Original Report:
COVID-19

Effect of Race and Ethnicity on In-Hospital Mortality in Patients with COVID-19

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Objective: To identify differences in short-term outcomes of patients with coronavirus disease 2019 (COVID-19) according to various racial/ethnic groups.

Design: Analysis of Cerner de-identified COVID-19 dataset.

Setting: A total of 62 health care facilities.

Participants: The cohort included 49,277 adult COVID-19 patients who were hospitalized from December 1, 2019 to November 13, 2020.

Methods: We compared patients' age, gender, individual components of Charlson and Elixhauser comorbidities, medical complications, use of do-not-resuscitate, use of palliative care, and socioeconomic status between various racial and/or ethnic groups. We further compared the rates of in-hospital mortality and non-routine discharges between various racial and/or ethnic groups.

Main Outcome Measures: The primary outcome of interest was in-hospital mortality. The secondary outcome was non-routine discharge (discharge to destinations other than home, such as short-term hospitals or other facilities including intermediate care and skilled nursing homes).

Results: Compared with White patients, in-hospital mortality was significantly higher among African American (OR 1.5; 95%CI:1.3-1.6, P<.001), Hispanic (OR1.4; 95%CI:1.3-1.6, P<.001), and Asian or Pacific Islander (OR 1.5; 95%CI: 1.1-1.9, P=.002) patients after adjustment for age and gender, Elixhauser comorbidities, do-not-resuscitate status, palliative care use, and socioeconomic status.

Conclusions: Our study found that, among hospitalized patients with COVID-2019, African American, Hispanic, and Asian or Pacific Islander patients had increased mortality compared with White patients after adjusting for sociodemographic factors, comorbidities, and do-not-resuscitate/palliative care status. Our findings add additional perspective to other recent studies. *Ethn Dis*. 2021;31(3):389-398; doi:10.18865/ed.31.3.389

Keywords: Race; Ethnicity; Disparities; Coronavirus Disease; Mortality; Outcomes

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Introduction

The National Healthcare Disparities Report (NHDR)[1] identified disparities related to race and ethnicity in all eight priority areas of health care. Reducing and eliminating health disparities among Americans has been a priority of the Healthy People Initiative by the United States (US) Department of Health and Human Services (DHHS).[2] Reports from the National Institutes of Health and the Institute of Medicine highlight the premature loss of life, increased burden of disease, and financial cost of health disparities[3,4] that are expected to be further exacerbated due to the coronavirus disease 2019 (COVID-19) pandemic. At the start of the COVID-19 pandemic, troubling disease patterns emerged among racial and minority groups who formed almost 33% of the US population being disproportionately affected.[5,6] The Centers for Disease Control and Prevention (CDC) reported that death rates among patients with COVID-19, were, compared with Whites, higher in African Americans (2.1 times), Hispanics (1.1 times), and American Indians or Alaskan Natives (1.4 times).[7]

Most US COVID-19 studies have been localized to specific cities

or states and much of the national-level data aggregates these local and state data sent to the CDC. With the initial pandemic data showing racial disparities, further studies were conducted to adjust for comorbidities, socioeconomic status, and geography. An integrated-delivery health system in New Orleans found that while African American patients had higher prevalence of certain comorbidities, once those comorbidities were adjusted for, there was no independent association between race and in-hospital mortality.[5] A multi-center study that included 92 hospitals in 12 states found no statistically significant difference in risk for mortality after adjustment for age, sex, insurance, comorbidities, neighborhood deprivation, and site for care.[8] Currently, it remains unclear whether racial or ethnic differences in COVID-19-associated mortality exists and there is a lack of understanding of factors that determine such differences. Such gaps in information prevent identification and implementation of targeted strategies to reduce COVID-19-associated mortality.

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The goals of our study were to: 1) quantitate racial or ethnic differences in COVID-19-associated mortality in US adults; 2) examine the extent to which socioeconomic status and use of do-not-resuscitate (DNR) and palliative care impact the mortality differences across groups; and 3) utilize findings to guide the policy by identifying appropriate interventions to eliminate racial/ethnic disparities in COVID-19-associated mortality. We conducted the study using a large cohort representative of the United States to analyze demographic and clinical characteristics, comorbidities, and outcomes in various racial and ethnic groups to identify possible associations between race or ethnicity and COVID-19 outcomes.

Methods

Patients

We analyzed the data from the Cerner de-identified COVID-19 dataset, a subset of Cerner Real-World Data extracted from the electronic medical records of health care facilities that have a data use agreement with Cerner Corporation.[9,10] The COVID-19 deidentified dataset is available through Cerner Corporation and includes data for patients who qualified for inclusion based on the following criteria: 1) Patient had a minimum of one emergency department or inpatient encounter with a diagnosis code (detailed list of 86 codes provided in previous publication[11]) that could be associated with COVID-19 exposure or infection; or 2) Patient had a minimum of one emergency department or inpatient encounter with a positive laboratory test for COVID-19.

The methodological aspects of the patient-level dataset have been published previously.[11] The Cerner Real World Data-COVID-2020 Q3's version of the data included data from 62 contributing Cerner Real-World Data health systems that had 490,373 qualifying patients. The data are based on electronic medical encounters between December 1, 2019 to November 13, 2020. Each patient has a unique identifier but as part of de-identification procedure, the data do not have an identifier for the medical institution of a patient's data or its precise location (for de-identification). Our analysis included only hospitalized patients, between December 1, 2019 to November 13, 2020, with prior medical history from the past five years available to ensure completeness of the records of potential comorbidities. Patients with some prior medical history constituted approximately 76% of the total cohort.

As previously described,[11] patients with a positive laboratory test for SARS-CoV-2 were identified based on Logical Observation Identifiers Names and Codes (*LOINC*®) 41458-1, 94309-2, 94500-6, 94533-7, 94534-5, and 94646-7. These codes denote detection of SARS-CoV-2 ribonucleic acid in respiratory (nasopharyngeal swabs, bronchoalveolar lavage, sputum) and other specimens or detection of SARS-CoV-2 N gene or RdRp gene in respiratory

Table 1. Definitions used to define Elixhauser medical co-morbidities, and use of DNR and palliative care

Variables	ICD-10-CM code
Elixhauser Component Comorbidities	
Paralysis	G04.1, G80.0-G80.2, G80.4-G80.9, G81-G83, I69, R53.2
Other neurologic disorders	E75.0, E75.1, E75.23, E75.25, E75.29, E75.4, F84.2, G10-G13, G20, G21.4, G24.0, G24.2, G24.8, G25.4, G25.5, G25.81, G30-G32, G35-G37, G40, G47.4, G80.3, G89.0, G91, G93.7, G93.89, G93.9, G94, O99.35, P91.6, R41.0, R41.82, R47.01, R56
Alcohol abuse	F10
Drug abuse	F11-F16, F18-F19, F55, O99.32
Psychoses	F20, F22-F25, F28-F31, F32.4, F32.5, F33.4, F34.8, F34.9, F39, F44.89, F84.3
Depression	F32, F33, F34.1, F43.21
Congestive heart failure	I09.81, I50
Peripheral vascular disease	I70, I71, I72.0-I72.4, I72.8, I72.9, I73.1, I73.8-I73.9, I74.2-I74.4, I76, I77.1, I77.71-I77.74, I77.79, I79, K55.1, K55.8-K55.9, Z95.8, Z95.9
Valvular heart disease	A52.03, I05-I08, I09.1, I09.89, I34-I39, Q23.0-Q23.3, Z95.2-Z95.4
Hypertension	I10, O10.0, O10.9, I16, I67.4
Chronic pulmonary disease	J40~J47, J60~J67, J68.4
Pulmonary circulation disorders	I26, I27, I28.9, T80.0XXA, T82.817A, T82.818A
Peptic ulcer disease	K25-K28
Liver disease	K70.2, K70.3, K71.1, K73, K74.0, K74.2-K74.6
Renal Failure	N01, N03, N05.2-N05.6, N07.2-N07.4, N18, N19, N25
Fluid and electrolyte disorders	E86, E87
Solid tumor without metastasis	C00-C26, C30-C34, C37-C41, C43, C45-C58, C60-C76, C7A, D03, E31.21-E31.23
Metastatic cancer	C77-C80
Lymphoma	C81-C86, C88, C90.0-C90.4, C90.9, C90.A, D47.Z9
Coagulopathy	D65-D68, D69.1, D69.3-D69.6, D75.82, O99.1
Blood loss anemia	D50.0, O90.81, O99.0
Deficiency anemia	D50.1, D50.8, D50.9, D51-D53, D63, D64.9
Rheumatoid arthritis and collagen vascular disorders	L90.0, L94.0, L94.1, L94.3, M05, M06, M08, M12.0, M32-M35, M36.0, M36.8, M45, M46.0, M46.1, M46.5-M46.9, M48.X, M49.8
Diabetes mellitus (uncomplicated)	E08.0, E08.1, E08.9, E09.0, E09.1, E09.9, E10.1, E10.9, E11.1, E11.9, E13.0, E13.1, E13.9, O24.0-O24.3, O24.8, O24.9
Diabetes mellitus (complicated)	E08.2, E08.31-E08.36, E08.39, E08.4-E08.8, E09.21, E09.22, E09.29, E09.31-E09.36, E09.39, E09.4-E09.8, E10.2, E10.31-E10.36, E10.39, E10.4-E10.8, E11.2, E11.31-E11.36, E11.39, E11.4-E11.8, E13.2, E13.31-E13.36, E13.39, E13.4-E13.8, P70.2
Hypothyroidism	E00-E03, E89.0
Obesity	E66, O99.21, R93.9, Z68.3, Z68.4, or recorded BMI > 30
Weight loss	E40-E46, E64, R63.4, R63.6
Use of DNR and Palliative care	
DNR	Z51.5
Palliative care	Z66

ICD-10-CM, international classification of diseases, tenth revision, clinical modification; DNR, do not resuscitate; HIV, human immunodeficiency virus; AIDS, acquired immunodeficiency syndrome.

Table 2. Definitions used to define Charlson medical co-morbidities

Variables	ICD-10-CM code
Charlson Component Comorbidities	
Cerebrovascular disease	I60-I69, G45-G46
Dementia	F01, F02
Hemiplegia/paraplegia	G04.1, G81, G82.2
Congestive heart failure	I50
Peripheral vascular disease	I71/I79.0/I73.9/Z95.8/Z95.9
Myocardial infarction	I21, I22, I25.2
Chronic pulmonary disease	J40-J47, J60-J67
Peptic ulcer disease	K25-K28
Mild liver disease	K70.2, K70.3, K71.1, K73, K74.0, K74.2-K74.6
Moderate or severe liver disease	K72.1, K72.9, K76.6, K76.7
Moderate or severe renal disease	N18.6, Z99.2
HIV/AIDS	B20
Malignancy (any type)	Z85
Metastatic solid tumor	C77-C80
Connective tissue disease	M05.0-M05.3, M05.8, M05.9, M06.0, M06.3, M06.9, M32, M33.2, M34, M35.3
Diabetes mellitus	E10.1, E10.5, E10.9, E11.1, E11.5, E11.9, E13.1, E13.5, E13.9
Diabetes mellitus with end-organ damage	E08.2, E08.31-E08.36, E08.39, E08.4-E08.8, E09.21, E09.22, E09.29, E09.31-E09.36, E09.39, E09.4-E09.8, E10.2, E10.31-E10.36, E10.39, E10.4-E10.8, E11.2, E11.31-E11.36, E11.39, E11.4-E11.8, E13.2, E13.31-E13.36, E13.39, E13.4-E13.8, P70.2

secretions, all by nucleic acid amplification with probe detection.

Data Ascertained

We used the Charlson[12] and Elixhauser[13] indices to identify co-morbidities among patients with COVID-19.[14] The International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnosis codes were utilized to identify various comorbidities, use of DNR, and use of palliative care statuses.[15,16] The details of ICD codes for Elixhauser comorbidities and use of DNR and palliative care are listed in Table 1. The details of ICD codes for the Charlson comorbidities are listed in Table 2.

Patients were categorized into the following socioeconomic groups based on the insurance payer status: 1) Low income: Medicaid, Medicaid (managed care), Medicaid health maintenance organization (HMO), charity, pending Medicaid coverage, Medicaid – out-of-state, Medicaid managed care other, refusal to pay/bad debt; 2) Middle to upper income: HMO, private health insurance, Blue Cross (BC)/Blue Shield, self-pay, managed care (private), preferred provider organization preferred provider organization (PPO), other government (federal/state/local), other (non-government), Tricare (Champus), worker's compensation, private health insurance-indemnity, BC managed care, Department of Veterans Affairs, point of service (POS), exclusive provider organization, BC managed care-PPO; and 3) Level unclear: None, Medicare, Medicare (managed care), Medicare HMO, Medicare other, foreign national. We divided the patients into the following mutually exclusive groups according to race and/or ethnicity: African American, White (non-Hispanic), Hispanic, Asian or Pacific Islander. We will refer to White (non-Hispanic) patients as White patients in this article. We categorized age into <35, 35-54, 55-70, and >70 years for ease of interpretation and using >70 years as highest cutoff based on previous reports that identify a pronounced

increase in mortality in COVID-19 patients aged >70 years.[17-19] The primary outcome of interest was in-hospital mortality. The secondary outcome was non-routine discharge (discharge to destinations other than home, such as short-term hospitals or other facilities including intermediate care and skilled nursing homes) to estimate global disability among survivors[20,21] as it relates to long-term mortality, health care expenditure, and burden on families and informal caregivers.[22,23]

Statistical Analysis

We compared patients' age, gender, individual components of Charlson and Elixhauser comorbidities, medical complications, use of DNR, use of palliative care, and socioeconomic status between various racial and/or ethnic groups. We further compared the rates of in-hospital mortality and non-routine discharges between various racial and/or ethnic groups. We used the χ^2 test for categorical data and analysis of variance (ANOVA) test for continuous.

We performed logistic regression analysis including all COVID-19 patients to identify the associations between various racial and ethnic groups and odds of in-hospital mortality. The effects of adding various variables in the model to derive adjusted odds ratios (OR) were analyzed in the following cumulative sequence for 1) age and gender; 2) all comorbidities (defined by Elixhauser index); 3) use of DNR and palliative care; and 4) socioeconomic status in the models. We performed a sensitivity analysis adjusting for all co-morbidities defined by Charlson index instead of Elixhauser index to confirm the robustness of our findings. All the hypothesis tests were 2-sided, with P<.05 considered statistically significant, and all the analyses were done using R (version 3.6.1).

Results

Records from a total of 49,277 hospitalized adult patients with COVID-19 from December 1, 2019 to November 13, 2020 were analyzed; 38.3%, 20.3%, 39.3%, and 2.0% were White, African American, Hispanic, and Asian or Pacific Islander patients with COVID-19, respectively.

Table 3. Comparison of demographic characteristics, co-morbidities, DNR and palliative care use, and outcomes in COVID-19 patients

Items	White	African American		Hispanic		Asian or Pacific Islander	
	N(%)	N(%)	P[a]	N(%)	P[a]	N(%)	P[a]
Number of patients	18888	10025		19366		998	
Age (in years)			<.001		<.001		<.001
<35	2277(12.1%)	1814(18.1%)		5282(27.3%)		161(16.1%)	
35-54	3314(17.6%)	2490(24.8%)		5293(27.3%)		249(25.0%)	
55-70	5538(29.3%)	3315(33.1%)		4895(25.3%)		285(28.6%)	
> 70	7759(41.1%)	2406(24.0%)		3896(20.1%)		303(30.4%)	
Men	9209(48.8%)	4291(42.8%)	<.001	8580(44.3%)	<.001	474(47.5%)	.02
Socioeconomic							
Low	1193(19.1%)	1918(63.0%)	<.001	3150(16.3%)	<.001	168(16.8%)	<.001
Middle to upper	5773(30.6%)	2936(29.3%)	.02	7060(36.5%)	<.001	341(34.2%)	<.001
Level unclear	11957(63.3%)	5209(52.0%)	<.001	9281(47.9%)	<.001	491(49.2%)	<.001
Charlson component index score-mean(SD)	2.78±2.82	3.06±3.01	<.001	2.29±2.73	<.001	2.53±2.68	.006
Elixhauser component index score-mean(SD)	14.69±14.84	12.65±14.82	<.001	9.31±13.29	<.001	12.0±13.58	<.001
Use of DNR and Palliative Care							
DNR	3955(20.9%)	1157(11.5%)	<.001	2115(10.9%)	<.001	136(13.6%)	<.001
Palliative care	2301(12.8%)	881(8.8%)	<.001	1678(8.7%)	<.001	102(10.2%)	.06
Outcomes							
Expired in hospital	2168(11.5%)	1080(10.8%)	.07	1930(10%)	<.001	121(12.1%)	.53
Routine discharge (home)	10055(53.2%)	6108(60.9%)	<.001	13495(69.7%)	<.001	638(63.9%)	<.001
Non-routine discharge (not including death)	6665(39.9%)	2837(28.3%)	<.001	3941(20.4%)	<.001	239(23.9%)	<.001

DNR, do not resuscitate; COVID-19, coronavirus disease 2019; SD, standard deviation.
a. The p-value derivated from comparison using group White as reference.

Table 4. Effect of race and ethnicity on in-hospital mortality and non-routine discharges among COVID-19 patients

Items	Death					Non-routine discharge				
	OR, 95%CI, P					OR, 95%CI, P				
	Unadjusted	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]	Unadjusted	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]
White	1(1-1)	1(1-1)	1(1-1)	1(1-1)	1(1-1)	1(1-1)	1(1-1)	1(1-1)	1(1-1)	1(1-1)
African American	1.1(1.0-1.2) P=.07	1.3(1.2-1.4) P<.001	1.1(1.0-1.2) P=.003	1.5(1.4-1.7) P<.001	1.5(1.3-1.6) P<.001	1.4(1.3-1.5) P<.001	.9(.9-1.0) P=.04	.9(.8-.9) P<.001	.9(.8-.9) P=.0005	.9(.8-1.0) P=.0005
Hispanic	1.1(1.1-1.3) P<.001	1.4(1.3-1.5) P<.001	1.3(1.3-1.5) P<.001	1.4(1.3-1.6) P<.001	1.4(1.3-1.6) P<.001	2.1(2.0-2.2) P<.001	.7(.6-.7) P<.001	.8(.7-.8) P<.001	.8(.7-.8) P<.001	.8(.7-.8) P<.001
Asian or Pacific Islander	.9(.8-1.1) P=.53	1.3(1.1-1.6) P=.005	1.2(1.0-1.5) P=.06	1.5(1.2-1.9) P=.002	1.5(1.1-1.9) P=.002	1.7(1.5-2.0) P<.001	.7(.6-.8) P<.001	.7(.6-.9) P<.001	.8(.6-.9) P=.002	.8(.6-.9) P=.002

DNR, do not resuscitate; COVID-19, coronavirus disease 2019.
a. Adjusted by age, gender.
b. Adjusted by age, gender, and Elixhauser comorbidities.
c. Adjusted by age, gender, Elixhauser comorbidities, DNR and palliative care.
d. Adjusted by age, gender, Elixhauser comorbidities, DNR, palliative care and socioeconomic status.

Characteristics of African American Patients with COVID-19

Compared with White patients, the proportion of patients aged >70 years was lower in African American patients with COVID-19 (Table 3). There was a lower proportion of men and a higher proportion of patients in the low-income group among African American patients. The proportions of patients with co-morbidities defined by Charlson were higher in African American patients, defined by Elixhauser indices were lower in African American patients (Table 3).

Characteristics of Hispanic Patients with COVID-19

Compared with White patients, the proportion of patients aged >70 years was lower in Hispanic patients with COVID-19 (Table 3). The proportion of middle-to-upper income level patients was higher in Hispanic patients. Hispanic patients had an overall lower Charlson and Elixhauser indices, indicating they have lower co-morbidities (Table 3).

Characteristics of Asian or Pacific Islander Patients with COVID-19

Compared with White patients, the proportion of patients aged >70 years was lower in Asian or Pacific Islander patients with COVID-19 (Table 3). There was a higher proportion of middle-to-upper income level people among Asian patients but a lower proportion for those with unclear income. The overall Charlson and Elixhauser indices were lower in Asian or Pacific Islander patients (Table 3).

Use of DNR and Palliative Care Status

The proportion of patients who had DNR orders was 20.9%, 11.5%, 10.9%, and 13.6% for White, African American, Hispanic, and Asian or Pacific Islander patients with COVID-19, respectively (P<.001). The proportion of patients who had palliative care was 12.8%, 8.8%, 8.7% and 10.2% for White, African American, Hispanic, and Asian or Pacific Islander patients with COVID-19, respectively (P<.001).

Overall In-hospital Mortality and Non-Routine Discharges

The in-hospital mortality rate was 10.8% (n=5,299) among 49,277 COVID-19 patients. The in-hospital mortality rates were 11.5%, 10.8%, 10.0%, and 12.1% in White, African American, Hispanic, and Asian or Pacific Islander patients with COVID-19, respectively. The rate of non-routine discharge (not including death) was 27.8% (n=13,682) among the 49,277 COVID-19 patients' records analyzed. The rates of non-routine discharge were 39.9%, 28.3%, 20.4%, and 23.9% in White, African American, Hispanic, and Asian or Pacific Islander patients with COVID-19, respectively.

Multivariate Analysis

Compared with White patients, the unadjusted odds of in-hospital mortality was 1.1 (95%CI, 1.0-1.2, P=.07) in African Americans (Table 4). After adjustment for age, gender and Elixhauser comorbidities, it was significantly higher in African Americans (OR 1.1, 95%CI, 1.0-1.2,

P=.003). After additional adjustment for the use of DNR and palliative care to age, gender, Elixhauser comorbidities, the in-hospital mortality was significantly higher among African Americans (OR 1.5, 95%CI, 1.4-1.7, P<.001). The in-hospital mortality remained significantly higher after an additional adjustment for socioeconomic status in African Americans (OR 1.5, 95%CI, 1.3-1.6, P<.001). In Hispanic patients, the unadjusted odds of in-hospital mortality was 1.1 (95% CI, 1.1-1.3, P<.001), which increased to 1.3 (95%CI, 1.3-1.5, P<.001) after adjustment for age and gender, as well as the addition of Elixhauser comorbidities to the model. After adjustment for DNR orders and palliative care, Hispanic patients continued to have a higher in-hospital mortality compared with White patients (OR 1.4, 95%CI, 1.3-1.6, P<.001). Additional adjustment for socioeconomic status did not change in-hospital mortality in Hispanic patients. Compared with White patients, the unadjusted odds of in-hospital mortality was .9 (95%CI, .8-1.1, P=.53) in Asian or Pacific Islanders (Table 4). After adjustment for age, gender and Elixhauser comorbidities, it was non-significantly higher in Asian or Pacific Islanders (OR 1.2, 95%CI, 1.0-1.5, P=.06). After additional adjustment for the use of DNR and palliative care to age, gender, Elixhauser comorbidities, the in-hospital mortality was significantly higher among Asian or Pacific Islander (OR 1.5, 95%CI, 1.2-1.9, P=.002). The in-hospital mortality remained significantly higher after an additional adjustment for socioeconomic status in Asian or Pacific Islander (OR 1.5, 95%CI, 1.1-1.9, P=.002). When Charlson co-morbidities were considered instead of using the Elixhauser co-morbidities, there was no change.

Compared with White patients, non-routine discharge was higher in African American patients without any adjustments (OR 1.4, 95%CI 1.3-1.5, P<.001) (Table 4). Non-routine discharge in African American patients was lower after additional adjustment for age and gender, Elixhauser comorbidities, DNR and palliative care use, and socioeconomic status (OR .9, 95%CI, .8-1.0, P=.0005). For Hispanic patients, non-routine discharge was higher than White patients without any adjustments (OR 2.1, 95%CI, 2.0-2.2, P<.001). After adjusted for age and gender, Elixhauser comorbidities, and DNR/palliative care individually and socioeconomic status, Hispanic patients went to a lower rate of non-routine discharge (OR .8, 95%CI .7-.8, P<.001). Asian or Pacific Islander patients had more non-routine discharges compared with White patients (OR 1.7, 95%CI, 1.5-2.0, P<.001). When adjusted for age, gender and Elixhauser comorbidities, non-routine discharge was lower among Asian or Pacific Islander patients (OR .7, 95%CI, .6-.9, P<.001). No significant changes for non-routine discharge were seen after additional adjustment for DNR and palliative care (OR .8, 95%CI, .6-.9, P=.002).

Discussion

Using a comprehensive dataset that included 62 sites around the country, we found that African American, Hispanic, Asian and Pacific Islander patients were at higher odds for in-hospital mortality compared with White patients with COVID-19 after adjusting for differences in age and gender distribution, co-morbidities, use of DNR orders or palliative care, and socioeconomic status. To our knowledge, no other studies on racial disparities among COVID-19 patients have adjusted for this variable. Several studies have found that utilization of DNR orders and palliative care varies by race and ethnicity of patients[24,25] although some studies have not identified such an association[26] necessitating a separate analysis in our study. Previous studies have demonstrated that patients with DNR orders have higher in-hospital mortality even after adjustment for characteristics such as age and severity of illness[27,28] and such an association has been seen in COVID-19 patients.[29] Therefore, adjustment for disproportionate use of DNR and palliative care is essential to accurately identify higher odds of in-hospitality among various race and ethnic groups.

Our study used standardized data and ICD-10 codes from Cerner's database, which relies on the completeness from each individual hospital system; thus, the data may not fully reflect patients' comorbidities, or their hospital stay. To ensure thoroughness, if a patient had a matching ICD-10 code for co-morbidities under study at any point within past 5 years of medical history, the patient was listed as having that comorbidity. The comorbidity indexes are based in part on chronic conditions that may not always be coded at each encounter even if the chronic condition is still

present. Therefore, we reduced the chances of missing chronic conditions by only accepting ICD codes found in the COVID-19 related encounter.

Study Strengths and Limitations

The prognostic value of Charlson and Elixhauser comorbidity measures based on ICD-10 codes in the prediction of outcome in hospitalized patients has been validated.[16,30] Furthermore, there is no evidence that accuracy of ascertainment of diagnoses using ICD-10 codes vary by race/ethnicity.[31]

…we found that African American, Hispanic, Asian and Pacific Islander patients were at higher odds for in-hospital mortality compared with White patients with COVID-19…

Second, collection of race and ethnicity data may be inconsistent between hospital systems, especially for Native American, Hispanic, and Asian/Pacific Islander populations.[32] In particular for this study, Native American patient information was not collected due to small Native American population size in this dataset.

Third, we used insurance payer status as a surrogate marker for socioeconomic status as used in previous studies.[33-35] Socioeconomic status has multiple domains including educational attainment, income, and marital status; household assets or wealth, and area-level poverty. However, such data are not available in electronic medical records and researchers have used insurance payer status to describe inequalities. Medical insurance eligibility is partly based on state and federal guidelines regarding poverty, and insurance payer status is associated with annual income and educational attainment.[35,36]

Fourth, we used non-routine discharge as a measure of global disability among survivors as used in previous studies.[20,21] Discharge destination such as home has a very high negative predictive value for identifying patients with global disability (ranging from mild, moderate to severe disability) post-hospitalization.[37] However, certain patients who were discharged home under hospice care may have severe disability. There may be improvement in level of disability within months and using discharge destination may overestimate the magnitude of long-term disability in this regard.

Finally, while Cerner's dataset includes 62 hospital sites throughout the country, the dataset does not include the actual location for each site, limiting the fine grain study of specific racial and socioeconomic distributions of each community.

Conclusion

Our study identifies prominent differences in short-term outcomes between various race/ethnicity groups among patients with COVID-19. Reducing the observed disparities in comorbidities, particularly among younger segments of the population, may be an important aspect of reducing the burden of COVID-19 in the United States. It is also important to understand differences in the use of DNR orders and palliative care, including expectations for care over the life course.

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Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Qureshi, D Shyu, C Shyu; Acquisition of data: Qureshi, Myers, C Shyu; Data analysis and interpretation: Baskett, Huang, D Shyu, Myers, Thompson, C Shyu; Manuscript draft: Qureshi, Baskett, Huang, D Shyu, Myers, Lobanova, Naqvi, Thompson, C Shyu; Statistical expertise: Baskett, Huang, D Shyu; Acquisition of funding: C Shyu; Administrative: Qureshi, Huang, D Shyu, Myers, Lobanova, Naqvi, Thompson; Supervision: Qureshi, Lobanova, C Shyu

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