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The Impact of Sociodemographic Factors, Comorbidities, and Physiologic Responses on 30-Day Mortality in Coronavirus Disease 2019 (COVID-19) Patients in Metropolitan Detroit

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Background. The relationship of health disparities and comorbidities in coronavirus disease 2019 (COVID-19)–related outcomes are an ongoing area of interest. This report assesses risk factors associated with mortality in patients presenting with COVID-19 infection and healthcare disparities.

Methods. We conducted a retrospective cohort study of consecutive patients presenting to emergency departments within an integrated health system who tested positive for COVID-19 between 7 March and 30 April 2020 in metropolitan Detroit. The primary outcomes were hospitalization and 30-day mortality.

Results. A total of 3633 patients with a mean age of 58 years were included. The majority were female and Black non-Hispanic. Hospitalization was required for 64% of patients, 56% of whom were Black. Hospitalized patients were older, more likely to reside in a low-income area, and had a higher burden of comorbidities. By 30 days, 433 (18.7%) hospitalized patients died. In adjusted analyses, the presence of comorbidities, an age >60 years, and more severe physiological disturbance were associated with 30-day mortality. Residence in low-income areas (odds ratio [OR], 1.02; 95% confidence interval [CI], .76–1.36) and public insurance (OR, 1.24; 95% CI, .76–2.01) were not independently associated with a higher risk of mortality. Black female patients had a lower adjusted risk of mortality (OR, 0.46; 95% CI, .27–.78).

Conclusions. In this large cohort of COVID-19 patients, those with comorbidities, advanced age, and physiological abnormalities on presentation had higher odds of death. Disparities in income or source of health insurance were not associated with outcomes. Black women had a lower risk of dying.

Keywords. COVID-19; Detroit; mortality; outcomes; SARS-CoV-2.

The pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) overwhelmed multiple metropolitan areas during March and April 2020 [1–3]. Data from various states have shown racial disparities in rates of coronavirus disease 2019 (COVID-19), the disease caused by SARS-CoV-2, as well as in cases and deaths. In a nationwide analysis of federal data through 5 July 2020, COVID-19 cases were 62 per 10 000 people among Blacks, 73 per 10 000 people among Latinos, and 23 per 10 000 people among Whites in the United States [4]. The Bronx, which has the highest proportion of racial/ethnic minorities and the highest number of persons living in poverty among the 5 boroughs, had higher COVID-19–related hospitalization and death rates when compared to the other 4 boroughs [5]. In Chicago, reported mortality rates were substantially higher among African American/Black individuals (129 per 100 000) compared with Latino (89 per 100 000) and White (48 per 100 000) residents [6].

Recent studies have also highlighted that non-Hispanic Black patients are overrepresented among hospitalized US COVID-19 patients [2, 7, 8]. Furthermore, hospitalized Black patients have been reported to have higher prevalences of preexisting conditions, including obesity, diabetes, hypertension, and chronic kidney disease, at baseline than their White counterparts [2]. However, there was no association between Black race and mortality after adjusting for differences in sociodemographic and clinical characteristics [2, 7–9].

Southeast Michigan became a coronavirus hot spot as cases surged in the state, with 1 of the highest incident rates in the nation during the early phase of the pandemic [9]. As of 13 July 2020, there were 69 338 confirmed cases and 6075 (8.7%) deaths in Michigan, representing the highest case fatality rate in the

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nation. Moreover, Wayne County, including the City of Detroit, was the hardest hit, with 23 996 infections and 2759 (11.5%) deaths, and was in the top 5 counties for the total number of COVID-19 deaths [10].

The objectives of this report are to assess risk factors associated with hospitalization and 30-day mortality in patients presenting to the emergency department (ED) with COVID-19 infection and to determine whether health disparities influenced mortality.

METHODS

Study Design, Setting, and Population

This retrospective, observational cohort study included all consecutive patients who presented to an ED within the Henry Ford Health System (HFHS) between 7 March and 30 April 2020 and had laboratory-confirmed SARS-CoV-2 on reverse-transcription polymerase chain reaction assay in a nasopharyngeal sample. Laboratory confirmation was performed by the Michigan Department of Health and Human Services or the HFHS clinical microbiology laboratory. We assessed mortality through 30 May 2020. Centered in metropolitan Detroit and serving southeast and south-central Michigan, HFHS is 1 of the largest integrated health systems in the state, with 9 EDs and 5 acute-care hospitals. The 5 hospitals together have a total of 2305 inpatient beds. Between 1 March and 30 April 2019, these 9 EDs evaluated 62 450 unique patients, of whom 36.7% self-identified as Black non-Hispanic and 52.4% as White non-Hispanic. The health system's institutional review board approved this study (#13903).

Data Collection and Definitions

The HFHS utilizes the Epic electronic health record (EHR) system. A team of data analysts created dedicated COVID-19 data tables within our enterprise data warehouse by 7 March 2020 for the purpose of public health monitoring and quality improvement. These data tables extracted patient demographic information, chronic comorbid conditions, body mass index (BMI), prescribed medications, chief complaint symptoms, ED vital signs, laboratory values, insurance status, and procedure codes. Based on the last recorded BMI, obesity was defined as a BMI $\geq$ 30 kg/m^2. Data for comorbid conditions included any documentation in problem lists within ambulatory or inpatient encounters that occurred at any point within the health system. Due to low numbers of patients that self-identified as Asian, American Indian or Alaska native, Native Hawaiian or Pacific Islander, and Middle Eastern, we grouped these patients as an "other" category. Patients who declined to provide race/ethnicity or those with missing data were categorized as "unknown."

For patients admitted to the hospital, standard protocols for COVID-19 blood examinations included a complete blood count with a differential, a basic metabolic panel, liver function tests, and measurements of ferritin, C-reactive protein (CRP), lactate dehydrogenase, creatine phosphokinase, high-sensitivity troponin-I (hs-cTnI), and D-dimer. COVID-19 data tables also included the Charlson comorbidity index, which was tabulated from comorbid condition diagnostic codes in each patient's EHR [11]. Treatment protocols were initiated within the health system by 20 March 2020, which included hydroxychloroquine and corticosteroid administration for hospitalized patients requiring oxygen. We used each patient's residing zip code to determine whether the patient lived in a low-income area. We defined a low-income area as an area in which the percentage of low-income residents, defined by the Uniform Data System Mapper, exceeds the Michigan benchmark of 31%, as previously described [2, 12]. Categories of health insurance included Medicare, Medicaid, and commercial or private insurance, based on what was documented in the patient chart.

Acute kidney injury (AKI) was defined by a rise in serum creatinine consistent with the Kidney Disease: Improving Global Outcomes definition [13]. Cardiac injury was characterized by the presence of serum levels of hs-cTnI above the 99th percentile upper reference limit. Primary outcomes included hospital admission and 30-day mortality. In addition to health system inpatient death data, we cross-referenced all patients for 30-day mortality with data from the Michigan Health Information Network [14], a health information exchange that tracks all admission and discharge information for any hospital in the state, to determine whether patients discharged within 30 days had a death outside the HFHS.

Statistical Analysis

Data are presented as means and standard deviations (SDs) or medians and interquartile ranges for continuous variables, and as frequencies and percentages for categorical variables. Baseline comparisons between the groups were made using the 2-sample *t*-tests or Wilcoxon rank tests, based on distributions, for continuous variables, and Pearson's $\chi 2$ tests or Fisher's exact tests, as appropriate, for categorical variables. We assessed outcomes with multilevel logistic regression models, clustered on community (zip code), to evaluate the risk factors associated with overall 30-day mortality among all patients that required hospitalization. We performed modeling to assess factors associated with death in 2 stages. The first stage, Model 1, was limited to fixed patient factors, including age, sex, race, comorbid conditions, insurance status, and low-income status. Age was tested as a continuous variable or as a categorical variable of >60 or ≤60 years, and minimal differences in the models were present. Hence, we retained the categorical variable for age. The second stage, Model 2, added physiological disturbances to these fixed factors. Physiological disturbances included vital signs on ED presentation, categorized as a heart rate >100 beats/minute, respiratory rate >24/min, pulse oximetry <94%, and systolic blood pressure <100 mm Hg. Physiological

disturbances also included the following laboratory findings, collected either at initial ED presentation or upon admission to the hospital: hs-cTnI >18 ng/L (>99th percentile), creatinine >1.5 mg/dL, D-dimer >1.5 mcg/mL, ferritin >500ng/mL, alanine aminotransferase (ALT) >40 U/liter, CRP >8.2 ng/mL, procalcitonin >0.25 ng/mL, hematocrit >40%, and absolute lymphocyte count <1000/uL.

We used multiple imputation modeling by fully conditional specification to impute continuous variables that had <20% missing data. This included the following variables: BMI, blood pressure, temperature, respiratory rate, pulse oximetry, procalcitonin, CRP, D-dimer, ferritin, ALT, hs-cTnI, creatinine, hematocrit, and absolute lymphocyte count. We created 5 imputed data sets, which were used for these analyses. A 2-sided $\alpha < 0.05$ was considered statistically significant. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported for all models. Statistical analyses were performed using R version 4.0.2 (Vienna, Austria).

RESULTS

Characteristics of COVID-19 Patients

During the study period, there were 3633 patients who presented to 1 of 9 EDs and tested positive for SARS-CoV-2. Patient characteristics are summarized in Table 1. The mean age of the cohort was 58.4 years. A majority were female (1954; 53.8%) and Black (2019; 55.6%). Rates of hypertension (51.3%), obesity (51.8%), and diabetes mellitus (31.7%) were high. Over half of the patients lived in low-income areas (52.2%) and had public insurance (Medicare or Medicaid insurance). Dyspnea (26.0%), fever (14.9%), and cough (13.5%) were the most common presenting symptoms. Tachycardia and elevated temperature were common (39.7% and 22.4% of patients, respectively), and 16.2% of patients required supplemental oxygen in the ED. There were 460 (12.7%) patients that died within 30 days. Among the decedents, 433 (94%) were hospitalized. The remaining 27 (6%) patients died in the ED or at a subsequent healthcare encounter following discharge to home from the ED.

Characteristics and Outcomes of Hospitalized COVID-19 Patients

A total of 2316 (63.7%) patients were hospitalized, 55.7% of whom were Black. Hospitalized patients had a higher mean age (64.5 vs 48.2 years, respectively) and were more likely to be male (51.8% vs 36.7%, respectively), have Medicare (56.4% vs 21.2%, respectively), reside in a low-income area (54.3% vs 48.4%, respectively), and have more than 2 comorbidities (90.6% vs 55%, respectively) than nonhospitalized patients. Patients requiring hospitalization were more likely to present with an altered mental status (4.9% vs 0.2%, respectively) and dyspnea (34.2% vs 11.5%, respectively) and had higher rates of physiological disturbances than nonhospitalized patients (Table 1). The mean age of hospitalized Black patients was 61.8 years (SD, 15.6), compared to 69.5 years, (SD, 16.6) among White patients.

Table 1. Characteristics of 3633 Consecutive, Confirmed Coronavirus Disease 2019 Patients to Henry Ford Health System Emergency Departments

	All	Discharged home	Hospitalized
Characteristics	N = 3633	n = 1317	n = 2316
Age, years	58.4 ± 18.1	48.2 ± 16.5	64.5 ± 16.3
Female sex, n (%)	1954 (53.8)	837 (63.6)	1117 (48.2)
Race and ethnicity, n (%)			
Black	2019 (55.6)	728 (55.3)	1291 (55.7)
White	1160 (31.9)	405 (30.8)	755 (32.6)
Hispanic	247 (6.8)	94 (7.1)	153 (6.6)
Other	207 (5.7)	90 (6.8)	117 (5.1)
Unknown	117 (3.2)	37 (2.8)	80 (3.5)
Low-income, n (%)	1895 (52.2)	638 (48.4)	1257 (54.3)
Insurance, n (%)			
Commercial	1152 (31.7)	525 (39.9)	627 (27.1)
Medicare	1586 (43.7)	279 (21.2)	1307 (56.4)
Medicaid	565 (15.6)	214 (16.2)	351 (15.2)
Physiological parameters, n (%)			
Temperature > 38.0℃	806 (22.4)	222 (17.3)	584 (25.3)
Respiratory rate > 24/min	729 (21.0)	55 (4.7)	674 (29.2)
SpO2 < 94%	889 (24.7)	49 (3.8)	840 (36.4)
HR ≥ 100 beats/min	1434 (39.7)	433 (33.3)	1001 (43.3)
Body mass index, kg/m^2	31.7 ± 9.1	31.7 ± 9.9	31.6 ± 8.7
Comorbidities, n (%)			
Human immunodeficiency virus	26 (.7)	0 (.0)	26 (1.1)
Coronary artery disease	552 (15.2)	55 (4.2)	497 (21.5)
Congestive heart failure	530 (14.6)	57 (4.3)	473 (20.4)
Stroke	222 (6.1)	23 (1.7)	199 (8.6)
Asthma	319 (8.8)	102 (7.7)	217 (9.4)
Chronic obstructive pulmonary disease	727 (20.0)	98 (7.4)	629 (27.2)
Peripheral vascular disease	218 (6.0)	25 (1.9)	193 (8.3)
Chronic kidney disease	782 (21.5)	84 (6.4)	698 (30.1)
End stage renal disease	218 (6.0)	25 (1.9)	193 (8.3)
Hypertension	1862 (51.3)	389 (29.5)	1473 (63.6)
Diabetes mellitus	1150 (31.7)	219 (16.6)	931 (40.2)
Solid organ transplant	44 (1.2)	9 (.7)	35 (1.5)
Cancer	305 (8.4)	59 (4.5)	246 (10.6)
Obesity	1758 (51.8)	574 (52.0)	1184 (51.7)
Dementia	358 (9.9)	14 (1.1)	344 (14.9)
Total mean comorbid conditions	2.6 ± 2.2	1.3 ± 1.5	3.3 ± 2.3
Charlson comorbidity index	1.6 ± 2.2	.44 ± 1.2	2.2 ± 2.4
Chief complaint, n (%)			
Altered mental status	117 (3.2)	3 (.2)	114 (4.9)
Fever	543 (14.9)	215 (16.3)	328 (14.2)
Nausea or vomiting	155 (4.3)	50 (3.8)	105 (4.5)
Dyspnea	943 (26.0)	152 (11.5)	791 (34.2)
Cough	490 (13.5)	218 (16.6)	272 (11.7)
Weakness	158 (4.3)	30 (2.3)	128 (5.5)

Plus-minus values are means ± SD. Race and ethnic groups are self-reported by each patient. Chronic kidney disease inclusive of end-stage renal disease. Comorbid conditions are determined by clinical documentation and assumed to not be present if not documented. Obesity is determined by a body mass index ≥30 kg/m^2.
Abbreviations: HR, heart rate; SD, standard deviation; SpO2, oxygen saturation.

Clinical characteristics and outcomes for hospitalized patients are presented in Table 2. A total of 433 (18.7%) hospitalized patients died within 30 days of their hospital encounter, of whom 407 (94%) died during their index admission. Following

Table 2. Characteristics of Hospitalized Patients With Coronavirus Disease 2019 Based on Primary Outcome

Characteristics	Alive at 30 days n = 1883	Deceased at 30 days n = 433	*P* value
Age, years	62.0 ± 15.9	74.7 ± 13.8	<.001
Female sex, n (%)	933 (49.5)	184 (42.5)	.004
Race and ethnicity, n (%)	…	…	<.001
Black	1087 (57.7)	204 (47.1)	
White	566 (30.1)	189 (43.6)	
Hispanic	132 (7.0)	21 (4.8)	
Other	65 (3.5)	15 (3.5)	
Low income, n (%)	1042 (55.3)	215 (49.7)	.037
Insurance, n (%)	…	…	<.001
Commercial	581 (30.9)	46 (10.6)	
Medicaid	321 (17.0)	30 (6.9)	
Medicare	951 (50.5)	356 (82.2)	
Physiological parameters, n (%)			
Temperature > 38.0℃	497 (26.4)	87 (20.2)	.009
Respiratory rate > 24/min	468 (24.9)	206 (47.7)	<.001
SpO2 < 94%	637 (33.9)	203 (47.2)	<.001
HR ≥ 100 beats/min	822 (43.7)	179 (41.4)	.422
Body mass index, kg/m^2	32.2 ± 8.6	29.4 ± 8.6	<.001
Comorbidities, n (%)			
Human immunodeficiency virus	18 (1.0)	8 (1.8)	.182
Coronary artery disease	336 (17.8)	161 (37.2)	<.001
Peripheral vascular disease	123 (6.5)	70 (16.2)	<.001
Congestive heart failure	320 (17.0)	153 (35.3)	<.001
Stroke	133 (7.1)	66 (15.2)	<.001
Asthma	186 (9.9)	31 (7.2)	.097
Chronic obstructive pulmonary disease	474 (25.2)	155 (35.8)	<.001
Chronic kidney disease	501 (26.6)	197 (45.5)	<.001
End-stage renal disease	79 (4.2)	35 (8.1)	.001
Hypertension	1171 (62.2)	302 (69.7)	.004
Diabetes mellitus	731 (38.8)	200 (46.2)	.006
Solid organ transplant	28 (1.5)	7 (1.6)	1.00
Cancer	183 (9.7)	63 (14.5)	.004
Obesity	1022 (54.7)	162 (38.1)	<.001
Total mean comorbid conditions	3.1 ± 2.2	4.3 ± 2.4	<.001
Charlson comorbidity index	1.9 ± 2.3	3.4 ± 2.6	<.001
Laboratory values, n (%)			
Troponin > 99th percentile	603 (31.4)	301 (72.0)	<.001
Absolute lymphocyte < 1000/uL	1137 (59.3))	298 (71.3)	<.001
Creatinine > 1.5 mg/dL	523 (27.3)	220 (52.6)	<.001
Glucose > 150 mg/dL	496 (25.9)	152 (36.4)	<.001
CRP > 10 mg/dL	650 (33.9)	228 (54.6)	<.001
Anion gap > 15	205 (10.7)	92 (22.0)	<.001
Hematocrit > 40%	900 (46.9)	164 (39.2)	.033
Ferritin > 500 ng/mL	778 (41.3)	241 (55.7)	<.001
D-dimer > 1.5 mg/L	655 (34.1)	251 (60.1)	<.001
Procalcitonin > .25 ng/mL	461 (24.0)	224 (53.6)	<.001
ALT > 40 IU/L	436 (23.2)	100 (23.1)	.152
Respiratory failure, n (%)	793 (42.1)	345 (79.7)	<.001
Mechanical ventilation, n (%)	151 (8.0)	208 (48.0)	<.001
Delirium, n (%)	212 (11.3)	136 (31.4)	<.001
Acute kidney injury, n (%)	581 (30.9)	254 (58.7)	<.001
Sepsis, n (%)	276 (14.7)	184 (42.5)	<.001

Plus-minus values are means ± SD. Race and ethnic groups are self-reported by each patient. Comorbid conditions are determined by clinical documentation and assumed to not be present if not documented. Obesity was determined by a body mass index ≥30 kg/m^2. Normal lab value ranges: troponin, <19 ng/L; absolute lymphocyte, 1.1–4.0 K/uL; creatinine, <1.28 mg/dL; glucose, 50–140 mg/dL; CRP, <0.5 mg/dL; anion gap, 3–13; hematocrit, 41–53%; ferritin, 24–336; D-dimer, <0.59 mg/L; procalcitonin, <0.25 ng/mL; and ALT, <52 IU/L.

Abbreviations: ALT, alanine aminotransferase; CRP, C-reactive protein; HR, heart rate; SD, standard deviation; SpO2, oxygen saturation.

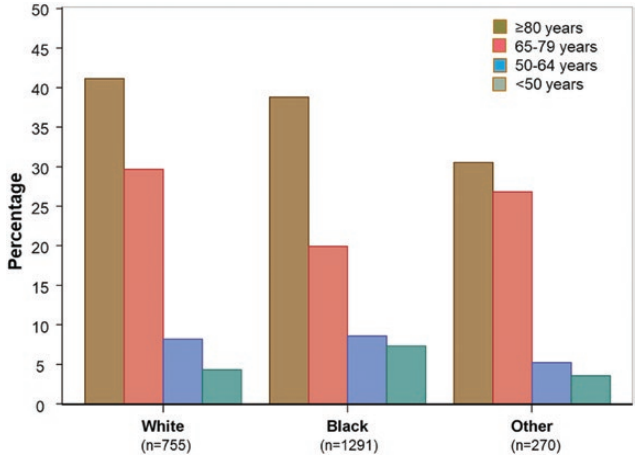

Figure 1. Percentage of hospitalized patients that had 30-day mortality based on race and age groups.

discharge from their initial hospitalization, 26 (6%) patients died either at home or during readmission. Patients who died were more likely to be male, older, and have chronic comorbidities. Figure 1 illustrates the proportion of deaths between the different age groups based on race, which was higher among the elderly across all races. The mean age of White patients who died was 80.0 years (SD, 11.9), compared to 70.9 years (SD, 14.4) among Black patients. Black patients who died had higher average Charlson comorbidity index scores (3.8; SD, 2.8) compared to White patients (3.3; SD, 2.3). During the first week of the pandemic, a higher proportion of Blacks died. However, over the course of the outbreak, Whites contributed to a higher proportion of deceased patients (Figure 2).

Deceased patients more frequently had physiological disturbances on presentation, including abnormal vital signs, higher inflammatory markers, and higher rates of cardiac injury, AKI, and lymphopenia (Table 2). Rates of complications were higher among the deceased patients as compared with patients who survived, including AKI, respiratory failure, sepsis, the need for mechanical ventilation, and delirium (Table 2). The mean length of hospitalization among survivors was 7.9 days (SD, 8.0), and the mean time to death was 11.1 days (SD, 7.9).

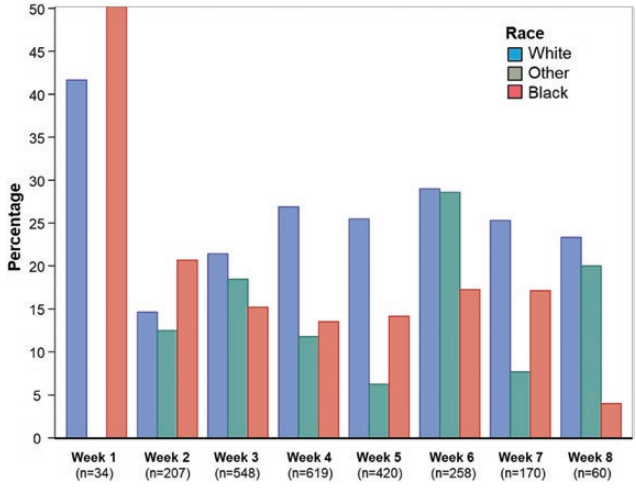

Figure 2. Weekly mortality rate over peak period of the pandemic based on race.

Factors Associated With 30-Day Mortality Among Hospitalized Patients

Table 3 shows the ORs for factors associated with 30-day mortality among hospitalized patients. Unadjusted death rates were higher in White patients compared with Black patients (16.4% vs 9.9%, respectively) and in patients >60 years (21.3% vs 3.0%, respectively) or with more than 2 comorbidities (27.8% vs 6.6%, respectively). In an adjusted analysis inclusive of fixed patient variables, an age >60 years, male sex, Medicare insurance, and a history of dementia were associated with mortality. Cardiopulmonary comorbidities were also associated with death. With the addition of physiological disturbances (Model

Table 3. Odds Ratios for 30-Day Mortality Among Hospitalized Patients With Coronavirus Disease 2019

	Odds Ratio (95% CI)	
Variable	Model 1	Model 2
Sex: male vs female	1.51 (1.20–1.91)	1.22 (.94–1.60)
Age > 60 years	2.77 (1.92–4.00)	2.45 (1.65–3.64)
Resides in low-income area	1.02 (.78–1.33)	1.01 (.76–1.35)
Medicaid insurance[a]	1.11 (.67–1.83)	1.06 (.62–1.82)
Medicare insurance	1.87 (1.28–2.75)	1.41 (.93–2.15)
Race: Black vs White	.79 (.59–1.05)	.56 (.40–.77)
Chronic obstructive pulmonary disease	1.31 (1.02–1.68)	1.49 (1.13–1.97)
Congestive heart failure	1.36 (1.03–1.81)	1.36 (1.00–1.83)
Coronary artery disease	1.46 (1.11–1.90)	1.35 (1.02–1.80)
Chronic kidney disease	1.24 (.96–1.61)	.94 (.69–1.27)
Hypertension	.69 (.53–.92)	.73 (.54–.99)
Obesity	.93 (.73–1.20)	.94 (.71–1.24)
Diabetes mellitus	1.18 (.92–1.52)	1.22 (.93–1.60)
Cancer	1.06 (.76–1.49)	1.02 (.71–1.47)
Dementia	1.90 (1.43–2.52)	1.67 (1.21–2.29)
Peripheral vascular disease	1.38 (.97–1.98)	1.27 (.87–1.87)
Stroke	1.28 (.90–1.82)	1.30 (.89–1.91)
Pulse oximetry < 94%	…	1.49 (1.15–1.94)
Respiratory rate > 24/min	…	1.87 (1.43–2.43)
SBP < 100 mmHg	…	1.78 (1.21–2.64)
Troponin > 99th percentile	…	2.36 (1.76–3.16)
Absolute lymphocyte < 1000/uL	…	1.31 (1.00–1.72)
Creatinine > 1.5 mg/dL	…	1.08 (.79–1.49)
D-dimer > 1.5 mg/L	…	1.55 (1.18–2.03)
Ferritin > 500 ng/mL	…	1.28 (.98–1.68)
ALT > 40 IU/L	…	.87 (.64–1.17)
CRP > 10 mg/L	…	1.43 (1.08–1.89)
Procalcitonin > .25 ng/mL	…	1.69 (1.19–2.39)

Model 1 is inclusive of fixed patient variables, including demographic, socioeconomic, and comorbid condition data. Model 2 is inclusive of Model 1, with the addition of physiological disturbances present on admission.

Abbreviations: ALT, alanine aminotransferase; CI, confidence interval; CRP, C-reactive protein; SBP, systolic blood pressure.

[a]Reference for insurance is commercial insurance.

2), an age >60 years, cardiopulmonary comorbidities, and dementia remained significantly associated with death. Otherwise, multiple physiological disturbances remained significantly associated with 30-day mortality. Residence in a low-income area and public insurance were not independently associated with higher risks of mortality among hospitalized patients. Black race was independently associated with lower mortality (OR, 0.56; 95% CI, .40–.77). When categorized by sex, the association of Black race and mortality, as compared to White patients, was significant for females (OR, 0.45; 95% CI, .27–.78) but not males (OR, 0.84; 95% CI, .54–1.30).

DISCUSSION

In contrast to recently published studies that addressed risk factors associated with mortality among patients admitted to the intensive care unit [9, 15], our report is the first and largest study that examines the clinical characteristics and risk factors associated with 30-day mortality in a cohort of all comers, irrespective of severity of illness, who presented to an ED with a confirmed COVID-19 infection.

The majority of COVID-19 patients in our cohort were female and Black, similar to previous reports [2, 5]. Although Black patients represented 36.7% of the patients evaluated in our EDs during the same period in 2019, they represented 55.5% of the overall COVID-19–positive patients within the health system. This disproportionate number of Black patients affected by COVID-19 is consistent with previous reports [2, 7]. During the first 2 weeks of the pandemic, Black patients had higher rates of death, but had lower rates compared to Whites for the remaining weeks. This finding may reflect random variability given the lower number of patients treated in the first weeks. It could also reflect the evolution of clinical management, including the initiation of corticosteroids as part of routine care, which may have contributed to this change.

Our findings support earlier observations that found the majority of hospitalized COVID-19 patients to be female, Black, and of older age with underling comorbidities [2, 7]. Additionally, a higher proportion of hospitalized patients had public insurance, resided in low-income areas and had noted physiologic abnormalities.

Among hospitalized patients, those who died were more likely to be male, be older than 60 years of age, be White, and have underlying cardiopulmonary comorbidities, including coronary artery disease, congestive heart failure, and chronic kidney disease. Most deceased patients had public insurance, particularly Medicare, which reflects advanced age, particularly among White patients. Nevertheless, the majority of decedents did not reside in low-income areas. Clinical features, such as tachypnea and hypoxia, and abnormal laboratory parameters, including elevated inflammatory and cardiac markers and lymphopenia, were more common among the deceased patients. These findings were consistent with other studies [2, 16] and likely reflect severity of the host response to COVID-19 infection. Notably, the vast majority (94%) of our deceased cohort died during their index hospitalization, in contrast to recently published reports, where in-hospital mortality was 62.0% across the United States [17].

Physiologic disturbances present at the time of hospitalization, including hypoxia, tachypnea, low blood pressure, elevated hs-cTnI, elevated D-dimer, and elevated procalcitonin, were associated with increased odds of mortality. In an adjusted analysis, insurance status and residence in low-income areas were not associated with 30-day mortality.

Death rates were higher in White patients, compared with Black patients and those of other races. This finding was significant among Black women, who had a substantially lower risk of death compared to White females. This higher death rate associated with White race persisted when adjusted for multiple patient characteristics, including extensive physiological variables. Notably, Black patients died at nearly a decade younger on average compared to White patients, a finding consistent with published national data [7]. This difference in age reflects the finding that Black ED patients that required hospitalization were, on average, nearly a decade younger than White patients requiring hospitalization. Whether other factors contribute to the differences in mortality based on race and sex warrants additional investigation.

This report highlights that advanced age and physiological abnormalities were most strongly associated with mortality, and suggests that White patients who were hospitalized had higher rates of mortality as a result. Although previously published reports have demonstrated the association between comorbidities and outcomes in patients with COVID-19 [18-20], these findings suggest that the host response and advanced age may be more important predictors of mortality. The study benefited from early implementation of a health system protocol that standardized collection of laboratory parameters among hospitalized patients. This relatively comprehensive assessment of presenting physiological disturbances may explain the discrepancy in the significance of comorbid conditions previously reported.

This study has a number of limitations. While a strength of the study is inclusion of a large and diverse population over southeast and south-central Michigan, we limited data to an integrated health system, which may have regional characteristics that are not generalizable to other healthcare settings. Many ED patients were not sick enough to warrant hospitalization and complete laboratory evaluation, which limited detailed laboratory data on the full cohort. As the main focus of the study was on patient factors present on initial presentation, we did not incorporate inpatient pharmacologic treatment into our analysis. Treatment guidance within the health system evolved during the first month of the pandemic to include a higher proportion of patients receiving

corticosteroids and hydroxychloroquine, which may have influenced outcomes over time. Our analysis did not account for stratification of disease severity, which could uncover additional details on the interplay of healthcare disparities and outcomes. Finally, data collection relied on structured data elements in the EHR, and all findings are dependent on the accuracy of documentation by study teams. While we incorporated comorbidity data in the EHR well beyond that of each patient's encounter with COVID-19, incomplete documentation may underestimate the burden of comorbidities in some patients.

CONCLUSION

In this large cohort of COVID-19 patients in metropolitan Detroit, patients with comorbidities, advanced age, and physiological abnormalities on presentation had higher odds of death. Among those hospitalized, Black race and socioeconomic disparities were not associated with higher risks of 30-day mortality, and Black females had a lower adjusted risk of death compared to White females.

Notes

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