Racial and Ethnic Differences and Clinical Outcomes of COVID-19 Patients Presenting to the Emergency Department

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Summary – Blacks and Hispanics comprised 60.3% of COVID-19 emergency department patients. Compared to Whites, hospitalization risks were similar between racial/ethnic groups. In-hospital mortality risk was higher in Blacks and Hispanics compared to Whites.

Abstract

Background – Since the introduction of remdesivir and dexamethasone for severe COVID-19 treatment, few large multi-hospital system US studies have described clinical characteristics and outcomes of minority COVID-19 patients who present to the emergency department (ED).

Methods – This cohort study from the Cerner Real World Database (87 US health systems) from December 1, 2019 to September 30, 2020 included PCR-confirmed COVID-19 patients who self-identified as non-Hispanic Black (Black), Hispanic White (Hispanic), or non-Hispanic White (White). The main outcome was hospitalization among ED patients. Secondary outcomes included mechanical ventilation, intensive care unit care, and in-hospital mortality. Descriptive statistics and Poisson regression compared sociodemographics, comorbidities, receipt of remdesivir, receipt of dexamethasone, and outcomes by racial/ethnic groups and geographic region.

Results – 94,683 COVID-19 patients presented to the ED. Blacks comprised 26.7% and Hispanics 33.6%. Nearly half (45.1%) of ED patients presented to hospitals in the South. 31.4% (n=29,687) were hospitalized. Lower proportions of Blacks were prescribed dexamethasone (29.4%; n=7,426) compared to Hispanics (40.9%; n=13,021) and Whites (37.5%; n=14,088). Hospitalization risks, compared to Whites, were similar in Blacks (Risk Ratio (RR)=0.94; 95% CI:0.82, 1.08; p=0.4)) and Hispanics RR=0.99 (95% CI:0.81, 1.21; p=0.91), but risk of in-hospital mortality was higher in Blacks, RR=1.18 (95% CI:1.06, 1.31; p=0.002) and Hispanics, RR=1.28 (95% CI: 1.13, 1.44; p < 0.001).

Conclusions – Minority patients were overrepresented among COVID-19 ED patients, and while they had similar risks of hospitalization as Whites, in-hospital mortality risk was higher. Interventions targeting upstream social determinants of health are needed to reduce racial/ethnic disparities in COVID-19.

Key Words - COVID-19, race, ethnicity, disparities, emergency department

Introduction

The United States (US) currently leads the world in confirmed COVID-19 cases and deaths[1] and the pandemic has disproportionately affected non-Hispanic Black (Black) and Hispanic White (Hispanic) communities [2-15]. Black people make up 13.4% of the US population [16], however have a 1.1x rate ratio of COVID-19 cases, 2.9x rate ratio of hospitalization, and 1.9x death rate ratio compared to non-Hispanic White (White) persons [4]. Hispanics make up 18.5% of the US population and their rate ratios of COVID-19 cases, hospitalization, and death are 1.3x, 3.2x, and 2.3x, respectivey [4]. Black and Hispanic persons are also overrepresented in several cohorts of hospitalized patients [2,3,7,10].

Well-established social determinants of health, health inequities, and structural racism place many minority patients at risk of contracting COVID-19 [4]. Social determinants of health, including decreased access to healthcare, increased occupational exposure to COVID-19 (e.g. essential and frontline workers), and low socioeconomic status are all risk factors for acquisition of COVID-19 in these communities [4]. Black Americans are also overrepresented in essential health care services including hospital food service workers, home health aides, and nursing home staff [17]. Many frontline jobs and jobs in the service industry, including employment at grocery stores, public transportation, and other essential service industries, increase the risk of exposure and disease burden [18,19]. Black Americans are more likely to live in housing settings that limit the ability to social distance due to crowded settings and it has been proposed that links between COVID-19 severity and disparate air pollution exposure may contribute to the disproportionate impact of COVID-19 on inner-city racial minorities [20].

Both Hispanic and Black persons with COVID-19 have increased rate ratios of death compared to Whites [4]. These disparities in mortality are also noted in rural communities. One study found that when 20 rural counties with the highest mortality were stratified in quartiles by percentage of racial/ethnic minorities, Black race was noted to have average

daily COVID-19 average daily death increases that were 70% higher in the top quartile than the bottom quartile [21,22].

Prior studies document racial and ethnic disparities in COVID-19 incidence and mortality, however many are limited to single center studies and few, if any, have reported on disparities by US geographic region with a focus on COVID-19 patients who present to the emergency department (ED). In addition, while several studies have noted similar, or lower, in-hospital mortality in Blacks compared to Whites [10,23,24], these studies were conducted prior to the widespread use of dexamethasone and remdesivir. Dexamethasone offers mortality benefit in hospitalized patients with severe COVID-19 and remdesivir decreases median time to recovery from 15 days to 10 days [25,26]. On May 1, 2020, the Food and Drug Administration (FDA) issued an Emergency Use Authorization for remdesivir for the treatment of severe COVID-19 in hospitalized patients and the RECOVERY trial preliminary results noting mortality benefits with dexamethasone were published in July 2020[26,27]. As effective treatments become more widespread, the potential for disparity in outcomes increases if these treatments are not equitably available across social groups.

The purpose of this study is to evaluate differences in hospitalization of patients who present to the ED and differences in clinical outcomes between COVID-19 Black, White, and Hispanic White (Hispanic) patients hospitalized from the ED.

Methods

Source population

The source population for this study came from the Cerner Real World Data COVID database from 12/01/2019 and included follow-up data through 09/30/2020. Cerner Real World Data (CRWD) was extracted from the electronic medical records of patients who presented to 87 contributing health systems across the US in which Cerner has a data use agreement. Encounter information included in the Cerner database include clinical, microbiology, laboratory, admission, and billing information from affiliated patient care locations. All admissions, laboratory orders and specimens are date and time stamped, providing a temporal relationship between treatment patterns and clinical information. Cerner Corporation has established Health Insurance Portability and Accountability Act-compliant operating policies to establish de-identification for CRWD; no hospital identifiers are available within the database.

Patients were included in the study population if they met the following criteria: a) had an ED visit defined by encounter or admission type, b) were 18 years of age or older, and c) had a PCR-positive COVID-19 test result. A total of 607,669 subjects were in the original source population. After exclusion of patients who were outpatient or urgent care patients (n=69,610), those with negative COVID-19 test results (n=339,205) and other racial groups except Black, Hispanic, and White (n=44,171), the final analytic cohort consisted of 94,663 patients and, of these, 29,667 were hospitalized (Figure 1).

Definition of variables

The main outcome variable was hospitalization among ED patients. Among hospitalized patients, three clinical outcomes were assessed: requirement of mechanical ventilation, necessity of ICU care (mechanical ventilation and/or vasopressor/inotropic support), and in-hospital mortality. The main exposure variable of interest was race/ethnicity categorized as Black, Hispanic, or White and was considered a social, rather than biologic, construct. ICD-10 codes were used to define comorbidities and procedure types (see appendix). To be regarded as requiring ICU care, a patient had to meet one of the following two criteria: a) intravenous receipt of vasopressors (norepinephrine, epinephrine, vasopressin, phenylephrine, or dopamine) or inotropes (dobutamine or milrinone); or b) underwent mechanical ventilation (identified by use of procedure codes). Health insurance was categorized into the following groups: Medicare, Medicaid, private insurance, uninsured, other or unknown. Patient US geographic region was categorized in the following US Census groups based on first digit of zip codes: Northeast (0, 1); South (2, 3 and 7); Midwest (4, 5, and 6) and West (8 and 9). Binary indicator variables for major comorbidities at the time of the clinical encounter were created including hypertension, diabetes, obesity, morbid obesity, congestive heart failure, coronary artery disease, chronic kidney disease, end stage renal disease, liver disease, asthma, chronic obstructive pulmonary disease, obstructive sleep apnea, cancer, prior recipient of a transplant, and human immunodeficiency virus. Medications to treat COVID-19, including remdesivir and dexamethasone, were measured during their hospital encounter and characterized by ever versus never use.

Statistical analysis

Descriptive statistics (mean/interquartile range for continuous variables, counts/percentages for categorical variables) of demographics, comorbidities, health insurance, and other clinical information were provided by racial/ethnic groups (Black, Hispanic, and White) and US geographic region (Northeast, South, Midwest, and West). Bivariate associations between race and outcomes of interest, including need for mechanical ventilation, necessity of ICU care, and in-hospital mortality were examined. Zip code data was missing in 216 patients (1.21%), health insurance status in 32 patients (0.03%) and comorbidities in 142 patients (0.79%). Since the missing data rate was low, a complete case analysis was conducted and patients with missing information were excluded in multivariable analyses.

Robust Poisson regression using general estimation equation and clustered by health system was used to estimate the association of race/ethnicity with hospital admission and death counts during hospitalization, adjusting for demographic, clinical characteristics and/or major comorbidities, and health insurance as potential confounding variables, and stratified by geographic region (Tables 2 and 3). In the case of non-rare outcomes, logistic model regression will overestimate the risk ratio (RR). Thus, robust Poisson modeling was performed, where the Poisson model incorporated robust estimation of standard errors to allow for mild violation of the distribution assumption that the variance equals the mean. Simulation studies have shown the efficacy of robust Poisson model in analyzing count data [28]. All analyses were performed using Python 3.6.8.

Results

Characteristics of the Study Population

Baseline characteristics of COVID-19 patients who visited the emergency department by race/ethnicity and geographic region

Race and Ethnicity

Among the 94,683 COVID-19 positive ED patients, 52.3% were women and the median age at encounter was 53 years old (yo) (IQR: 36-68). Blacks comprised 26.7%, Hispanics comprised 33.6%, and Whites 39.7% of this cohort. The largest age group (representing 40.7% of the population) was 40-64 yo. White patients were older, with an average age at encounter of 59 yo, compared to Hispanics of 48 yo and Blacks 51 yo. This age difference was also reflected in the different age quartiles by race/ethnicity: the 80+ age group constituted 14.2% of the White cohort, while only 6.3% of Hispanics and 5.7% of Blacks (Table 1).

Uninsured patients comprised 12.3% (n=11,687) of patients. Among the 60.6% (n=57,340) of those who were insured, most had private insurance (27.2%; n=25,750)). There were racial/ethnic differences in the distribution of health insurance: 43.0% of Hispanics (n=13,684), 68.5% of Blacks (n=17,313), and 70.0% of Whites were insured. A total of 33.4% (n=12,558) of White patients who presented to the ED had Medicare compared to 24.5% (n = 6,193) of Blacks and 9.4% (n=2,996) of Hispanics. The proportion of uninsured status was highest in Hispanics patients, with 16.9% without insurance (n=5,383) compared to 12.8% (n=3,236) in Blacks and 8.2% (n=3,068) among Whites. Lower proportions of Blacks were prescribed dexamethasone (29.4%; n=7,426) compared to Hispanics (40.9%;

n=13,021) and Whites (37.5%; n=14,088). Lower proportions of Blacks were prescribed remdesivir (8.9%; n=2,259) compared to Hispanics (15.0%; n=4,774) and Whites (12.7%; n=4,775) (Table 1).

Geographic Region

The ED cohort was comprised primarily of patients in the South (45.1%; n=42,705), followed by the West (23.31%, n= 21,923), Northeast (20.9%, n=19,773), and Midwest (10.9%; n=10,282) (Table 1). The leading comorbidities in the ED cohort were hypertension (51.9%), diabetes (31.6%), and obesity (26.8%), and the three most prevalent comorbidities in each race/ethnicity group were also hypertension, diabetes, and obesity. Notable differences were found in the composition of patients by race/ethnicity by geographic region (Supplemental Table 1). Blacks and Hispanics, combined, comprised only 29.4% (n=3024) of patients presenting to Midwestern EDs compared to 71.1% (n=30,358) of Southern EDs.

Baseline characteristics of COVID-19 hospitalized patients by race/ethnicity and geographic region

Race and Ethnicity

Compared to the ED cohort which was comprised of predominantly women (52.3%), the hospitalized cohort was comprised of 52.9% men. The hospitalized cohort was older, with a median age at encounter of 63 yo (IQR: 50-75), with higher proportions of White patients (44.7%; n=13,262) and lower proportions of Hispanic patients (26.3% (n=7803) (Supplemental Table 2). Similarly, the three most common comorbidities of the hospitalized cohort were hypertension, diabetes, and obesity.

Geographic region

Similar to ED patients, patients admitted to hospitals in the South comprised the largest proportion of the cohort at (40.4% (n=11,980), followed by the Northeast at 27.3% (n=8,118), the West 20.4% (n= 6,067), and the Midwest at 11.9% (n =3,522). (Supplemental Table 2). There were low proportions of uninsured patients in each region - South 6.3% (n=754), West 6.7% (n=404), Midwest 7.0% (n=245), and Northeast 8.8% (n=716). Of the patients with health insurance, most in each region were insured via Medicare. Similar to the ED cohort, the most common comorbidities among hospitalized patients in each geographic region were hypertension, diabetes, and obesity (Supplemental Table 2).

Incidence of Outcomes

Incidence of hospitalization of COVID-19 positive ED patients by race/ethnicity and geographic region

Of 94,683 patients who presented to the ED, 31.4% (29,687) were hospitalized. Compared to Whites, overall hospitalization risks were similar in Blacks (RR=0.94; 95%CI:0.82, 1.08; p=0.4) and Hispanics (RR=0.99 (95% CI:0.81, 1.21; p=0.91), after adjusting for demographics, insurance, and comorbidities (Table 2). One notable exception was in the Midwest where Hispanics and Blacks had higher RR of hospitalization when adjusted for the same factors (Hispanics RR=1.78 (95% CI:1.37, 2.31; p <0.001) and Blacks RR=1.26 (95% CI:1.0, 1.58; p = 0.048). After adjustment, there was an increased RR of hospitalization with increasing age in each geographic region - Midwest RR=1.03 (95% CI:1.03, 1.03), Northeast RR=1.02 (95% CI:1.02, 1.03), South RR=1.02 (95% CI:1.02, 1.03), and West RR=1.02 (95% CI:1.02, 1.03) (each p < 0.001). Patients with diabetes and end stage renal disease had increased risks of hospitalization in each region when adjusted for demographics, insurance and comorbidities (Table 2).

Incidence of clinical outcomes among COVID-19 hospitalized patients by race/ethnicity and geographic region

Mechanical ventilation was initiated in 14.6% (n=4,348) of hospitalized COVID-19 patients. (Table 3). Over one third (38.9%; n=11,546) of the hospitalized cohort required ICU care. Overall in-hospital mortality among hospitalized patients was 17.5% (n=5,181) (Table 3). Compared to Whites, both Hispanics and Blacks had overall increased RR of in-hospital mortality, RR=1.28 (95% CI:1.13, 1.44; p < 0.001) and RR=1.18 (95% CI:1.06, 1.31; p = 0.002), respectively, and this finding was observed in each geographic region. In the overall cohort of hospitalized patients, older age, male sex, diabetes, chronic kidney disease and end stage renal disease each increased RR of in-hospital mortality (Table 4). Time spent in the ICU notably had the following RR of death by geographic region - Midwest RR=3.77 (95% CI:2.78, 5.12; p < 0.001), Northeast RR=5.15 (95% CI:2.25, 11.79), South RR=4.59 (95% CI:3.32, 6.34), and West RR=5.57 (95% CI:4.28, 7.24) (p < 0.001 in each region). Dexamethasone was associated with an decreased RR of in-hospital mortality (RR=0.81 (95% CI: 0.72, 0.9; p <0.001)) (Table 4).

Discussion

Black and Hispanic patients comprised nearly two-thirds (60.3%) of all patients in this cohort who presented to the ED with COVID-19, which is a substantial overrepresentation compared to the general population of Blacks (13.4%) and Hispanics (18.5%) in the US [16]. While our study did not find that Black or Hispanic patients had higher risk of hospitalization, we did observe increased in-hospital mortality compared to Whites.

The overrepresentation of Black and Hispanic patients in this study suggests that COVID-19 racial disparities are due to higher risk for exposure due to social, rather than biologic factors. Social determinants of health that contribute to these disparities include economic

instability, lack of access to education, healthcare inequities, the patients' neighborhood, and their social and community support [29]. For example, minorities are known to be at increased risk of contracting COVID-19 and those living in low-income households are at higher risk, with these disparities extending across age groups [30]. A US community survey (2014-2018), found that minority populations are overrepresented in frontline industry jobs and that 41.2% of frontline workers are Hispanic, Black, Asian-American/Pacific Islander, or do not identify as White[31]. They are also overrepresented in occupations including transit and intercity bus drivers, childcare workers, and building cleaning services [31]. Of the top 10 healthcare occupations (except physicians, registered nurses, managers, secretaries and administrative staff), minorities are overrepresented and 10% of frontline workers are uninsured [31]. In our study, we observed a higher proportion of uninsured patients in the ED cohort compared to the hospitalized cohort. These results suggest that to decrease racial/ethnic disparities in COVID-19, a focus on addressing social determinants of health that put minorities at risk for infection should aid in decreasing racial/ethnic disparities found in COVID-19.

Data from public health agencies have noted increased death rate ratios among minority patient populations [4]. Notably, we observed that minorities were less likely to be treated with dexamethasone and remdesivir compared to White patients with COVID-19. While many studies have not noted increased mortality in Black cohorts, many were performed before effective therapeutics, including dexamethasone and remdesivir, were recommended for the treatment of severe COVID-19 [3,10,23,24]. The mortality and death rate differences noted in these studies may be due, in part, to differing social determinants of health, community-level factors, and differences in treatment options available at the time of individual studies [32]. This finding is consistent with fundamental cause theory, which posits that racial and socioeconomic disparities in mortality occur when the benefits of medical advances are distributed according to social resources [33]. Examples of this theory in action include the emergence of racial disparities in cancer mortality for cancers with effective

screening or treatments [34] and the reversal of the income gradient in cholesterol after the introduction of statins [35]. As treatments for COVID-19 continue to advance, special attention must be paid to ensuring equity in treatment decisions to avoid exacerbating racial disparities.

A higher proportion of uninsured patients were noted in the ED cohort (12.3%) compared to the hospitalized cohort (7.1%) (Table 1; Supplementary Table 2). One explanation may be due to the ability to pay, however another explanation is that the population of ED patients who are uninsured are younger (thus less likely to be hospitalized) and that age is an important confounder of this relationship. This is supported by our data, where 14.2% of White patients were 80+ years versus, approximately, 6% for Hispanic and Black patients. Large national data sources report that uninsured patients are less likely to have inpatient hospital admissions – 3% of uninsured adults were hospitalized compared to 7.6% insured, 16% publicly insured, and 16.9% of adults on Medicaid in these large cohorts [36].

White patients who presented to the ED were older, with a median age of 59 yo [IQR 42-73] compared to 51 yo in Black [IQR 34-64], and 48 yo in Hispanic [IQR 36-68] patients. Increasing age was associated with increased hospitalization in each region, therefore the contribution of age as the reason for increased hospitalization in the White population is a consideration. However, the influence of implicit bias (favoring Whites) with respects to which patients are more likely to be hospitalized once they present to the ED warrants further exploration. Many studies have demonstrated implicit racial/ethnic bias (favoring Whites) among healthcare professionals [37,38]. One systematic review of 15 studies found that implicit racial/ethnic bias was found in low to moderate levels in all but one of the studies and, though some associations between health care outcomes and implicit bias were not significant, significant implicit bias was shown in patient-provider interactions and treatment decisions [38]. The race and ethnicity of the clinicians caring for these patients is unknown, thus the effect of clinician racial concordance on patient outcomes is not known.

Given the disproportionate effect that of COVID-19 on minority populations, interventions are required to mitigate these disparities. Action items that should be considered include funding community programs to enhance neighborhood stability, instituting policies to increase economic empowerment in minority communities, unemployment insurance reform to allow frontline workers to socially distance and stay home, cultural competency training among providers to ensure equitability in access to treatments and care, increasing community based participatory research engagement, changing policies that keep structural racism in place and consistency in efforts by the healthcare systems to build trust in vulnerable communities [39,40].

Limitations of this study included unmeasured confounding, both at the hospital system and the US geographic region level. Factors that may influence hospitalization and clinical outcomes may include, but are not limited to, hospital admission protocols, COVID-19 treatment protocols, access to emergency use authorized drugs and clinical trials, community COVID-19 spread, community mitigation efforts, and whether the hospital systems were located in a rural or urban community. We also do not know the underlying population of patients at risk for COVID-19 within (and beyond) each larger geographic region and this study also does not capture deaths outside of the hospital. Furthermore, the data from Cerner does not detail identifiable hospital information, and there are likely unmeasured hospital-level characteristics that influence outcomes. Due to blinding of participating health systems, it is unknown the extent to which these results are generalizable to all hospitals and patient populations across the US.

In conclusion, this study found that racial and ethnic minority patients were overrepresented among COVID-19 patients presenting to the ED, and while racial/ethnic minorities experienced similar risks of hospitalization, there was an increased risk of in-hospital mortality in Black and Hispanic patients when compared to White patients. Interventions to impact racial and ethnic disparities in COVID-19 (and beyond) are required to improve care upon arrival to the emergency department, care once hospitalized, and upstream effects of social determinants of health.

NOTES

Acknowledgements

The authors acknowledge the Cerner Learning Health Network HealtheDataLab™ for providing the data, and the Emory Health Services Research Center in the Emory University School of Medicine Department of Medicine and Department of Surgery for resources to support analyst time and effort to complete the study.

Funding

This work was not supported by grant funding.

Conflicts of Interest

There are no conflicts of interest to report from any of the authors.

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Figure 1. Flow diagram of study cohort inclusion

Table 1. Baseline Characteristics by Race/Ethnicity among COVID-19 Patients who Visited an Emergency Department, 12/01/2019-09/30/2020 (n = 94,683)

	Total (n=94,683)	**Hispanic (n=31,835)**	**Black (n=25,292)**	**White (n=37,556)**
Male, n (%)	45,172 (47.7%)	15,361 (48.3%)	11,198 (44.3%)	18,613 (49.6%)
Age at Encounter (years), Median (IQR)	53.0 (36.0-68.0)	48.0 (33.0-62.0)	51.0 (34.0-64.0)	59.0 (42.0-73.0)
Age Category (years)				
18-39	27,997 (29.6%)	11,350 (35.7%)	8,239 (32.6%)	8,408 (22.4%)
40-64	38,489 (40.7%)	13,547 (42.6%)	10,914 (43.2%)	14,028 (37.4%)
65-79	19,386 (20.5%)	4,927 (15.5%)	4,688 (18.5%)	9,771 (26.0%)
80+	8,811 (9.3%)	2,011 (6.3%)	1,451 (5.7%)	5,349 (14.2%)
Health Insurance				
Medicare	21,747 (23.0%)	2,996 (9.4%)	6,193 (24.5%)	12,558 (33.4%)
Medicaid	9,843 (10.4%)	2,790 (8.8%)	4,513 (17.8%)	2,540 (6.8%)
Private	25,750 (27.2%)	7,898 (24.8%)	6,607 (26.1%)	11,245 (29.9%)
Uninsured	11,687 (12.3%)	5,383 (16.9%)	3,236 (12.8%)	3,068 (8.2%)
Other	3,446 (3.6%)	1,140 (3.6%)	739 (2.9%)	1,567 (4.2%)
Unknown	22,178 (23.4%)	11,621 (36.5%)	3,999 (15.8%)	6,558 (17.5%)
Geographic Region of Hospital				
Northeast	19,773 (20.9%)	6,140 (19.3%)	4,997 (19.8%)	8,636 (23.0%)
South	42,705 (45.1%)	15,191 (47.7%)	15,167 (60.0%)	12,347 (32.9%)

Midwest	10,282 (10.9%)	714 (2.2%)	2,310 (9.1%)	7,258 (19.3%)
West	21,923 (23.2%)	9,790 (30.8%)	2,818 (11.1%)	9,315 (24.8%)
Clinical conditions or comorbidities, n (%)				
Hypertension	49,146 (51.9%)	13,928 (43.8%)	14,648 (57.9%)	20,570 (54.8%)
Diabetes	29,953 (31.6%)	10,245 (32.2%)	8,976 (35.5%)	10,732 (28.6%)
Obesity	25,395 (26.8%)	7,822 (24.6%)	8,221 (32.5%)	9,352 (24.9%)
Morbid Obesity	8,697 (9.2%)	2,399 (7.5%)	3,188 (12.6%)	3,110 (8.3%)
Congestive heart failure	12,866 (13.6%)	2,624 (8.2%)	3,838 (15.2%)	6,404 (17.1%)
Coronary artery disease	7,367 (7.8%)	1,727 (5.4%)	1,970 (7.8%)	3,670 (9.8%)
Chronic kidney disease	8,993 (9.5%)	1,788 (5.6%)	2,982 (11.8%)	4,223 (11.2%)
End stage renal disease	3,435 (3.6%)	976 (3.1%)	1,595 (6.3%)	864 (2.3%)
Liver disease	8,115 (8.6%)	3,266 (10.3%)	1,593 (6.3%)	3,256 (8.7%)
Asthma	16,942 (17.9%)	3,798 (11.9%)	4,934 (19.5%)	8,210 (21.9%)
Chronic obstructive pulmonary disease	6,149 (6.5%)	1,001 (3.1%)	1,358 (5.4%)	3,790 (10.1%)
Obstructive sleep apnea	7,698 (8.1%)	1,373 (4.3%)	2,330 (9.2%)	3,995 (10.6%)
Cancer	5,820 (6.1%)	1,263 (4.0%)	1,469 (5.8%)	3,088 (8.2%)
Prior receipt of a transplant	828 (0.9%)	218 (0.7%)	289 (1.1%)	321 (0.9%)
Human immunodeficiency virus	725 (0.8%)	127 (0.4%)	433 (1.7%)	165 (0.4%)
COVID-19 Targeted Therapy				
Remdesivir	11808 (12.5%)	4774 (15.0%)	2259 (8.9%)	4775 (12.7%)
Dexamethasone	34535 (36.5%)	13021 (40.9%)	7426 (29.4%)	14088 (37.5%)

Table 2: Adjusted Robust Poisson Model of Hospitalization among Emergency Department COVID-19 Patient Visits by US Geographic Region (n = 94,683)

Region	**Overall**	**Overall**	**Midwest**	**Midwest**	**Northeast**	**Northeast**	**South**	**South**	**West**	**West**
Model	RR (95%CI)	P-value	RR (95%CI)	P-value	RR (95%CI)	P-value	RR (95%CI)	P-value	RR (95%CI)	P-value
White	**1.00 (ref.)**		**1.00 (ref.)**		**1.00 (ref.)**		**1.00 (ref.)**		**1.00 (ref.)**	
Hispanic	0.99 (0.81, 1.21)	0.905	1.78 (1.37, 2.31)	<0.001	0.86 (0.84, 0.88)	<0.001	0.97 (0.7, 1.36)	0.873	1.0 (0.91, 1.1)	0.933
Black	0.94 (0.82, 1.08)	0.400	1.26 (1.0, 1.58)	0.048	0.91 (0.79, 1.04)	0.171	0.9 (0.74, 1.1)	0.318	1.14 (1.01, 1.3)	0.039
Medicare	**1.00 (ref.)**		**1.00 (ref.)**		**1.00 (ref.)**		**1.00 (ref.)**		**1.00 (ref.)**	
Medicaid	1.21 (1.01, 1.44)	0.043	1.06 (0.85, 1.31)	0.622	1.06 (0.98, 1.15)	0.130	1.21 (0.83, 1.75)	0.318	1.08 (0.96, 1.22)	0.190
Other	1.08 (0.9, 1.29)	0.426	0.89 (0.78, 1.01)	0.079	0.99 (0.8, 1.24)	0.962	0.98 (0.69, 1.4)	0.909	1.25 (0.97, 1.63)	0.090
Unknown	0.8 (0.52, 1.22)	0.293	0.47 (0.26, 0.85)	0.013	0.9 (0.81, 1.0)	0.052	0.62 (0.28, 1.39)	0.247	0.86 (0.63, 1.16)	0.320

Private	1.2 (1.01, 1.41)	0.038	1.14 (1.01, 1.3)	0.039	1.1 (0.93, 1.29)	0.260	1.26 (0.93, 1.7)	0.140	1.05 (0.97, 1.15)	0.244
Self-Pay	0.87 (0.66, 1.15)	0.337	0.91 (0.8, 1.04)	0.164	0.99 (0.71, 1.39)	0.958	0.68 (0.44, 1.05)	0.078	0.87 (0.69, 1.1)	0.243
Age	1.02 (1.02, 1.03)	<0.001	1.03 (1.02, 1.03)	<0.001	1.02 (1.02, 1.03)	<0.001	1.02 (1.02, 1.03)	<0.001	1.02 (1.02, 1.03)	<0.001
Female	**1.00 (ref.)**		**1.00 (ref.)**		**1.00 (ref.)**		**1.00 (ref.)**		**1.00 (ref.)**	
Male	1.28 (1.24, 1.33)	<0.001	1.26 (1.12, 1.42)	<0.001	1.22 (1.19, 1.25)	<0.001	1.28 (1.19, 1.39)	<0.001	1.32 (1.27, 1.36)	<0.001
Clinical Conditions or Comorbidities										
Hypertension	1.08 (1.0, 1.16)	0.050	1.0 (0.79, 1.26)	0.989	1.2 (1.14, 1.25)	<0.001	1.14 (1.06, 1.23)	<0.001	0.98 (0.94, 1.03)	0.466
Diabetes	1.21 (1.15, 1.28)	<0.001	1.11 (1.04, 1.19)	0.003	1.22 (1.14, 1.31)	<0.001	1.17 (1.09, 1.26)	<0.001	1.27 (1.22, 1.33)	<0.001
CKD	0.98 (0.92, 1.03)	0.360	1.03 (0.91, 1.17)	0.615	0.91 (0.87, 0.96)	<0.001	1.05 (1.0, 1.11)	0.034	0.89 (0.85, 0.93)	<0.001
ESRD	1.38 (1.28, 1.48)	<0.001	1.37 (1.07, 1.75)	0.014	1.38 (1.33, 1.44)	<0.001	1.37 (1.24, 1.51)	<0.001	1.29 (1.18, 1.4)	<0.001

ICU	1.45 (1.37, 1.54)	<0.001	1.3 (1.13, 1.5)	<0.001	1.43 (1.27, 1.6)	<0.001	1.53 (1.41, 1.66)	<0.001	1.43 (1.33, 1.53)	<0.001
COVID-19 Targeted Therapy										
Remdesivir	1.75 (1.49, 2.06)	<0.001	2.1 (1.47, 3.0)	<0.001	1.7 (1.23, 2.35)	0.001	1.85 (1.45, 2.37)	<0.001	1.49 (1.42, 1.56)	<0.001
Dexamethasone	0.81 (0.67, 0.99)	0.037	0.61 (0.39, 0.93)	0.023	0.85 (0.62, 1.16)	0.314	0.81 (0.6, 1.09)	0.165	1.01 (0.83, 1.23)	0.928

Model is clustered by health system (tenant ID) and adjusted for age, sex, health insurance status, hypertension, diabetes, chronic kidney disease (CKD), end-stage renal disease (ESRD) and ICU admission (ICU), remdesivir and dexamethasone.

Table 3: Clinical Outcomes of Hospitalized COVID-19 patients by Race/Ethnicity and US Geographic Region, 12/01/2019-09/30/2020, (n= 29,687)

		Midwest			Northeast			South			West		
	Total (n=94,683)	Hispanic (n=714)	Black (n=2,310)	White (n=7,258)	Hispanic (n=6,140)	Black (n=4,997)	White (n=8,636)	Hispanic (n=15,191)	Black (n=15,167)	White (n=12,347)	Hispanic (n=9,790)	Black (n=2,818)	White (n=9,315)
Hospitalized	29,687 (31.4%)	261 (36.6%)	857 (37.1%)	2,404 (33.1%)	1,819 (29.6%)	2,047 (41.0%)	4,252 (49.2%)	3,478 (22.9%)	4,754 (31.3%)	3,748 (30.4%)	2,245 (22.9%)	964 (34.2%)	2,858 (30.7%)
		Midwest			Northeast			South			West		
	Total (n=29,687)	Hispanic (n=261)	Black (n=857)	White (n=2,404)	Hispanic (n=1,819)	Black (n=2,047)	White (n=4,252)	Hispanic (n=3,478)	Black (n=4,754)	White (n=3,748)	Hispanic (n=2,245)	Black (n=964)	White (n=2,858)
Mechanical Ventilation	4,348 (14.6%)	32 (12.3%)	116 (13.5%)	267 (11.1%)	365 (20.1%)	358 (17.5%)	723 (17.0%)	329(9.5%)	621 (13.1%)	455 (12.1%)	425 (18.9%)	193 (20.0%)	464 (16.2%)
Intensive Care Unit	11,546 (38.9%)	88 (33.7%)	312 (36.4%)	936 (38.9%)	777 (42.7%)	837 (40.9%)	1,693 (39.8%)	1189 (34.2%)	1,956 (41.1%)	1,544 (41.2%)	796 (35.5%)	322 (33.4%)	1,096 (38.3%)
In-Hospital Mortality	5,181 (17.5%)	20 (7.7%)	107 (12.5%)	381 (15.8%)	398 (21.9%)	379 (18.5%)	923 (21.7%)	471 (13.5%)	776 (16.3%)	661 (17.6%)	325 (14.5%)	207 (21.5%)	533 (18.6%)

Table 4: Adjusted Robust Poisson model for in-Hospital Mortality among Hospitalized COVID-19 patients by US Geographic Region (N = 29,687)

Region	Overall	Overall	Midwest	Midwest	Northeast	Northeast	South	South	West	West
Model	**RR (95%CI)**	**P-value**	**RR (95%CI)**	**P-value**	**RR (95%CI)**	**P-value**	**RR (95%CI)**	**P-value**	**RR (95%CI)**	**P-value**
White	**1.00 (ref)**		**1.00 (ref)**		**1.00 (ref)**		**1.00 (ref)**		**1.00 (ref)**	
Hispanic	1.28 (1.13, 1.44)	<0.001	1.42 (0.89, 2.25)	0.137	1.22 (1.07, 1.39)	0.002	1.27 (0.99, 1.64)	0.063	1.15 (1.1, 1.21)	<0.001
Black	1.18 (1.06, 1.31)	0.002	1.38 (1.16, 1.65)	<0.001	1.04 (0.95, 1.13)	0.409	1.2 (0.98, 1.48)	0.081	1.37 (1.06, 1.76)	0.017
Medicare	**1.00 (ref)**		**1.00 (ref)**		**1.00 (ref)**		**1.00 (ref)**		**1.00 (ref)**	
Medicaid	0.92 (0.78, 1.09)	0.337	0.91 (0.47, 1.75)	0.772	0.82 (0.67, 0.99)	0.040	0.8 (0.66, 0.96)	0.020	1.11 (0.87, 1.42)	0.409
Other	1.19 (0.94, 1.5)	0.142	0.54 (0.26, 1.15)	0.111	1.16 (1.03, 1.31)	0.013	1.28 (0.82, 1.99)	0.277	1.15 (0.65, 2.04)	0.631
Unknown	0.95 (0.87, 1.04)	0.233	0.0 (0.0, 0.0)	<0.001	0.93 (0.8, 1.08)	0.324	0.96 (0.86, 1.08)	0.500	0.88 (0.74, 1.05)	0.151
Private	0.8 (0.73, 0.89)	<0.001	0.72 (0.49, 1.06)	0.100	0.94 (0.86, 1.01)	0.106	0.76 (0.65, 0.88)	<0.001	0.82 (0.67, 1.0)	0.056
Self-Pay	0.88 (0.62, 1.25)	0.487	1.02 (0.52, 1.99)	0.952	1.13 (0.95, 1.33)	0.160	0.55 (0.36, 0.83)	0.004	0.67 (0.51, 0.9)	0.007
Age	1.04 (1.03, 1.04)	<0.001	1.06 (1.04, 1.07)	<0.001	1.03 (1.02, 1.05)	<0.001	1.04 (1.03, 1.04)	<0.001	1.04 (1.04, 1.04)	<0.001
Female	**1.00 (ref)**		**1.00 (ref)**		**1.00 (ref)**		**1.00 (ref)**		**1.00 (ref)**	

Male	1.17 (1.09, 1.25)	<0.001	1.23 (1.07, 1.43)	0.004	1.1 (1.01, 1.19)	0.031	1.09 (1.03, 1.16)	0.002	1.34 (1.27, 1.41)	<0.001
Hypertension	0.98 (0.91, 1.06)	0.656	0.69 (0.56, 0.86)	<0.001	0.94 (0.82, 1.08)	0.369	1.0 (0.87, 1.14)	0.965	1.09 (0.98, 1.21)	0.134
Diabetes	1.13 (1.07, 1.2)	<0.001	1.08 (0.82, 1.41)	0.596	1.1 (0.97, 1.24)	0.132	1.17 (1.07, 1.28)	<0.001	1.12 (1.04, 1.19)	0.002
CKD	1.02 (0.94, 1.1)	0.648	1.17 (0.89, 1.54)	0.254	1.01 (0.88, 1.16)	0.859	1.13 (1.05, 1.21)	<0.001	0.87 (0.83, 0.91)	<0.001
ESRD	1.06 (0.94, 1.19)	0.339	0.99 (0.67, 1.46)	0.944	1.03 (0.76, 1.4)	0.839	1.03 (0.9, 1.17)	0.693	1.11 (0.96, 1.29)	0.147
ICU	4.9 (3.65, 6.58)	<0.001	3.77 (2.78, 5.12)	<0.001	5.15 (2.25, 11.79)	<0.001	4.59 (3.32, 6.34)	<0.001	5.57 (4.28, 7.24)	<0.001
COVID-19 Targeted Therapy										
Remdesivir	1.37 (1.16, 1.62)	<0.001	1.3 (0.67, 2.54)	0.441	0.75 (0.59, 0.96)	0.02	1.92 (1.52, 2.43)	<0.001	1.46 (0.96, 2.22)	0.081
Dexamethasone	0.81 (0.72, 0.9)	<0.001	0.68 (0.33, 1.36)	0.273	1.2 (0.94, 1.52)	0.138	0.3 (0.22, 0.41)	<0.001	0.56 (0.43, 0.72)	<0.001

Model is clustered by health system (tenant ID) and adjusted for age, gender, race/ethnicity, health insurance status, hypertension, diabetes, chronic kidney disease (CKD), end-stage renal disease (ESRD) and ICU admission (ICU), Remdesivir and Dexamethasone

Figure 1