Comparative Analysis of Costs of Caring for Inpatient COVID-19 Patients and Non-COVID-19 Patients at One Academic Center

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Objectives: The coronavirus disease 2019 (COVID-19) pandemic has created a significant financial burden on the US healthcare system. The purpose of this study was to compare the costs of caring for patients admitted with COVID-related illness versus non-COVID patients. We hypothesized that the average daily costs of hospitalization would be higher among COVID patients compared with non-COVID patients.

Methods: This was a retrospective cohort study. Data were downloaded for patients who were admitted at Atrium Wake Forest Baptist Hospital from January 1, 2020 through February 28, 2021. The study population was dichotomized by COVID and non-COVID patients, and the average daily hospital cost was calculated. Multivariate adjusted linear regression models were used to calculate additional "average daily cost" comparisons.

Results: The COVID group was slightly older (mean age 61.0 vs 58.0 years), with longer mean length of stay (6.12 vs 4.95 days) and higher mean average daily direct cost ($1504.01 vs $1341.30) when compared with the non-COVID group, respectively ($P < 0.001$). After adjusting for various patient characteristics, the direct inpatient cost was $123.00 (95% confidence interval 74.4–171.5) higher per day in patients with COVID-19 ($P < 0.0001$). When indirect costs are considered, the combined indirect and direct cost may be four times greater.

Conclusions: The average daily direct hospital cost is higher among patients with COVID compared with non-COVID-related illness. Many reasons contributed to this cost difference, including decreased nurse staffing ratios, lower physician censuses, and needed infrastructure changes. Studies with a larger sample size and more precise comparable study groups are warranted to validate our findings.

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The coronavirus disease 2019 (COVID-19) pandemic has created unprecedented hardships for the healthcare industry. Shortages of ventilators and personal protective equipment (PPE) resulted in various nonmedical companies contributing to the manufacture of these products.[1,2] In addition, to limit the spread of the virus and to free up hospital beds, hospitals delayed, halted, or canceled elective procedures, which generate an estimated $48 to $65 billion in revenue annually.[3] Furthermore, the COVID-19 pandemic brought on new costs for hospitals such as purchasing more PPE, ventilators, and COVID-19 medications; creating additional negative pressure rooms; and setting up drive-through vaccination clinics. As a result of low revenue generation and significantly higher costs, several hospital systems reported decreased cash reserves that threatened their financial viability.[4,5]

Key Points

- We estimated the average daily direct cost for adult inpatients. The direct inpatient cost was $123 (95% confidence interval 74.4–171.5) higher per day in patients with coronavirus disease 2019 (COVID-19) and compared with patients who did not have COVID-19 when adjusted for age, sex, race, and Medicare Severity-Diagnosis Related Group.
- The indirect costs of caring for COVID-19 patients also are notable, including decreased nurse staffing ratios, lower physician censuses, and needed infrastructure changes (negative pressure rooms, ventilation/ heating, ventilation, and air conditioning system upgrades) for these patients who naturally required more intense care.
- Although not included in our analysis, if these costs were added, then it would only increase the difference in cost between COVID-19 patients and their uninfected counterparts. Conservatively speaking, in hospitalized patients with COVID-19 as a result of these additional costs, the actual increase is approximately $4000 per patient during the hospital stay.

To help hospital systems with these financial challenges, the Coronavirus Aid, Relief, and Economic Security (CARES) Act was signed into law on March 27, 2020. This legislative bill included $100 billion in aid for healthcare systems. It provided a 20% increase in payments of inpatient COVID-19 admissions, a 50% payroll tax cut, and more.[6,7] In addition to the funds for any provider that billed for Medicare fee-for-service during the pandemic, the CARES Act targeted specific groups for additional financial support. These categories included hospitals with high numbers of COVID-19 patients, rural hospital systems, "safety net" hospitals, skilled nursing facilities, and the Indian Health Service and tribal hospitals.[7]

The CARES Act also allocated additional funds for those at high risk of financial instability. For example, vulnerable hospitals are more likely to be rural than urban. In many cases, small, rural hospitals often rely more on outpatient services and surgical volume for revenue generation.[8] This distribution of revenue generation already placed struggling rural hospitals at greater risk of financial instability during the COVID-19 pandemic.

Another category that received special funds from the CARES Act was safety net hospitals. These institutions are hospitals that dedicate their mission to serving vulnerable patient populations or to serving a disproportionate number of individuals covered by Medicaid or who are uninsured.[9] These hospitals thus tend to serve a large number of minority patients, specifically African American/Black and Hispanic patients. Minority populations have not only experienced higher rates of severe acute respiratory syndrome-coronavirus 2 infection than non-Hispanic White populations but they also have a greater hospitalization risk and mortality from COVID-19.[10] Given that these patients tend to have more severe courses of COVID-19, it can be inferred that safety net hospitals likely have high costs associated with their care for COVID patients and thus require additional funds to sustain operations. The study by Tsai et al on Medicare fee-for-service beneficiaries noted that hospitalization for COVID-19 patients was approximately $21, 7652, with a length of stay of 9.2 days.[11] Wang et al conducted a cross-sectional study of 1378 US hospitals before and after the COVID-19 pandemic.[12] The authors concluded that although many health systems experienced a reduction in their operating margin during the COVID-19 pandemic, the CARES Act funds allowed government, rural, and smaller hospitals to receive this focused funding that may not otherwise have been possible.[12] Other studies compared the direct medical costs of COVID-19 and used diseases such as pneumonia and influenza as proxies.[13,14]

The purpose of this study was to compare the costs of caring for these two groups at one academic center in North Carolina. By quantifying the cost difference between these two patient populations, we could appropriately assess the financial needs for inpatient COVID-19 care and effectively distribute funds to the hospitals and facilities that need them the most. We hypothesized that the daily average cost of hospitalization would be higher among COVID-19 patients compared with non-COVID patients admitted to inpatient medicine services.

Methods

Study Design and Patient Selection

This was a retrospective cohort study. The data were downloaded for patients who were admitted at Wake Forest Baptist Hospital from January 1, 2020 through February 28, 2021. Two separate datasets were downloaded initially based on their primary admitting diagnosis: COVID-19–related illness versus non-COVID-19–related illness. During the initial data pull, 868 patients were admitted with a primary diagnosis of COVID-19–related illness and 39,995 patients were admitted for a diagnosis other than COVID-19–related illness. Institutional review board approval was obtained.

Exclusion Criteria

We used the following inclusion and exclusion criteria sequentially to derive the final dataset for the final analyses: excluded patients who were younger than 18 years old, excluded surgical patients, excluded $0 charge financial encounters, included only patients admitted as an inpatient, included patients only admitted and discharged from the medical-surgical unit admitted under either the Hospital Medicine or General Internal Medicine/resident team, excluded patient > ± 2 standard deviations numerical value of average daily cost to exclude outliers (Fig.).

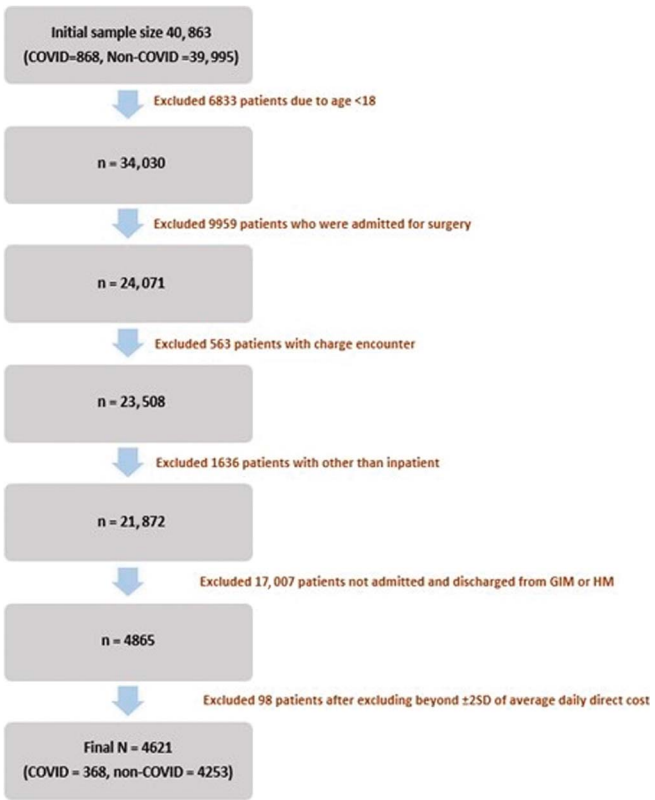

Fig. Sample size selection flowchart. COVID, coronavirus disease; GIM, General Internal Medicine; HM, Hospital Medicine.

Table 1. Study population characteristics

Variable	COVID patient	Non-COVID patient	*P*
N	368	4253	N/A
Age, y, mean (SD)	61.0 (16.0)	58.0 (17.4)	<0.01
Age > 65 y, n (%)	139 (37.8)	1515 (35.6)	0.41
Male sex, n (%)	198 (53.8)	2226 (52.3)	0.59
Race, n (%)			<0.001
White	188 (51.2)	2715 (63.9)	
African American	94 (25.5)	1267 (29.8)	
Other	86 (23.4)	270 (6.4)	
Marital status, n (%)			<0.001
Single	91 (24.7)	1496 (35.2)	
Married	181 (49.2)	1454 (34.2)	
Other than single or married	96 (26.1)	1303 (30.6)	
Length of stay, d, mean (SD)	6.12 (5.70)	4.95 (4.72)	<0.001
MS-DRG weight, mean (SD)	1.85 (0.76)	1.32 (0.69)	<0.001

COVID, coronavirus disease; MS-DRG, Medicare Severity-Diagnosis Related Group; SD, standard deviation.

Calculation of Average Daily Cost

The direct cost for each hospitalization was calculated by adding fixed direct costs and variable direct costs. Fixed direct costs are direct patient care costs that do not fluctuate with patient volume, thus exhibiting "fixed" behavior. Variable direct costs are direct patient care costs that fluctuate with patient volume, thus "varying" with the volume of activity. An example of a fixed direct cost is the cost of the depreciation of a magnetic resonance imaging machine: Within a reasonable level of patient activity, the magnetic resonance imaging machine will not change the total cost incurred. An example of a variable direct cost is the cost of pharmaceuticals administered to patients: The more patients seen, the more pharmaceuticals will be administered. In practice, we assess the behavior of costs by quantitatively evaluating the strength of the direct cost fluctuations against the volume fluctuations. Costs that exhibit strong and positive correlation with volume fluctuations in the linear regression model are variable, whereas costs that exhibit weak or even negative correlation with volume fluctuations are fixed.

Because of the wide variety in length of stay among patients, the total direct cost did not seem to be a valid surrogate for costs associated with the individual patient. As such, an average daily cost was calculated as direct cost divided by total length of stay in days.

Statistical Analysis

The study population was dichotomized by COVID and non-COVID groups. Demographic and important clinical characteristics were compared between the groups. The least squares means and maximum likelihood ratio were used to find the statistical significance for continuous and categorical variables, respectively, among groups. The mean of the average daily cost was calculated between COVID and non-COVID groups and the Student *t* test was performed for comparison. Then, three different linear regression models were used to calculate the additional average daily cost needed for the COVID-19 patient group in comparison with the non-COVID patient group. Model 1 was unadjusted; model 2 was adjusted for age (continuous), sex, and race; and model 3 was adjusted for variables adjusted in model 2 plus Medicare Severity-Diagnosis Related Group (MS-DRG) weight (continuous). SAS Enterprise Guide 8.3 (SAS Institute, Cary, NC) was used for the statistical analysis.

Results

After applying exclusion and inclusion criteria, the COVID-19 arm had 368 patients and the non-COVID arm had 4253 patients during the specific period of the study. Notable significant differences between the two populations were that the COVID-19 cohort had a higher proportion of males, longer lengths of stay, and higher MS-DRG weights. Specifically, mean age was statistically significantly higher (61.0 years) among COVID patients compared with non-COVID patients (58.0 years); however, the prevalence of age older than 65 years was similar among two groups (37.8% and 35.6% among COVID and non-COVID groups, respectively, $P = 0.41$; Table 1). The sex distribution was similar; however, the non-COVID patients had a higher prevalence of white race of 63.9% compared with 51.2% in the COVID group ($P < 0.001$).

The mean length of stay was 6.12 days among COVID patients compared with 4.72 days in non-COVID patients, with a significant $P < 0.001$. The mean MS-DRG weight was significantly higher among COVID patients (1.85) compared with non-COVID patients (1.32; Table 1).

The mean average daily direct cost was higher among COVID patients ($1504.10) compared with non-COVID patients ($1341.30) with statistical significance. In a multivariate-adjusted (adjusted for age, sex, race, and MS-DRG weight) linear regression model (model 3 in Table 2), patients with the primary diagnosis of COVID had a $123.00 higher average daily direct cost compared with non-COVID patients ($P < 0.0001$). Of note, indirect costs, such as PPE and increased nurse staffing, were not included

Table 2. Multivariate adjusted linear regression model to estimate average daily direct cost by COVID patient

	Parameter estimate in US$ (95% CI)	*P*
Model 1: unadjusted	162.9 (115.2–210.5)	<0.0001
Model 2: adjusted for age, sex, and race	160.1 (112.2–207.9)	<0.0001
Model 3: adjusted for model 2 plus MS-DRG weight	123.0 (74.4–171.5)	<0.0001

CI, confidence interval; COVID, coronavirus disease; MS-DRG, Medicare Severity-Diagnosis Related Group.

in the statistical analysis because of the challenges of associating these costs directly to specific patients.

Discussion

The fiscal impact of the COVID-19 pandemic to the healthcare system has been unlike any other event in the modern medicine era. To assist hospitals during this crisis, the CARES Act funding provided US$100 billion of relief funding to qualifying hospitals. We hypothesized that in addition to losses experienced by hospitals, the cost of caring for a patient with COVID-19 in the inpatient setting was higher than for patients with similar demographics admitted to the hospital for another diagnosis. Using a multivariate adjusted linear regression model, we estimated the average daily direct cost for adult inpatients. The direct inpatient cost was $123.00 (95% confidence interval 74.4–171.5) higher per day in patients with COVID-19 compared with patients who did not have COVID-19 when adjusted for age, sex, race, and MS-DRG. Because of the many added expenditures beyond direct patient costs, the difference of $123.00/day is likely a marked underestimate of the true costs.

Through our analysis we were able to show a significant increase in the cost of caring for patients infected with COVID-19 admitted to the hospital. The difference in cost was significant when looking at the overall average, after adjusting for age, sex, and race, as well when adding the MS-DRG weight.

The indirect costs of caring for COVID-19 patients are also notable, including decreased nurse staffing ratios, lower physician censuses, and needed infrastructure changes (negative pressure rooms, ventilation/heating, and ventilation and air conditioning system upgrades) for these patients who naturally required more intensive care. For example, shifting a nurse staffing ratio from 6:1 down to 3–4:1 on the COVID-19–dedicated floors led to an estimated increase of $277.78 per patient in nursing costs. Another expenditure in which we saw significant increases, not only in the amount purchased but also the cost per item, was with PPE. The cost per month at our academic hospital increased by 136% ($236,942 to $559,698) beginning in March 2020.

Moreover, because of the difficulty of obtaining an accurate cost per patient, the expected cost differences of environmental services; in-hospital transportation; respiratory therapy; physical, occupational, and speech-language therapy; and other consultative services were not included in the study. Although not included in our analysis, if these costs were added, then it would only increase the difference in costs between COVID-19 patients and their uninfected counterparts.

Conservatively speaking, one would surmise that in hospitalized patients with COVID-19, the actual increase would be approximately $4000 per patient during the hospital stay. Considering the direct and indirect cost of caring for COVID-19 patients as inpatients, the financial impact would have been detrimental to hospitals and healthcare systems nationwide without the CARES Act funding. In addition, the downstream effects of the negative fiscal consequences of the pandemic may have disproportionately affected smaller and more rural institutions.

It is possible that our results are affected by cofounders that have not been taken into account and not measured in our study. Although we had COVID-19 inpatients at all of our hospitals within the health system, our study was focused only on the main academic center because of the complicated nature of retrieving the data accurately. In that vein, our study may not be representative of all patient populations. The other limitation may be around our efforts to compare similarly medically complex cases by using the MS-DRG weight as a proxy.

We believe that this study is important to highlight the increased costs during the COVID-19 pandemic and the financial benefit that the CARES Act provided to many hospitals and healthcare systems. These essential funds allowed our hospitals to provide strong, stable care to our patients while keeping our healthcare workers safe. More studies are recommended to validate our findings.

Conclusions

The average daily direct hospital cost is higher among patients with a primary diagnosis of COVID-19–related illness compared with non-COVID-19–related illness. There are many reasons that contribute to this cost difference, such as decreased nurse staffing ratios, lower physician censuses, needed infrastructure changes, and so forth. Studies with a larger sample size and more precise comparable study groups are warranted to validate our finding, however.

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