

ORIGINAL RESEARCH ARTICLE

Racial and Ethnic Differences in Presentation and Outcomes for Patients Hospitalized With COVID-19

Findings From the American Heart Association's COVID-19 Cardiovascular Disease Registry

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BACKGROUND: The coronavirus disease 2019 (COVID-19) pandemic has exposed longstanding racial and ethnic inequities in health risks and outcomes in the United States. We aimed to identify racial and ethnic differences in presentation and outcomes for patients hospitalized with COVID-19.

METHODS: The American Heart Association COVID-19 Cardiovascular Disease Registry is a retrospective observational registry capturing consecutive patients hospitalized with COVID-19. We present data on the first 7868 patients by race/ethnicity treated at 88 hospitals across the United States between January 17, 2020, and July 22, 2020. The primary outcome was in-hospital mortality. Secondary outcomes included major adverse cardiovascular events (death, myocardial infarction, stroke, heart failure) and COVID-19 cardiorespiratory ordinal severity score (worst to best: death, cardiac arrest, mechanical ventilation with mechanical circulatory support, mechanical ventilation with vasopressors/inotrope support, mechanical ventilation without hemodynamic support, and hospitalization alone). Multivariable logistic regression analyses were performed to assess the relationship between race/ethnicity and each outcome adjusting for differences in sociodemographic, clinical, and presentation features, and accounting for clustering by hospital.

RESULTS: Among 7868 patients hospitalized with COVID-19, 33.0% were Hispanic, 25.5% were non-Hispanic Black, 6.3% were Asian, and 35.2% were non-Hispanic White. Hispanic and Black patients were younger than non-Hispanic White and Asian patients and were more likely to be uninsured. Black patients had the highest prevalence of obesity, hypertension, and diabetes. Black patients also had the highest rates of mechanical ventilation (23.2%) and renal replacement therapy (6.6%) but the lowest rates of remdesivir use (6.1%). Overall mortality was 18.4% with 53% of all deaths occurring in Black and Hispanic patients. The adjusted odds ratios for mortality were 0.93 (95% CI, 0.76–1.14) for Black patients, 0.90 (95% CI, 0.73–1.11) for Hispanic patients, and 1.31 (95% CI, 0.96–1.80) for Asian patients compared with non-Hispanic White patients. The median odds ratio across hospitals was 1.99 (95% CI, 1.74–2.48). Results were similar for major adverse cardiovascular events. Asian patients had the highest COVID-19 cardiorespiratory severity at presentation (adjusted odds ratio, 1.48 [95% CI, 1.16–1.90]).

CONCLUSIONS: Although in-hospital mortality and major adverse cardiovascular events did not differ by race/ethnicity after adjustment, Black and Hispanic patients bore a greater burden of mortality and morbidity because of their disproportionate representation among COVID-19 hospitalizations.

Key Words: cardiovascular diseases ■ COVID-19 ■ health status disparities ■ race factors

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Clinical Perspective

What Is New?

- In a large national registry of coronavirus disease 2019 (COVID-19) hospitalizations, Black and Hispanic patients accounted for >50% of the hospitalizations and were significantly younger than non-Hispanic White patients.
- After adjusting for sociodemographic and clinical characteristics, mortality and major cardiovascular or cerebrovascular adverse events did not differ by race/ethnicity in hospitalized patients.
- Asian patients had the highest risk of cardiorespiratory disease severity at presentation.

What Are the Clinical Implications?

- Although race/ethnicity was not independently associated with worse in-hospital mortality or major adverse cardiovascular events, Black and Hispanic patients bore a greater burden of mortality and morbidity because of their disproportionate representation among COVID-19 hospitalizations.
- Interventions to reduce disparities in COVID-19 should focus upstream from hospitalizations.

Nonstandard Abbreviations and Acronyms

AHA	American Heart Association
COVID-19	coronavirus disease 2019
MACE	major adverse cardiovascular events
OR	odds ratio
SARS-CoV-2	severe acute respiratory syndrome coronavirus 2

The coronavirus disease 2019 (COVID-19) pandemic has exposed longstanding racial/ethnic health inequities in the United States. In preliminary, mostly single-center or regional studies, Black and Hispanic individuals were shown to bear a disproportionate rate of COVID-19 infection, hospitalizations, and adverse outcomes.¹⁻⁴ The reasons for these disparities are complex and include the pervasive effects of structural racism that result in conditions that increase the risk of transmission of COVID-19, such as being overrepresented in the essential workforce, living in multigenerational households, and limited access to regular testing.⁵⁻⁷ Historically marginalized populations also have a higher prevalence of underlying comorbidities that may increase disease severity and adverse outcomes.⁸

The relationship between COVID-19 and cardiovascular disease (CVD) complications has not been fully characterized. However, retrospective single-center studies have found an association between underlying CVD and increased mortality.^{6,9,10} In part because of the affinity

of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) for the angiotensin-converting enzyme 2 receptor and its tendency to cause coagulopathy, COVID-19 is postulated to have important effects on the vasculature beyond that of other traditional respiratory viruses.¹¹⁻¹³ The observed cardiovascular manifestations are broad and include myocardial injury, heart failure, and thrombotic complications.^{14,15} Differences by race/ethnicity of these CVD complications have not been previously described.

The American Heart Association (AHA) COVID-19 CVD Registry leveraged a preexisting quality improvement registry infrastructure to rapidly and systematically collect data that are inclusive of cardiovascular outcomes associated with COVID-19 across diverse hospitals and patient populations in the United States. Using these national data, we aimed to comprehensively characterize racial/ethnic differences in risk factors, presentation, patterns of care, cardiorespiratory disease severity, and mortality for patients hospitalized with COVID-19. We hypothesized that Black and Hispanic patients would be overrepresented in COVID-19 hospitalizations and experience worse in-hospital outcomes.

METHODS

Study Population

Development and deployment of the AHA COVID-19 CVD Registry have been described previously.¹⁶ In brief, the AHA COVID-19 CVD Registry is powered by the Get With The Guidelines quality improvement program and was made available as a free quality improvement tool to all US hospitals caring for adults with active COVID-19. To minimize data collection bias, hospitals retrospectively abstracted all consecutive patients who were ≥18 years of age and hospitalized with COVID-19 as a diagnosis. Data abstraction was not considered complete until the patient was discharged from the hospital, with complete data on admission and discharge dates, age, sex, and medical history assessment. For all hospitals, participation in this quality improvement registry was approved or review was waived by an institutional review board.

Data Collection

The AHA COVID-19 CVD registry contains >200 data elements including patient demographics, insurance status, hospital admission, and disposition dates, presenting symptoms and admission clinical features. Because of its CVD focus, the registry includes detailed information on several CVD complications including myocardial infarction and new heart failure. Medication use during the hospitalization includes the use of therapies either as part of a clinical trial or routine care. The case report form is available at <https://www.heart.org/-/media/files/professional/quality-improvement/covid-19-cvd-registry/ahacovidcvdcfr428-fillable-pdf.pdf?la=en>. The Get With The Guidelines programs are provided by the AHA. IQVIA (Parsippany, NJ) serves as the data collection and coordination center. Deidentified data from the AHA COVID-19 CVD Registry are available through the

AHA's Precision Medicine Platform. Requests to access the data should be made through the AHA COVID-19 CVD Registry after submitting a proposal: <https://www.heart.org/en/professional/quality-improvement/covid-19-cvd-registry/covid-19-cvd-registry-research-opportunities>.

Race/ethnicity of study participants was extracted from the electronic health records at each site. For this study, race/ethnicity was categorized using hierarchical, mutually exclusive categories as follows: Hispanic for all races; non-Hispanic Black, Asian/Pacific Islander, non-Hispanic White, and American Indian/Alaska Native. Median household income, educational attainment, and employment status were extracted from the 2018 American Community Survey 5-year estimates based on patient zip code. We also estimated the racial/ethnic demographic composition of the geographic area served by each hospital in the registry based on the hospital's zip code. Hospital characteristics, including region, number of beds, rural location, and academic/teaching status, were obtained from hospital self-report, supplemented by American Hospital Association survey data.

Outcomes

The primary outcome was in-hospital all-cause mortality. Secondary outcomes included major adverse cardiovascular events (MACEs) and COVID-19 cardiorespiratory disease severity. For this study, MACE was defined as a composite of death, myocardial infarction, stroke, new-onset heart failure, or cardiogenic shock. A cardiorespiratory-specific COVID-19 disease severity scale, adapted from the World Health Organization's ordinal outcomes scale,¹⁷ ranked the following outcomes from worst to best: in-hospital death, in-hospital cardiac arrest, mechanical ventilation with mechanical circulatory support (intra-aortic balloon pump, percutaneous ventricular assist devices, extracorporeal membrane oxygenation), mechanical ventilation with vasopressors/inotrope, mechanical ventilation without hemodynamic support, and hospitalization without any of the preceding.

Statistical Analyses

Among 8590 patients with completed records in the registry, 688 (8%) had no race or ethnicity documented. Patient characteristics were compared between those with and without documented race/ethnicity with standardized differences and are shown in [Table 1 in the Data Supplement](#).

Baseline clinical characteristics, admission features, and in-hospital treatments for each racial/ethnic group were reported as percentages for categorical variables and median and interquartile range for continuous variables. Because of the small number of the American Indian/Alaskan Native patients (n=34), this group was not included in the tables. For laboratory results, rates of measurement, and measured values, as well, were presented.

Weekly unadjusted in-hospital mortality rates were calculated as naive case fatality ratios (number who died that week divided by the sum of those who died or were discharged to home or a nonacute health care facility). Patients who were discharged to hospice, who were discharged to another hospital, or who had an unknown discharge disposition were excluded from case fatality ratio calculations. To ensure stable assessments of mortality, weekly hospitalization and mortality

rates were calculated from March 2020 to May 2020 because prior time periods had denominators <20 patients and some sites reported ongoing data abstraction for more recent hospitalizations.

We performed sequential multivariable logistic regression analyses to test the strength of the association between race/ethnicity and each clinical outcome after incrementally adjusting for sociodemographic and patient characteristics. The base unadjusted model included race/ethnicity alone. Model 1 adjusted for age only. Model 2 also adjusted for other sociodemographic factors, including sex, insurance status, household income, employment status, and education level. Model 3 added medical history, including coronary artery disease, heart failure, cerebrovascular disease, atrial fibrillation/flutter, chronic kidney disease, diabetes, hypertension, smoking/e-cigarette use, cancer, pulmonary disease, immune disorder, pulmonary embolism/deep venous thrombosis, and obesity (body mass index ≥ 30 kg/m²). Model 4 added clinical features at presentation, including days from symptom onset to hospital arrival, on- versus off-hour presentation (on-hour defined as hospital arrival between 8 AM and 5 PM on Mondays through Fridays), fever (temperature $>38^\circ\text{C}$) on admission, tachycardia (heart rate >100 beats/min) on admission, hypotension (systolic blood pressure <90 mmHg) on admission, hypoxia on admission (oxygen saturation $<94\%$ or need for supplemental oxygen on admission), and pulmonary infiltrate present on chest radiograph or computed tomogram. All models included a random intercept for hospital to account for within- and across-hospital variability. We also reported the median odds of each clinical outcome across hospitals to capture the random-effect variance or variation in log-odds attributable to between-hospital differences. The same models were fit for the primary outcome of in-hospital mortality, and the secondary outcomes of MACE and COVID-19 cardiorespiratory disease severity, as well; the latter was fit with an ordinal logistic model. Sensitivity analyses for each outcome used a nonhierarchical generalized estimating equation modeling approach adjusting for the covariates in model 4, while considering within-hospital clustering.

All continuous variables were accounted for using restricted cubic splines. Missing insurance status values for patients ≥ 65 years of age were imputed to Medicare; otherwise, multiple imputation methods were used with 10 data sets. Variable missing rates were $<3.5\%$ for all adjustment variables, with the exception of obesity (10.6%), symptom onset to hospital arrival (13.1%), off-hour presentation (8.0%), and hypoxia (O₂ saturation $<94\%$ or requiring supplemental oxygen [8.4%]). Statistical analyses were performed using SAS software (version 9.4, SAS Institute), and 2-tailed P values <0.05 were considered significant for all statistical tests.

RESULTS

From January 17, 2020, to July 22, 2020, 8950 unique patients were hospitalized with COVID-19 at 88 hospitals in the AHA COVID-19 CVD Registry. Weekly hospitalization rates by race/ethnicity showed little change over time ([Figure 1 in the Data Supplement](#)). Participating hospitals were located across 76 zip codes with the following median racial/ethnic demographics: non-Hispanic White 59.3%, Black 10.6%, Hispanic (all races) 9%, and Asian 4.7%. These hospitals had a median size of 415 beds (in-

terquartile range, 265–550), 36.4% were in the Northeast, 34.1% in the South, 13.6% in the West, and 13.6% in the Midwest. The majority (81.8%) were teaching hospitals.

Among hospitalized patients, 33.0% were Hispanic, 25.5% were non-Hispanic Black, 6.3% were Asian, and 35.2% were non-Hispanic White; fewer than half were women (45%). The ratio of patients treated at each site by race/ethnicity compared with the demographic characteristics of each site's zip code are shown in [Figure II in the Data Supplement](#). Hospitalized Hispanic and Black patients were substantially younger than non-Hispanic White patients (median age 57 and 60 years of age versus 69, respectively; Table 1). Hispanic patients were more than twice as likely to be uninsured than other groups and had the lowest educational attainment. Black patients had the lowest median household income and highest unemployment rate.

Almost half of hospitalized Black patients were obese (49.3%), compared with just 17.7% of hospitalized Asian patients. Whereas Black patients had the highest prevalence of obesity, hypertension, diabetes, prior cerebrovascular disease, and advanced kidney disease on admission, non-Hispanic White patients had the highest prevalence of prior coronary artery disease and pulmonary disease (Table 1) in comparison with other racial/ethnic groups. Asian patients had the longest time from symptom onset to hospital arrival (7 days) compared with other racial/ethnic groups. The timing of COVID-19 diagnosis was 71.1% during the hospitalization with fewer non-White patients diagnosed before hospital arrival. Hispanic patients were most likely to present during off hours (60.1%). Black and Hispanic patients were more likely to present with fever and tachycardia, but less likely to be hypoxic on admission compared with non-Hispanic White patients. Admission laboratory values did not differ meaningfully across racial/ethnic groups (Table 1). Laboratory measurements, such as D-dimer and procalcitonin levels, were more frequently assessed in non-White patients. Among patients with measurements, Black patients had the highest C-reactive protein and procalcitonin levels.

One in five patients required mechanical ventilation; the lowest likelihood was among Hispanic patients (18.3%), who also had the lowest likelihood of treatment in an intensive care unit (22.6%). Black patients had the highest observed rates of mechanical ventilation, new renal replacement therapy, and transfusion (Table 2). Only 9.5% of patients were enrolled in a COVID-19–related trial; the lowest enrollment was among Black patients. The most frequently administered COVID-19–specific therapy was hydroxychloroquine (42.4%), with the highest use in Asian patients. In contrast, remdesivir was used to treat 8.1% of patients during this study time period, with the lowest rate of use in Black patients.

During the study period, there was a total of 1447 deaths (18.4%), of which 768 (53.1% of all deaths) occurred in Black or Hispanic patients (Table 3). In-hospital deaths were observed in 17.6% of Black, 16.0% of Hispanic, and 19.3% of Asian patients compared with 21.1% of non-

Hispanic White patients ($P<0.001$). For patients <70 years of age, mortality was highest among Black patients and lowest in Asian patients (Table 3). Case fatality ratios had an early peak, then appeared to slowly decline (Figure A, P for trend=0.049) with similar trends for Black and Hispanic patients (Figure B). In sequential modeling, racial/ethnic differences in mortality became nonsignificant after adjusting for differences in age at presentation (Table 4). In the final multivariable model, additionally adjusting for sociodemographic, clinical, and presentation characteristic differences among groups, the adjusted odds ratios (ORs) for mortality were 0.93 (95% CI, 0.76–1.14) for Black patients, 0.90 (95% CI, 0.73–1.11) for Hispanic patients, and 1.31 (95% CI, 0.96–1.80) for Asian patients compared with non-Hispanic White patients. Sequential model results stratified by age group are shown in [Table II in the Data Supplement](#). Sensitivity analyses using nonhierarchical generalized estimating equations showed similar results ([Table III in the Data Supplement](#)). The median OR across hospitals was 1.99 (95% CI, 1.74–2.48) in the final adjustment model, suggesting that the odds of in-hospital death for a patient was 99% higher at 1 hospital than for a similar patient treated at another hospital.

Similar results were seen for the secondary outcome of MACE that occurred in 21.4% of patients (Table 3). Whereas observed unadjusted MACE rates were lower in Black (21.4%) and Hispanic (17.7%) patients than in non-Hispanic White patients (24.7%, $P<0.001$), these differences were attenuated and no longer different after full adjustment. In the fully adjusted models, the adjusted ORs for MACE were 0.99 (95% CI, 0.82–1.20) for Black patients, 0.88 (95% CI, 0.72–1.08) for Hispanic patients, and 1.28 (95% CI, 0.95–1.72) for Asian patients compared with non-Hispanic White patients. The median OR across hospitals was 1.92 (95% CI, 1.69–2.36) in the final model.

For the secondary outcome of cardiorespiratory COVID-19 disease severity, Black and Hispanic patients had lower unadjusted probabilities of experiencing more severe disease, but these differences were attenuated after multivariable adjustment. After adjusting for sociodemographic characteristics, Asian patients had a higher probability of experiencing greater COVID-19 cardiorespiratory disease severity than non-Hispanic White patients, and this relationship persisted after further adjusting for medical history and presentation characteristics (adjusted OR, 1.48 [95% CI, 1.16–1.90]).

Median length of stay was shortest among Hispanic patients, and non-Hispanic White patients were more likely to be discharged to a nursing facility compared with other patients (Table 3).

DISCUSSION

In a large study of patients hospitalized for COVID-19 across the United States, we report several noteworthy findings. First, Hispanic and Black patients comprised more

Table 1. Baseline and In-Hospital Characteristics of Patients Hospitalized With COVID-19, by Race/Ethnicity

Characteristics	Non-Hispanic White (n=2768)	Non-Hispanic Black (n=2009)	Hispanic, all races (n=2593)	Asian/Pacific Islander (n=498)
Demographics				
Age, y	69.0 (57.0, 81.0)	60.0 (49.0, 71.0)	57.0 (44.0, 71.0)	64.0 (50.0, 77.0)
Female	1203 (43.5)	1006 (50.1)	1128 (43.5)	202 (40.6)
Insurance				
Private/commercial	1023 (37.0)	677 (33.7)	566 (21.8)	190 (38.2)
Medicare	1311 (47.4)	784 (39.0)	802 (30.9)	191 (38.4)
Medicaid	191 (6.9)	331 (16.5)	749 (28.9)	72 (14.5)
Other government	28 (1.0)	13 (0.6)	5 (0.2)	1 (0.2)
Other	32 (1.2)	50 (2.5)	126 (4.9)	12 (2.4)
Self-pay/uninsured	68 (2.5)	91 (4.5)	332 (12.8)	25 (5.0)
Education*				
Advanced degree	14.62 (8.25, 22.75)	8.25 (4.82, 14.56)	10.34 (4.40, 15.59)	15.29 (9.62, 25.54)
College degree	31.12 (25.03, 37.49)	23.53 (17.90, 28.83)	25.10 (17.56, 29.26)	31.98 (25.86, 38.67)
High school	42.91 (31.79, 52.91)	49.05 (40.36, 55.73)	42.23 (33.07, 47.13)	32.11 (25.27, 43.55)
Did not complete high school	8.00 (4.54, 15.05)	16.20 (11.14, 22.48)	24.11 (14.30, 30.12)	13.40 (6.12, 22.56)
Household income, \$*	66 180 (51 071, 91 333)	43 662 (34 928, 60 908)	53 615 (41 154, 72 660)	72 261 (45 566, 103 680)
Unemployment rate*	4.70 (3.70, 6.40)	8.10 (5.50, 10.70)	6.90 (4.80, 9.60)	5.20 (3.80, 7.00)
Medical history				
Obesity (body mass index ≥ 30 , kg/m ²)	1007 (36.4)	991 (49.3)	979 (37.8)	88 (17.7)
Diabetes	844 (30.5)	908 (45.2)	971 (37.4)	189 (38.0)
Hypertension	1743 (63.0)	1404 (69.9)	1297 (50.0)	283 (56.8)
Coronary artery disease	367 (13.3)	154 (7.7)	158 (6.1)	51 (10.2)
Heart failure	421 (15.2)	284 (14.1)	195 (7.5)	32 (6.4)
Cerebrovascular disease	292 (10.5)	234 (11.6)	151 (5.8)	35 (7.0)
Peripheral artery disease	94 (3.4)	63 (3.1)	50 (1.9)	10 (2.0)
Atrial fibrillation/flutter	456 (16.5)	126 (6.3)	142 (5.5)	47 (9.4)
Pulmonary disease	682 (24.6)	406 (20.2)	304 (11.7)	78 (15.7)
Pulmonary embolus or deep venous thrombosis	158 (5.7)	128 (6.4)	59 (2.3)	6 (1.2)
Cancer	455 (16.4)	209 (10.4)	173 (6.7)	42 (8.4)
Immune disorder	123 (4.4)	139 (6.9)	89 (3.4)	14 (2.8)
Kidney function, glomerular filtration rate, mL/min				
≥ 90	543 (19.6)	477 (23.7)	922 (35.6)	126 (25.3)
60 to <90	966 (34.9)	636 (31.7)	839 (32.4)	198 (39.8)
30 to <60	797 (28.8)	464 (23.1)	414 (16.0)	93 (18.7)
<30	308 (11.1)	267 (13.3)	207 (8.0)	50 (10.0)
Dialysis	60 (2.2)	118 (5.9)	127 (4.9)	16 (3.2)
Smoking/vaping	203 (7.3)	159 (7.9)	122 (4.7)	31 (6.2)
Diagnosis and hospital presentation				
Days from symptom onset to hospital arrival	5.0 (2.0, 9.0)	5.0 (2.0, 7.0)	6.0 (2.0, 8.0)	7.0 (3.0, 10.0)
Days from symptom onset to diagnosis	4.0 (2.0, 8.0)	5.0 (2.0, 8.0)	5.0 (2.0, 8.0)	6.0 (3.0, 9.0)
Timing of COVID-19 diagnosis				
Before hospital arrival	878 (31.7)	477 (23.7)	680 (26.2)	117 (23.5)
During hospitalization	1844 (66.6)	1488 (74.1)	1887 (72.8)	372 (74.7)
After hospital discharge	20 (0.7)	33 (1.6)	16 (0.6)	4 (0.8)

(Continued)

Table 1. Continued

Characteristics	Non-Hispanic White (n=2768)	Non-Hispanic Black (n=2009)	Hispanic, all races (n=2593)	Asian/Pacific Islander (n=498)
Unknown	10 (0.4)	8 (0.4)	6 (0.2)	2 (0.4)
Off-hour presentation†	1509 (54.5)	1115 (55.5)	1559 (60.1)	283 (56.8)
Admission features				
Fever (temperature >38 °C, 100.4 °F)	473 (17.1)	534 (26.6)	607 (23.4)	99 (19.9)
Tachycardia (heart rate >100 beats per minute)	841 (30.4)	779 (38.8)	1003 (38.7)	182 (36.5)
Hypotension (systolic blood pressure <90 mmHg)	81 (2.9)	44 (2.2)	40 (1.5)	12 (2.4)
Hypoxia (O ₂ saturation <94% or requiring supplemental oxygen)	1417 (51.2)	870 (43.3)	1249 (48.2)	235 (47.2)
Infiltrate on initial chest radiography or computed tomogram	1921 (69.4)	1465 (72.9)	1956 (75.4)	368 (73.9)
Laboratory values				
White blood cell count on admission				
No. measured (%)	2675 (96.6)	1969 (98.0)	2538 (97.9)	490 (98.4)
Measured value, ×10 ⁹ /L	6.70 (4.80, 9.50)	6.40 (4.80, 8.80)	7.00 (5.30, 9.30)	6.60 (4.90, 8.90)
C-reactive protein				
No. measured (%)	839 (30.3)	562 (28.0)	833 (32.1)	173 (34.7)
Measured value, mg/L	11.8 (4.5, 25.0)	14.0 (5.7, 25.4)	11.3 (5.2, 20.0)	11.7 (5.4, 19.3)
D-Dimer				
No. measured (%)	1226 (44.3)	956 (47.6)	1322 (51.0)	252 (50.6)
Measured value, ng/mL	800.0 (380.0, 1349)	821.5 (383.0, 1378)	582.5 (256.0, 1084)	800.0 (328.5, 1400)
Procalcitonin				
No. measured (%)	1626 (58.7)	1180 (58.7)	1619 (62.4)	344 (69.1)
Measured value, ng/mL	0.13 (0.08, 0.34)	0.20 (0.10, 0.60)	0.14 (0.08, 0.40)	0.12 (0.08, 0.45)

Continuous variables expressed as median (25th, 75th percentiles); categorical variables expressed as n (%). COVID-19 indicates coronavirus disease 2019.

*Socioeconomic variables extracted from the 2018 American Community Survey 5-year estimates based on patient zip code.

†“On hours” were defined as 8 AM to 5 PM on Monday to Friday.

than half of patients hospitalized with COVID-19; these patients were more often uninsured, had lower socioeconomic status, and had longer delays from symptom onset to COVID-19 diagnosis. Second, hospitalized Hispanic and Black patients were substantially younger than non-Hispanic White and Asian patients. Third, Black patients had the highest prevalence of obesity, hypertension, and diabetes, and they had the highest rates of mechanical ventilation and renal replacement therapy initiation during their hospitalization. Last, observed differences between racial/ethnic groups were no longer significant after adjusting for age and further attenuated after accounting for sociodemographic characteristics, clinical comorbidities, and presenting features. Overall mortality was high at 18.4%, with Black and Hispanic patients representing more than half of all in-hospital deaths. Similar results were seen for the outcomes of MACE and cardiorespiratory COVID-19 disease severity. Hospitalized Asian patients had the highest risk-adjusted cardiorespiratory disease severity at presentation.

Our study supports state and administrative national reports that Black and Hispanic individuals are more likely to be hospitalized with severe acute respiratory

syndrome coronavirus 2 infection and therefore bear a disproportionate burden of COVID-19 mortality.^{1,18–20} In census data, Black and Hispanic individuals constituted 13% and 19% of the US population in 2019,²¹ respectively, but they comprised 26% and 33% of hospitalized COVID-19 patients in our study. The representation of Black and Hispanic patients was even higher than the expected racial/ethnic composition of each of the zip codes where the participating hospital sites were located and other AHA Get With The Guidelines registries.^{22,23} Despite being almost 10 years younger than non-Hispanic White patients, Black patients had the highest rates of diabetes, hypertension, and obesity, all of which have been associated with adverse COVID-19 outcomes.²⁴ Hispanic patients in our study, in contrast, did not have more comorbidities than other racial/ethnic groups. This observation may be explained by their younger age and relative lack of health insurance, which may delay diagnosis of underlying chronic disease. Black and Hispanic individuals are also overrepresented in the essential workforce,²⁵ which increases the potential for viral exposure and community transmission. The

Table 2. In-Hospital Treatment of Patients Hospitalized With COVID-19, by Race/Ethnicity

Characteristics	Non-Hispanic White (n=2768)	Non-Hispanic Black (n=2009)	Hispanic, all races (n=2593)	Asian/Pacific Islander (n=498)
Clinical trial participation, n (%)	259 (9.4)	164 (8.2)	276 (10.6)	49 (9.8)
Intensive care unit admission, n (%)	927 (33.5)	616 (30.7)	587 (22.6)	147 (29.5)
In-hospital procedures, n (%)				
Mechanical ventilation	597 (21.6)	466 (23.2)	474 (18.3)	113 (22.7)
Mechanical circulatory support*	8 (0.3)	8 (0.4)	15 (0.6)	5 (1.0)
New renal replacement therapy	95 (3.4)	133 (6.6)	65 (2.5)	24 (4.8)
Invasive coronary angiogram	13 (0.5)	8 (0.4)	2 (0.1)	1 (0.2)
Transfusion	90 (3.3)	92 (4.6)	46 (1.8)	13 (2.6)
In-hospital COVID-19 therapies, n (%)				
Hydroxychloroquine	1108 (40.0)	847 (42.2)	1151 (44.4)	232 (46.6)
Remdesivir	222 (8.0)	123 (6.1)	247 (9.5)	46 (9.2)
Tocilizumab	207 (7.5)	143 (7.1)	172 (6.6)	47 (9.4)
Steroids	617 (22.3)	449 (22.3)	493 (19.0)	120 (24.1)
Convalescent serum	80 (2.9)	67 (3.3)	59 (2.3)	14 (2.8)

COVID-19 indicates coronavirus disease 2019.

*Mechanical circulatory support defined as venoarterial-extracorporeal membrane oxygenation, venovenous-extracorporeal membrane oxygenation, Impella, other percutaneous ventricular assist device, or intra-aortic balloon pump.

observed longer time to diagnosis from symptom onset for non-White patient groups may represent inequities in testing access. Structural and social factors such as discrimination, multigenerational households, and living in crowded, urban areas also increase the chance of viral transmission.^{20,26,27}

Almost one-third of patients required intensive care unit admission and one-fifth required mechanical ventilation. Black patients had the highest observed rate of mechanical ventilation, whereas Hispanic patients had the lowest. Black patients were also more likely to require initiation of renal replacement therapy during

Table 3. In-Hospital Outcomes of Patients Hospitalized With COVID-19, by Race/Ethnicity

Characteristics	Non-Hispanic White (n=2768)	Non-Hispanic Black (n=2009)	Hispanic, all races (n=2593)	Asian/Pacific Islander (n=498)
In-hospital death (overall), n (%)	583 (21.1)	353 (17.6)	415 (16.0)	96 (19.3)
Age <55 y	37 (6.3)	53 (7.1)	62 (5.4)	7 (4.6)
Age 55–70 y	137 (15.4)	142 (19.2)	124 (15.9)	21 (12.7)
Age >70 y	864 (31.7)	158 (30.2)	229 (34.9)	68 (37.6)
Major adverse cardiovascular events,* n (%)	683 (24.7)	430 (21.4)	459 (17.7)	111 (22.3)
COVID-19 disease severity score	6.0 (4.0–6.0)	6.0 (5.0–6.0)	6.0 (6.0–6.0)	6.0 (5.0–6.0)
Score components (other than death), n (%)				
In-hospital cardiac arrest	14 (0.5)	7 (0.3)	5 (0.2)	1 (0.2)
Mechanical ventilation and mechanical circulatory support†	6 (0.2)	2 (0.1)	7 (0.3)	2 (0.4)
Mechanical ventilation and vasopressors/inotrope support	90 (3.3)	88 (4.4)	74 (2.9)	24 (4.8)
Mechanical ventilation without need for hemodynamic support	206 (7.4)	134 (6.7)	123 (4.7)	40 (8.0)
Length of stay, days	6.0 (3.0–11.0)	6.0 (3.0–12.0)	5.0 (3.0–10.0)	6.0 (3.0–12.0)
Discharge status, n (%)				
Home	1303 (47.1)	1264 (62.9)	1885 (72.7)	294 (59.0)
Hospice	129 (4.7)	30 (1.5)	26 (1.0)	7 (1.4)
Nursing facility	553 (20.0)	274 (13.6)	190 (7.3)	80 (16.1)
Transfer to another hospital	182 (6.6)	62 (3.1)	54 (2.1)	19 (3.8)

COVID-19 indicates coronavirus disease 2019.

*Death, myocardial infarction, stroke, heart failure.

†Mechanical circulatory support defined as venoarterial-extracorporeal membrane oxygenation, venovenous-extracorporeal membrane oxygenation, Impella, other percutaneous ventricular assist device, or intra-aortic balloon pump.

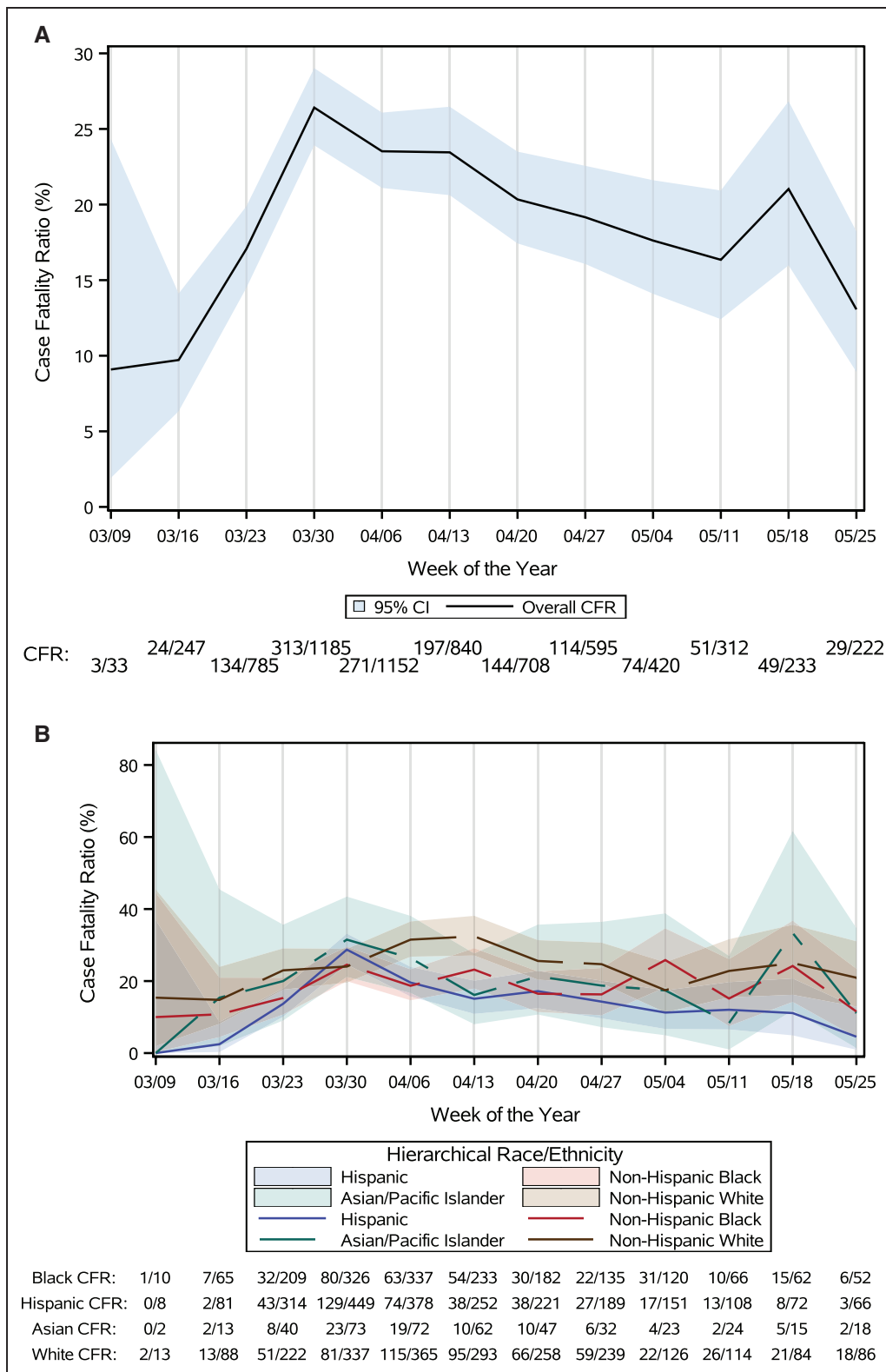


Figure. Weekly case fatality ratio in the overall population (A) and by race/ethnicity (B).

A and **B** show the temporal trends in coronavirus disease 2019 (COVID-19) hospitalizations and case fatalities across registry sites. The change in the trend of case fatalities from March to May is trending to nonsignificance ($P=0.0492$). CFR indicates case fatality ratio.

their hospitalization. Asian patients had the worst cardio-respiratory disease severity with second highest rates of mechanical ventilatory and circulatory support. This may

be explained by the longer time to hospital arrival and diagnosis from symptom onset, older age, and a high burden of comorbidities. Other studies have shown that

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Table 4. Odds Ratios of Clinical Outcomes Among 7868 Patients Hospitalized for COVID-19, by Race/Ethnicity

Outcome	Base model (unadjusted)		Model 1 (adjusted for age)		Model 2 (model 1 + sociodemographic)		Model 3 (model 2 + medical history)		Model 4 (model 3 + presentation features)	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Mortality										
Non-Hispanic White	Reference	<0.0001	Reference	0.1618	Reference	0.0908	Reference	0.0907	Reference	0.1414
Black	0.69 (0.58–0.81)		1.01 (0.85–1.20)		0.95 (0.79–1.15)		0.90 (0.74–1.10)		0.93 (0.76–1.14)	
Hispanic	0.54 (0.46–0.64)		0.87 (0.73–1.04)		0.82 (0.68–1.00)		0.88 (0.72–1.08)		0.90 (0.73–1.11)	
Asian/Pacific Islander	0.92 (0.70–1.19)		1.17 (0.88–1.55)		1.16 (0.86–1.55)		1.29 (0.96–1.75)		1.31 (0.96–1.80)	
Major adverse cardiovascular events*										
Non-Hispanic White	Reference	<0.0001	Reference	0.0344	Reference	0.0278	Reference	0.0891	Reference	0.1094
Black	0.72 (0.62–0.84)		1.04 (0.88–1.22)		1.00 (0.84–1.19)		0.96 (0.80–1.16)		0.99 (0.82–1.20)	
Hispanic	0.53 (0.45–0.62)		0.83 (0.70–0.99)		0.80 (0.67–0.96)		0.87 (0.72–1.06)		0.88 (0.72–1.08)	
Asian/Pacific Islander	0.90 (0.71–1.16)		1.14 (0.87–1.48)		1.12 (0.85–1.48)		1.27 (0.95–1.68)		1.28 (0.95–1.72)	
COVID-19 disease severity†										
Non-Hispanic White	Reference	<0.0001	Reference	0.0061	Reference	0.0046	Reference	0.0003	Reference	0.0009
Black	0.76 (0.67–0.87)		0.96 (0.83–1.10)		0.93 (0.80–1.09)		0.89 (0.76–1.04)		0.90 (0.76–1.06)	
Hispanic	0.63 (0.55–0.73)		0.87 (0.76–1.01)		0.87 (0.74–1.02)		0.93 (0.79–1.10)		0.90 (0.76–1.07)	
Asian/Pacific Islander	1.11 (0.89–1.38)		1.32 (1.05–1.65)		1.34 (1.06–1.68)		1.52 (1.20–1.93)		1.48 (1.16–1.90)	

COVID-19 indicates coronavirus disease 2019; and OR, odds ratio.

*Death, myocardial infarction, stroke, heart failure.

†COVID-19 cardiorespiratory ordinal severity score: death, cardiac arrest, mechanical ventilation with mechanical circulatory support, mechanical ventilation with vasopressors/inotrope support, mechanical ventilation without requiring hemodynamic support, and hospitalization without any of the preceding.

health services are underused among Asian immigrant populations, which may be influenced by acculturation and experiences of discrimination, in particular, during the COVID-19 pandemic.^{28,29}

During this earlier phase of the pandemic, hydroxychloroquine use rates were >40% across all racial/ethnic groups. Remdesivir use rates were low overall and were lower among Black patients despite greater need for mechanical ventilation. This may be explained by more advanced kidney disease and lower rates of clinical trial participation seen in this population. It will be imperative to carefully evaluate and ensure that emerging evidence-based therapies for COVID-19 are delivered equitably across diverse populations.

The overall rate of MACE in our study was 21.4%, driven largely by the high mortality rate. The 18% mortality rate observed in our study is consistent with other US studies from early in the pandemic.^{30,31} Mortality rates appeared to decline over time, because hospitals were better equipped to deal with the pandemic and new ther-

apeutic options became available. The improving trends were consistent among racial/ethnic groups. Contrary to our hypothesis, we found no differences in mortality by race/ethnicity in fully adjusted models. Sensitivity analyses showed similar associations for Black and Hispanic patients and outcomes, regardless of whether modeling accounted for across-hospital and within-hospital effects. Similar to our study, other risk-adjusted single-center reports found no association between race/ethnicity and in-hospital survival. In a large cohort of patients cared for by an integrated-delivery health system in Louisiana, Black race was not independently associated with higher in-hospital mortality.¹ Kabarriti et al³² also found no association between race/ethnicity and survival in a large urban medical center in New York, although this study also included patients who were not hospitalized. The neutral association of race/ethnicity with hospital outcomes must be viewed in the context of the marked overrepresentation of Black race and Hispanic ethnicity among consecutive hospitalized patients captured in this

registry. Despite similar comparative outcomes, Black and Hispanic patients comprised more than half of the in-hospital COVID-19 mortality and morbidity.

Our study also provided evidence that the hospital at which the patient was treated contributed significantly to the variation in the odds of poor outcomes. Our results suggest that where a patient was treated explained more of the variation in odds of mortality than race/ethnicity in and of itself. Early in a new pandemic, we expected significant interhospital practice variation in the absence of solid treatment evidence. We also observed significant variation in the proportion of Black and Hispanic patients with COVID-19 treated at each hospital. Our findings of similar risk-adjusted outcomes by race/ethnicity suggests that racial/ethnic differences in age, demographics, and clinical characteristics at hospital presentation all contribute to the differences in observed clinical outcomes. We still need to address the important disparities contributing to higher COVID-19 burden upstream of hospitalization, and potential interhospital care differences, as well, that might be related to the proportion of non-White patients served at each hospital.

Our study should be interpreted in the context of several limitations. First, this study describes racial/ethnic differences in treatment and outcomes among patients hospitalized with COVID-19, not all patients with COVID-19. Patients may have died or experienced nonfatal events without seeking hospital-based medical care, and racial/ethnic disparities in care-seeking behavior have been described previously.^{33,34} Second, the 88 hospitals enrolled in this registry overrepresent academic hospitals in urban communities with concentrations in certain geographic regions such as the Northeast and South, areas that were initially hard hit by the pandemic. It is possible that patients treated at these institutions (that volunteered to be part of a quality improvement registry) receive different care and have different outcomes than those treated at other hospitals. Third, race/ethnicity was not recorded in 8% of individuals. Fourth, sociodemographic factors were extracted from the American Community Survey based on patient zip code data and do not fully account for individual patient factors. Fifth, because this was an observational quality improvement registry, not all patients underwent all laboratory and testing procedures, and clinical outcomes were not independently validated. Last, as with all ongoing registries, incomplete and nonconsecutive data entry may result in a biased study sample, but we expect this to be nondifferential by race/ethnicity.

CONCLUSION

Hispanic and Black patients comprised more than half of the patients hospitalized with COVID-19. Although substantially younger than non-Hispanic White patients,

Hispanic and Black patients more often had lower socioeconomic status and differences in COVID-19 diagnosis and presentation characteristics. After adjustment for demographic and clinical characteristics, no racial/ethnic differences were observed for in-hospital mortality and MACE. Asian patients had the highest risk of cardiorespiratory COVID-19 disease severity. However, overall mortality was high at 18.4%, and Black and Hispanic patients bore a greater burden of the mortality and morbidity because of their disproportionate representation among COVID-19 hospitalizations.

ARTICLE INFORMATION

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Supplemental Materials

Data Supplement Tables I–III
Data Supplement Figures I and II

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