

Estimation of Coronavirus Disease 2019 Hospitalization Costs From a Large Electronic Administrative Discharge Database, March 2020–July 2021

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Background. Information on the costs of inpatient care for patients with coronavirus disease 2019 (COVID-19) is very limited. This study estimates the per-patient cost of inpatient care for adult COVID-19 patients seen at >800 US hospitals.

Methods. Patients aged ≥ 18 years with ≥ 1 hospitalization during March 2020–July 2021 with a COVID-19 diagnosis code in a large electronic administrative discharge database were included. We used validated costs when reported; otherwise, costs were calculated using charges multiplied by cost-to-charge ratios. We estimated costs of inpatient care per patient overall and by severity indicator, age, sex, underlying medical conditions, and acute complications of COVID-19 using a generalized linear model with log link function and gamma distribution.

Results. The overall cost among 654 673 patients hospitalized with COVID-19 was \$16.2 billion. Estimated per-patient hospitalization cost was \$24 826. Among surviving patients, estimated per-patient cost was \$13 090 without intensive care unit (ICU) admission or invasive mechanical ventilation (IMV), \$21 222 with ICU admission alone, and \$59 742 with IMV. Estimated per-patient cost among patients who died was \$27 017. Adjusted cost differential was higher among patients with certain underlying conditions (eg, chronic kidney disease [\$12 391], liver disease [\$8878], cerebrovascular disease [\$7267], and obesity [\$5933]) and acute complications (eg, acute respiratory distress syndrome [\$43 912], pneumothorax [\$25 240], and intracranial hemorrhage [\$22 280]).

Conclusions. The cost of inpatient care for COVID-19 patients was substantial through the first 17 months of the pandemic. These estimates can be used to inform policy makers and planners and cost-effectiveness analysis of public health interventions to alleviate the burden of COVID-19.

Keywords. cost; COVID-19; hospitalization; SARS-CoV-2; severity.

The coronavirus disease 2019 (COVID-19) pandemic has been the major public health concern in the United States since early 2020. The health impacts of COVID-19, including hospitalizations and deaths, have been well documented [1–5]. As of September 30, 2021, more than 43.3 million COVID-19 cases and over 694 thousand COVID-19 deaths had been reported in the United States [1]. During August 1, 2020–September 28, 2021, more than 3.0 million new hospitalized patients with COVID-19 were reported [2]. As a result, there has been overwhelming demand for inpatient care of COVID-19 patients, including readmission, intensive care unit (ICU) admission, and invasive mechanical ventilation (IMV) [4, 6–8]. Although the cost of inpatient care for patients hospitalized with COVID-19

can be substantial [9, 10], information on those costs, a significant component of healthcare burden of COVID-19, is limited. Previous studies on costs have been limited to the early months of the pandemic or to patients with specific insurance types [11–14], based on flu or pneumonia diagnoses as proxies for COVID-19 [9, 12], or limited to small numbers of hospitals that reported costs [15]. Detailed information on hospitalization costs of COVID-19 is important not only to understand the economic burden of disease but also to assess economic benefits of COVID-19 prevention efforts such as vaccination efforts in the United States. In this study, using the most recent data from >800 hospitals covering all payers in the United States, we assess the average per-patient cost of inpatient care for adult COVID-19 patients, overall, and by severity, age, sex, underlying medical conditions, and acute complications.

METHODS

Data Source

The data for this study was obtained from the Premier Healthcare Database Special COVID-19 Release ([PHD-SR]

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release date: September 14, 2021). The PHD-SR is a large, geographically diverse US all-payer administrative database that contains information on inpatient discharges from more than 800 hospitals located in 48 states [16].

Patient Consent Statement

This activity was reviewed by the Centers for Disease Control and Prevention (CDC) and was conducted consistent with applicable federal law and CDC policy.

Cohort Selection

Patients aged ≥ 18 years with ≥ 1 hospitalization with a COVID-19 diagnosis code in PHD-SR during March 2020–July 2021 were included. Coronavirus disease 2019 diagnosis was based on an *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) diagnosis of U07.1 (“COVID-19, virus identified”) during April 2020–July 2021 or B97.29 (“Other coronavirus as the cause of diseases classified elsewhere”, recommended before the April 2020 release of U07.1) during March–April 2020 [17, 18]. Patients whose sex was not recorded ($n = 309$ [0.05%]) and those with zero costs ($n = 1174$ [0.18%]) were excluded from the study. The final sample included 654 673 unique patients (Supplementary Figure 1).

Outcomes and Covariates

The outcome variable was the estimated cumulative per-patient hospitalization cost of all hospitalizations with a COVID-19 discharge diagnosis code for each patient in PHD-SR. We used validated costs that passed all validity checks, including financial reconciliation in PHS-SR; otherwise, costs were calculated using reported charges multiplied by estimated hospital-specific cost-to-charge ratios (CCRs) when available or aggregate CCR otherwise (Supplementary Figure 2). Costs and charges reported by hospitals are facility fees, inclusive of salaries but excluding professional fees for services billed to patients by independent physicians.

Covariates of interest were patient and hospital characteristics, severity indicators, underlying medical conditions, acute complications of COVID-19, and patient demographic characteristics. All patient and hospital information (sex, age, race/ethnicity, payer type, hospital US Census region, hospital urbanicity) was obtained from patient medical records during a patient’s first COVID-19 hospitalization in PHD-SR. Severity indicators included the following: ICU admission, IMV, and death. Intensive care unit admission and IMV were defined using patient billing records, and death was determined at patient discharge. Underlying medical conditions were captured by ICD-10-CM diagnosis codes from inpatient or outpatient medical records in PHD-SR from January 2019 up to and including a patient’s first inpatient encounter with COVID-19. Conditions included in the analysis were those defined by the

CDC as risk factors for severe COVID-19 illness [19]. Acute complications were obtained from all hospitalizations with COVID-19 for each patient [20].

Statistical Analysis

We used 3 multivariable generalized linear models with log link function and gamma distribution, with the outcome variable being the cost of COVID-19 inpatient care per patient. All models (1) used robust standard errors clustered on hospital identifier and (2) controlled for patient age group, sex, race/ethnicity, payer type, hospital urbanicity, hospital US Census region, and admission month as a linear and quadratic term (to account for potential nonlinear unobservable changes in the severity of illness over the course of the pandemic). Model 1 included severity indicators (ICU admission, invasive mechanical ventilation, death) and their interactions as the covariates of interest; the model estimated the per-patient cost of COVID-19 inpatient care overall and by each severity indicator. Model 2 estimated differences in the cost of COVID-19 inpatient care by age, sex, race/ethnicity, and underlying medical conditions as the covariates of interest. Model 3 estimated the differences in the hospitalization costs for patients with COVID-19 by acute complications of COVID-19 as the covariates of interest. Finally, mean and median costs per COVID-19 patient were compared with hospitalization costs of influenza (ICD-10-CM codes J09–11) or pneumonia (ICD-10-CM codes J12–J18) in 2019, adjusted to 2020 US dollars using the Personal Consumption Expenditures: Health care index ([https://www/apps.bea.gov](https://www.apps.bea.gov)) [21].

We performed 3 supplemental analyses, modified from Model 1. The first analysis was performed among surviving patients. The second analysis was performed among patients with COVID-19 as a primary diagnosis. The third analysis used the cost of the first hospitalization with COVID-19 as the outcome variable.

All analyses were conducted using R 4.0.2 (R Foundation for Statistical Computing [Vienna, Austria] or <https://www.R-project.org/>) and Stata 15.1 (Stata Statistical Software: Release 15; StataCorp LLC, College Station, TX).

RESULTS

Of 654 673 adult hospitalized patients with COVID-19, 198 222 (30.3%) required ICU admission, but neither required ventilation nor died before discharge; 39 309 (6.0%) required IMV but did not die; and 87 766 (13.4%) died before discharge (Table 1). Coronavirus disease 2019 as a primary diagnosis was present among 410 489 (62.7%) patients. Median age was 65 years (interquartile range [IQR], 52–76). The largest proportions of patients were non-Hispanic white individuals (45.1%), covered by Medicare (52.2%), admitted to urban hospitals (87.9%), and admitted to hospitals in the South region (46.7%). The

Table 1. Patient Characteristics, Premier Healthcare Dataset Special COVID-19 Release (March 2020–July 2021)

Characteristics	N (%)
Total	654 673 (100.0)
Sex	
Female	317 984 (48.6)
Male	336 689 (51.4)
Age, years: median (IQR)	
18 to 29	31 969 (4.9)
30 to 39	46 255 (7.1)
40 to 49	66 499 (10.2)
50 to 59	109 211 (16.7)
60 to 69	141 065 (21.5)
70 to 79	138 340 (21.1)
80+	121 334 (18.5)
Race/Ethnicity	
Hispanic or Latino	111 545 (17.0)
Non-Hispanic White	295 413 (45.1)
Non-Hispanic Black	103 248 (15.8)
Non-Hispanic Asian	13 758 (2.1)
Non-Hispanic Other ^a	20 440 (3.1)
Unknown	110 269 (16.8)
Payer Type	
Commercial	166 637 (25.5)
Medicare	341 829 (52.2)
Medicaid	92 247 (14.1)
Charity/Indigent/Self-Pay	20 776 (3.2)
Payer Unknown	33 184 (5.1)
Urbanicity	
Rural	78 953 (12.1)
Urban	575 720 (87.9)
US Census Region	
Midwest	135 502 (20.7)
Northeast	118 729 (18.1)
South	305 895 (46.7)
West	94 547 (14.4)
Severity Indicator	
No ICU/IMV/Death	329 376 (50.3)
ICU, no IMV or death	198 222 (30.3)
IMV, no death	39 309 (6.0)
Death	87 766 (13.4)
COVID as Primary Diagnosis	
Yes	410 489 (62.7)
No	244 184 (37.3)
Number of Hospitalizations	
1	621 272 (94.9)
2	31 085 (4.7)
≥3 hospitalizations	2316 (0.4)
	Mean/Median (IQR)
Length of stays (days) per patient	8.7/ 6 (3–11)
Inpatient cost (dollars) per patient	24 713/12 732 (6993–25 331)

Abbreviations: COVID-19, coronavirus disease 2019; ICU, intensive care unit; IMV, invasive mechanical ventilation; IQR, interquartile range.

^aThe non-Hispanic others include (1) American Indians or Alaska Natives and (2) Native Hawaiians or other Pacific Islanders.

median number of hospital days was 6 days (IQR, 3–11 days). Most patients (621 272 [94.9%]) had only 1 hospitalization with COVID-19, the remaining patients had 2 hospitalizations

(31 085 [4.7%]) or ≥3 hospitalizations (2316 [0.4%]). The overall cost among 654 673 adult patients with COVID-19 in PHD-SR was \$16.2 billion, averaging \$24 713 per patient. The median hospitalization cost per patient was \$12 732 (IQR, \$6993–\$25 331).

Based on Model 1, the estimated mean per-patient cost was \$24 826 (95% confidence interval [CI], \$23 795–\$25 858) (Figure 1), \$20 674 (95% CI, \$19 830–\$21 518) among surviving patients (Supplementary Figure 3), and \$21 889 (95% CI, \$21 035–\$22 743) among patients with a primary diagnosis of COVID-19 (Supplementary Figure 4). The estimated mean per-patient cost for the first hospitalization with COVID-19 was \$23 656 (95% CI, \$22 668–\$24 644) (Supplementary Figure 5). The average estimated per-patient cost was lowest for patients with no ICU admission, IMV, or death and highest for surviving patients with IMV.

The estimated cost was \$13 543 higher for patients with ICU admission (95% CI, \$12 474–\$14 612) compared to those without ICU admission, \$39 840 higher for patients who needed IMV (95% CI, \$36 159–\$43 520) compared to those without IMV, and not significantly different for patients who died (absolute difference = \$955; 95% CI, –\$192 to \$2102) compared to patients who survived (Figure 1).

Based on Model 2, compared to female patients, male patients had 14% higher estimated cost (\$3280; 95% CI, \$2983–\$3577) (Figure 2). There was a nonlinear association between age and cost of inpatient care, with the incremental difference in hospitalization costs rising with older age until the ages of 60–69 years, and then decreasing slightly with age groups over 70 years. The incremental difference in hospitalization costs ranged from \$2044 (95% CI, \$1496–\$2592) for patients aged 30–39 years to \$9750 (95% CI, \$8986–\$10 515) for patients aged 60–69 years, compared to those aged 18–29 years.

The estimated costs also varied by race/ethnicity. The highest adjusted cost differentials compared to non-Hispanic white patients were observed among non-Hispanic Asian and Hispanic patients, with absolute differences of \$7014 (95% CI, \$4534–\$9493) and \$5720 (95% CI, \$4183–\$7256), respectively (Figure 2). In contrast, non-Hispanic black patients had a differential per-patient cost of –\$1169 (95% CI, –\$1920 to –\$418) compared to non-Hispanic white patients.

Based on Model 2, per-patient hospitalization cost was the highest among patients with chronic kidney disease (by 64% or \$12 391; 95% CI, \$11 522–\$13 260), followed by liver disease (by 37% or \$8878; 95% CI, \$7879–\$9878), cerebrovascular disease (by 30% or \$7267; 95% CI, \$6316–\$8219), and obesity (by 26% or \$5933; 95% CI, \$5445–\$6422), compared to patients without the corresponding condition (Figure 2).

Based on Model 3, acute complications of COVID-19 were associated with higher costs of inpatient care (Figure 3). The cost of per-patient inpatient care was 3.09 times as high for patients with acute respiratory distress syndrome (95% CI,

2.96–3.22), 2.05 times as high for patients with pneumothorax (95% CI, 1.98–2.12), and 1.89 times as high for patients with intracranial hemorrhage (95% CI, 1.80–1.99), compared to patients without the corresponding complication.

DISCUSSION

This study provides estimates of the cost of inpatient care for adult patients hospitalized with COVID-19 during March 2020–July 2021, using data from >800 geographically dispersed US hospitals covering all payers. This study builds on a prior study using data from the PHD-SR [15] by creating the cost-to-charge ratios to obtain costs when they were not verified in the data, by including an additional 10 months of data, adding death as a severity indicator, estimating costs by underlying medical condition and acute complication of COVID-19, and by providing adjusted estimates of costs.

The unadjusted mean cost of \$24 717 per patient hospitalized with COVID-19 in this study is comparable to the mean cost of \$24 571 from a prior study using the Premier Healthcare COVID-19 database during April 1–October 31, 2020 [15] and mean Medicare fee-for-service payment of \$24 454 per COVID-19 hospitalization using the Centers for Medicare & Medicaid Services (CMS) data during January 1, 2020–July 24, 2021 [13], but slightly higher than mean hospitalization cost of \$21 752 among Medicare free-for-service beneficiaries during April 1–December 31, 2020 [14]. Our estimated and unadjusted mean per-patient cost of \$24 826 and \$24 713 are much higher than the unadjusted mean cost of influenza-related inpatient care in 2019 (\$13 483 in 2020 dollars) and slightly higher than

that of pneumonia-related inpatient care in 2019 (\$21 447, in 2020 dollars) in Premier Healthcare Database Special COVID-19 Release database (Supplementary Table 1). The finding that patients needing ICU admission and IMV for COVID-19 have higher costs of care is comparable to that of a previous study [15]. Our finding of a nonlinear positive adjusted association between age and cost of inpatient care shows the need for more intensive use of resources with older age, and it is comparable to previously reported patterns of unadjusted mean or median hospitalization costs by age group [15] and median estimated allowed amount by age group [11]. Our finding of higher COVID-19 hospitalization costs among males than females could be due to a combination of factors, including relatively higher odds of readmission and having higher proportion of clinical severity such as ICU admission and IMV among males than females [8, 15, 22].

Our supplementary analyses showed that the estimated cost of the first COVID-19 hospitalization was comparable to that from the main analysis because most patients (94.9%) had only 1 hospitalization with COVID-19. The estimated per-patient cost among 410 489 patients with a primary diagnosis of COVID-19 was slightly lower, but it was comparable to estimates from the main analysis. This indicates that the per-patient hospitalization cost from the main analysis is likely a close estimate of the hospitalization cost attributable to COVID-19. On the other hand, as expected, the estimated per-patient cost of surviving patients with COVID-19 was slightly lower than per-patient cost estimated including patients who died of COVID-19. This could be due to differences in the average unadjusted number of hospital days per patient (8 days vs 13.5 days) and prevalence of IMV

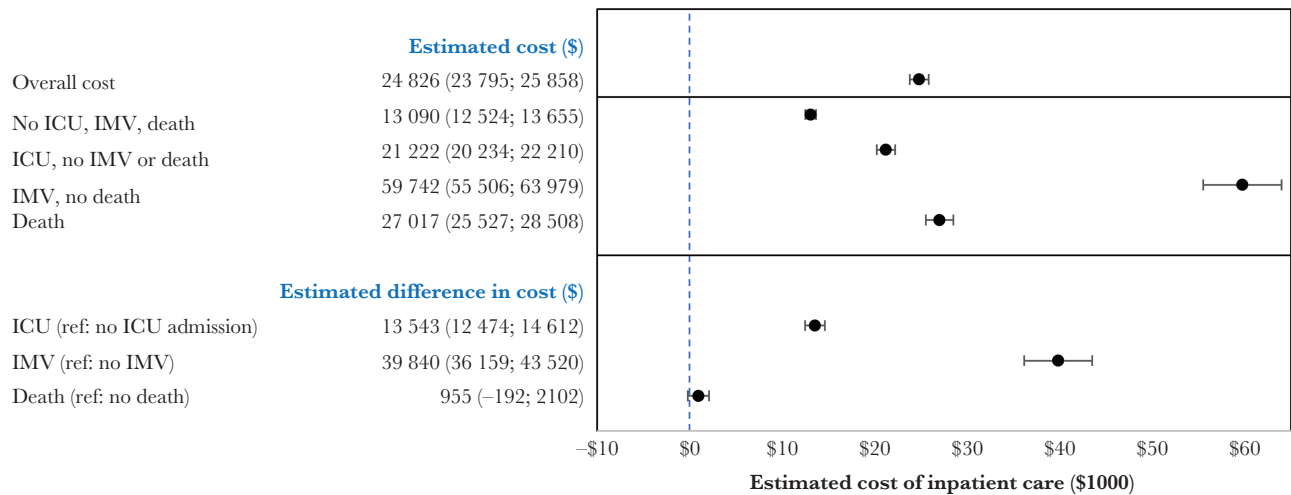


Figure 1. Estimated total per-patient cost (95% confidence interval) of inpatient coronavirus disease 2019 care by level of severity, March 2020–July 2021 (n = 654 673). The figure represents the results from Model 1, a single multivariable generalized linear model, with log link and gamma distribution function, and severity indicators as covariates of interest (intensive care unit [ICU] admission, invasive mechanical ventilation [IMV], death, and their interactions), adjusted for other control variables. Control variables included age group, sex, race/ethnicity, payer type, hospital US Census region, hospital urbanicity, and admission month (linear and quadratic terms). The top panel represents estimated cost of inpatient care overall, the middle panel represents estimated cost of inpatient care by severity indicator, and the bottom panel represents incremental difference in cost of inpatient care by severity indicator, compared with absence of that severity indicator. Error bars represent 95% confidence intervals.

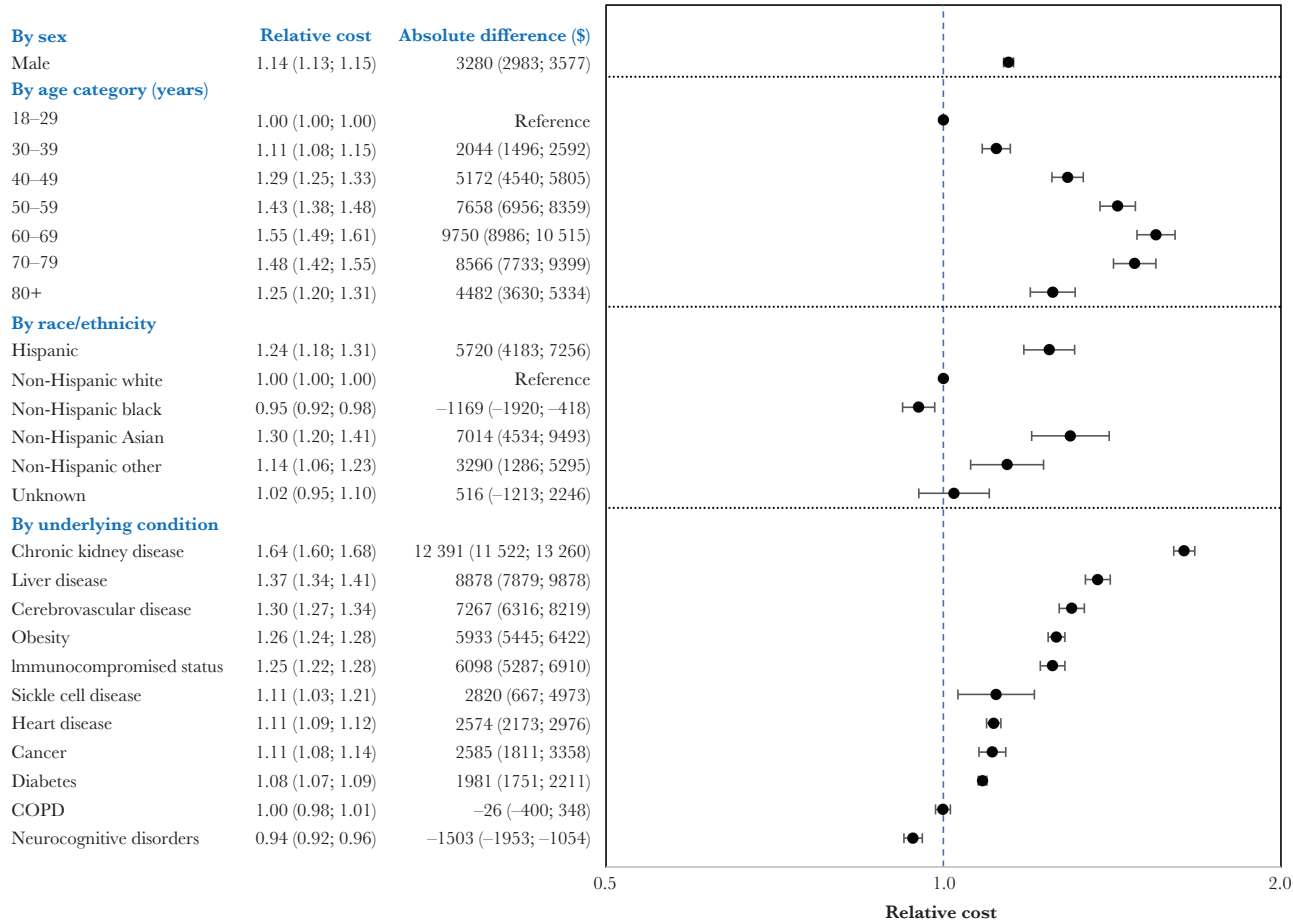


Figure 2. Differences in inpatient care cost of coronavirus disease 2019 (COVID-19) per patient: by sex, age, race/ethnicity, and underlying medical condition, March 2020–July 2021 (n = 654 673). The figure represents the results from Model 2, a single multivariable generalized linear model, with log link and gamma distribution function, and age group, sex, race/ethnicity, and underlying conditions as covariates of interest, adjusted for other control variables (payer type, hospital US Census region, hospital urbanicity, and admission month as a linear and quadratic term). Relative and absolute adjusted differences in costs are presented. Error bars represent 95% confidence intervals. The definition of the underlying medical condition is aligned with the Centers for Disease Control and Prevention (CDC) definition of people with certain medical conditions and risk of severe COVID-19 illness (available at: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-care/underlyingconditions.html>. Updated October 14, 2021). COPD, chronic obstructive pulmonary disease.

(6.9% vs 60.6%) among surviving patients and those who died, respectively (results not shown).

Our finding shows modestly lower COVID-19 hospitalization costs among non-Hispanic black patients compared to non-Hispanic white patients. Previous studies suggest that non-Hispanic black patients have higher rates of underlying medical conditions, acute complications, and greater severity than non-Hispanic white patients [23–25] and greater odds of hospital admission at the time of presenting with COVID-19. Those patterns possibly reflect delays in seeking care due to barriers to accessing care [26]. Some studies suggest that once hospitalized with COVID-19, there were no differences in risk of poor outcomes [27], or of mortality between non-Hispanic black and non-Hispanic white patients [28], whereas others show a higher risk of poor outcomes and death among non-Hispanic black patients [29]. The modestly lower average costs among non-Hispanic black patients compared to non-Hispanic white

patients, controlling for underlying medical conditions, could be a result of a combination of factors, including barriers in access to care, lower odds of readmission [8], and higher odds of COVID-19 mortality [29, 30]. Further research on the relationship between COVID-19 hospitalization cost and race/ethnicity may be warranted.

Our findings of variations in the cost of COVID-19 hospitalization by patients' underlying medical conditions and acute complications could be due to several factors. Those include differences in relative risk severity, readmission, and length of stay by conditions or complications. For example, the higher cost for COVID-19 patients with chronic kidney disease could be because of (1) relatively higher odds of readmission [8] and (2) COVID-19 severity and ICU admission [31, 32].

The findings in this study have limitations. First, although the PHD-SR data cover more than 20% of inpatient admissions in the United States [17], the results may not be generalizable

Respiratory	Relative cost	Absolute difference (\$)
ARDS	3.09 (2.96, 3.22)	43 912 (41 029, 46 796)
Pneumothorax	2.05 (1.98, 2.12)	25 240 (23 314, 27 166)
Respiratory failure	1.46 (1.43, 1.50)	9586 (8899, 10 273)
Pulmonary collapse	1.42 (1.37, 1.47)	10 365 (9084, 11 645)
COPD exacerbation	1.08 (1.06, 1.10)	2032 (1548, 2516)
Pneumonia	1.01 (0.99, 1.03)	177 (-369, 722)
Cardiovascular		
Cardiogenic shock	1.46 (1.37, 1.56)	11 508 (9009, 14 007)
Congestive heart failure	1.23 (1.20, 1.25)	5588 (4879, 6296)
Ischemic heart disease	1.12 (1.09, 1.15)	2984 (2134, 3833)
Hypertensive crisis	1.13 (1.10, 1.17)	3364 (2581, 4147)
Myocarditis	1.09 (1.02, 1.16)	2295 (532, 4057)
Hematologic		
Venous thromboembolism	1.47 (1.44, 1.51)	11 473 (10 498, 12 448)
DIC	1.54 (1.42, 1.68)	13 586 (10 234, 16 938)
Neurologic		
Intracranial hemorrhage	1.89 (1.80, 1.99)	22 280 (19 549, 25 012)
Cerebral ischemia/infarction	1.50 (1.46, 1.54)	12 351 (11 239, 13 463)
Endocrine		
Diabetic ketoacidosis	1.11 (1.09, 1.14)	2890 (2192, 3588)
Renal		
Dialysis initiation	1.69 (1.59, 1.80)	17 119 (14 334, 19 904)
Acute kidney injury	1.29 (1.27, 1.31)	6530 (6084, 6976)
Other		
Bacteremia	1.69 (1.62, 1.76)	17 201 (15 208, 19 194)
Pressure ulcer	1.70 (1.65, 1.74)	16 826 (15 471, 18 181)
Sepsis	1.39 (1.36, 1.42)	8492 (7771, 9213)
Hepatitis	1.33 (1.28, 1.38)	8273 (6979, 9566)

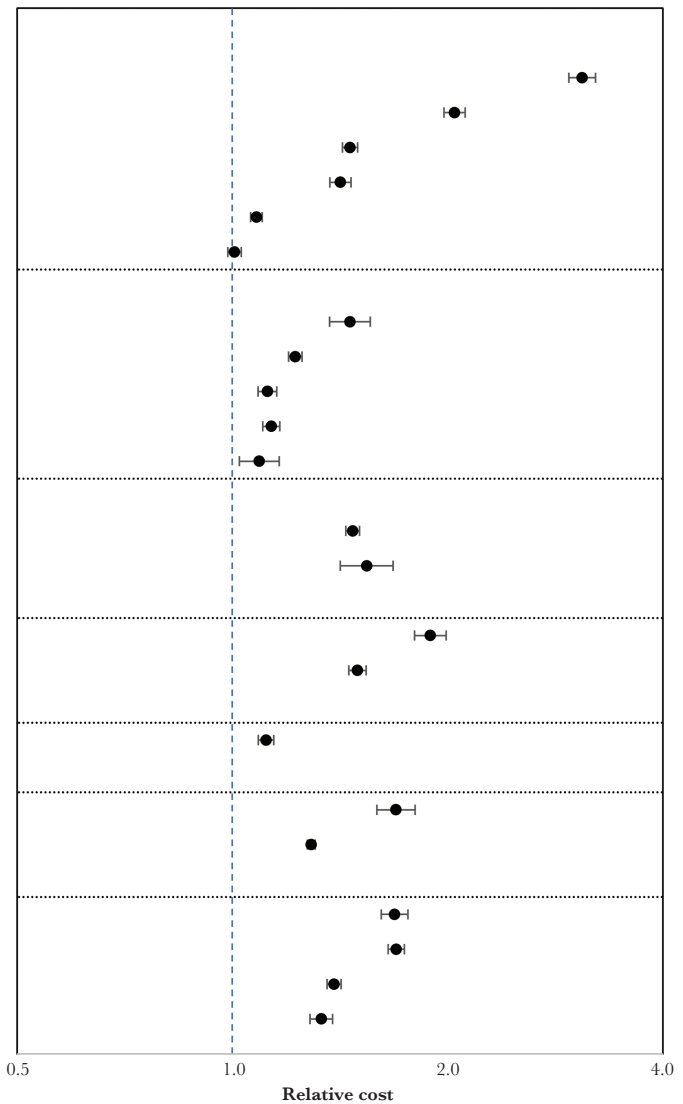


Figure 3. Differences in inpatient care cost of coronavirus disease 2019 (COVID-19) per patient: by acute COVID-19 complication, March 2020–July 2021 (n = 654 673). The figure represents the results from Model 3, a single multivariable generalized linear model, with log link and gamma distribution function, and acute complications as covariates of interest, adjusted for other control variables (age group, sex, race/ethnicity, payer type, hospital US Census region, hospital urbanicity, and admission month as a linear and quadratic term). Relative and absolute adjusted differences in costs are presented. Error bars represent 95% confidence intervals. ARDS, acute respiratory distress syndrome; COPD, chronic obstructive pulmonary disease; DIC, disseminated intravascular coagulation.

to all hospital patients. For example, the PHD-SR database underrepresents hospitals in the Western states. Second, because the cost in PHD-SR data only represents the facility or institutional fees and excludes noninstitutional (professional) fees, our estimated hospitalization costs would be underestimated. A study using the MarketScan databases calculated that including professional fees increased total per-admission payments in 2012 by 26.4% for commercially insured admissions and by 17.7% for Medicaid admissions relative to facility-only payments [33]. Third, in our cost estimation, we did not adjust 2020 costs to 2021 equivalents because suitable index data were not available for all months. Fourth, there is likely incomplete and potentially biased reporting of race/ethnicity, which

complicates the interpretation of the obtained associations of cost with race/ethnicity. For example, just one third of patients hospitalized with COVID-19 in the PHD-SR were classified as either non-Hispanic black or Hispanic. Hospitalization data from states that have reported complete data on race/ethnicity have consistently reported that non-Hispanic black individuals accounted for much larger shares of hospitalized patients than in the general population [34]. Furthermore, the exclusion of public hospitals in the sample and lack of representativeness of hospitals in the sample would have reduced the share of disadvantaged minority populations in the sample, complicating the interpretation of our results. Fifth, the reliance on ICD-10-CM diagnosis codes for identification

of COVID-19 patients is subject to risk of misclassification. However, although COVID-19 diagnoses were not laboratory confirmed, the risk of misclassification of COVID-19 cases is low. A study that linked PHD-SR data to laboratory test results for a subset of 150 hospitals found specificity of 99% and sensitivity of 98% for the U07.1 ICD-10-CM code for COVID-19 [17]. Similarly, the identification of underlying medical conditions and acute complications was based on ICD-10-CM codes, and the co-occurring conditions may therefore be misclassified. The accuracy of hospital diagnoses for other conditions is heterogeneous [35]. Sixth, the per-patient hospitalization cost may be underestimated because of likely exclusion of patients who received care in other hospitals, and only some professional services, those provided by hospitals, are included in the hospital charges. Seventh, we did not estimate the excess costs attributable to COVID-19 because we did not estimate costs for patients with non-COVID-19 hospitalizations. In a supplementary analysis, we estimated costs among patients with COVID-19 as a primary diagnosis, which can reflect potential costs attributable to COVID-19. However, further research would be needed to estimate costs attributable to COVID-19. Finally, the costs in this study represent the resource costs incurred by hospitals in providing inpatient services. These costs may be either higher or lower than the reimbursements received by hospitals for the care provided, which can vary greatly by payer type. Because the PHD-SR database does not report payments received by hospitals, it is impossible to infer from these estimates the financial impact of COVID-19 care on participating hospitals. Similarly, these estimates of costs should not be confused with expenditures incurred by health plans or patients, information that was not available in the PHD-SR data.

CONCLUSIONS

Costs of hospitalized patients diagnosed with COVID-19 were estimated using a large observational cohort of all-payer electronic health administrative data from >800 US hospitals during the first 17 months of the pandemic in 2020 and 2021. The results indicated that the average per-patient cost incurred by hospitals for inpatient care of COVID-19 patients in the United States was substantial. The cost was higher with an increasing level of clinical severity among surviving patients, with the highest cost associated with IMV. The cost estimates by patients' profile provide additional insight into patient groups needing special attention. These cost estimates could be used in combination with trial-based estimates of averted COVID-19 adult hospitalizations to assess the largest component of the economic benefits of COVID-19 vaccination efforts to the US healthcare system and the cumulative economic impact of COVID-19 on US hospitals. The results could also be used to assess the resources required to treat COVID-19 patients in a hospital setting with specific

underlying or acute medical conditions or demographic characteristics.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

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