ethnic data (39). In addition, we identified Arabs, Hispanics/Latinos, and Asians as POC. Although this might not be a uniform way of presenting race (17, 40), it is acceptable based on a lack of definitive ethnicity norms in the United States (41–43).

Racial disparities are commonplace and an important issue in providing medical care. The literature supports the contention that African-Americans are infected and die of COVID-19 at a rate higher than their population percentage would dictate (13, 14). This requires continued investigation as the COVID-19 pandemic continues. Our study investigated whether racial differences affected outcomes in patients with COVID-19 admitted to an ICU. We describe no differences between the persons of color and White patients inhospital mortality, ICU LOS, or time to mechanical ventilation. Conversely, persons of color had a significantly longer survival time when compared with white patients and a decreased 28-day mortality. These results, while intriguing, need to be confirmed beyond this single-center experience. Nonetheless, our findings are encouraging that persons of color might receive similar care to White patients after admission to an ICU.

CONCLUSIONS

In critically ill patients infected with COVID-19, POC had a lower 28-day mortality than Whites with no difference in hospital mortality, ICU LOS, or rates of intubation. These findings are contrary to previously held beliefs surrounding the pandemic.

ACKNOWLEDGMENTS

We thank Mohamad Raad, MD, and Mohammed Ferras Dabbagh, MD, for their assistance with data collection.

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The authors have disclosed that they do not have any potential conflicts of interest.

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