ORIGINAL RESEARCH

Health Care Costs Following COVID-19 Hospitalization Prior to Vaccine Availability

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Background: **Postacute sequelae of coronavirus (PASC) disease of 2019 (COVID-19) include morbidity and mortality, but little is known of the impact on medical expenditures. This study measures patients' health care costs after COVID hospitalization before vaccinations.**

Methods: **The Merative MarketScan database is used to track trends in medical expenditures for commercially insured patients hospitalized for COVID-19 (case subjects) compared with COVID-19 patients not hospitalized (control subjects) using a propensity score matching model. Medical expenditures were estimated from 30-, 60-, and 120-day clean periods after an initial COVID-19 encounter through the end of 2020.**

Results: **Average total medical expenditures were 96% higher for individuals hospitalized for COVID-19 starting 30 days after initial COVID-19 encounter and almost 70% higher 120 days after based on the propensity score matching. The average spending differential was $11,242 30 days after and $4959 120 days after. This effect is highest for inpatient admissions and services 60 days after at $56,862 and lowest among pharmaceuticals 120 days after at $329. The magnitude of the difference is greater for those with hypertension or diabetes where total expenditures is $14,958 30 days after, and $5962 120 days after compared with those without these chronic conditions.**

Discussion: **The results suggest both health and economic implications for COVID-19 hospitalization and supports the use of vaccinations to help mitigate these implications. PASC includes increased health care costs for hospitalized patients, particularly for those with chronic conditions. Preventing COVID-19 hospitalization has economic value in terms of reduced medical spending in addition to health benefits associated with reduced morbidity and mortality. (J Am Board Fam Med 2023;00:000–000.)**

Keywords: **COVID-19, Health Care Economics, Health Expenditures, Hospitalization, Pandemics, Propensity Score, Vaccination**

Introduction

Postacute sequelae of coronavirus (PASC) disease of 2019 (COVID-19) describes long-term symptoms experienced weeks or months after primary infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) and may entail direct and indirect consequences on human health[1,2] Studies have shown that prevalence of PASC range from 5% among nonhospitalized patients to 80% among hospitalized patients 3 to 24 weeks after acute phase or hospital discharge,[3,4] with approximately 10% of all patients presenting with PASC.[5] This is the time frame when patients continue to experience a variety of physical and mental health consequences.[6–9] Severe PASC outcomes are more likely among patients hospitalized with more serious infections[10–13] but they also occur for less severe cases as well.[6,14] In fact, symptoms across a range of health domains were present in certain patients 1 year after hospital discharge with COVID-19.[6]

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The numerous clinical sequelae of COVID-19 impact the quality of life of patients which result in increased health care utilization.[6,15,16] However, the impact of COVID-19 on health care costs before vaccinations is not clearly understood. One study investigated the costs post COVID-19 diagnosis and discovered that it was associated with increased health care utilization and costs over a 6-month post diagnosis period.[17] However, that study did not distinguish PASC outcomes between patients who had been initially hospitalized with COVID-19 versus those who had not been hospitalized. Furthermore, the medical costs for treating PASC have not been estimated, but are predicted based on other illnesses.[18,19]

Medical costs post COVID-19 may offer insight into both the economic and health benefits of preventing COVID-19 hospitalizations among all populations. The purpose of this study is to estimate the health care cost implications for patients hospitalized with COVID-19 relative to nonhospitalized patients before the availability of vaccinations, in an attempt to show the value associated with mitigating the risks of COVID hospitalization. In this study, the investigators also specifically analyze the health care costs for patients with cardiovascular disease, hypertension, or diabetes.

Methods

Study Data

This study utilized a subset of individual-level data from the Merative MarketScan Lab Results Database, which is a 4.4-million-person subsample of the Merative MarketScan Treatment Pathways. This deidentified data set allowed a focus on the commercially insured population. The database contained integrated claims, lab test results, and enrollment information submitted by more than 150 employers and 200 commercial insurance carriers.

Outpatient services data contained encounters and claims for services in a doctor's office, hospital outpatient facility, emergency department, or other outpatient facility. Inpatient admissions data contained encounters and claims associated with an admission (eg, hospital, physician, surgeon, independent laboratory claims) defined as presence of a room and board claim. Some claims for nursing homes and skilled nursing facilities were included but are a trivial part of the total. Outpatient pharmaceutical claims records contained a mail order or card program prescription drug claim. All data sets were merged by enrollee identification number.

All data in this study was from the 2020 calendar year. Patients were included in the study if they had COVID-19 and were aged ≥18 and < 65 years old to restrict analysis to adults not eligible for Medicare. COVID-19 diagnosis was ascertained via any of 3 ways: positive COVID-19 polymerase chain reaction (PCR) test result (LOINC: 94500-6, 94309-2, 94559-2, 94562-6, 94563-4, 94564-2, 94565-9, 94762-2, 94763-0, 95209-3,95380-2); an outpatient claims with a COVID-19 diagnosis using *International Classification of Diseases, Tenth Revision* (ICD-10) codes (ICD10 U07.1); an inpatient claim with a COVID-19 diagnosis (ICD10 U07.1). The COVID-19 hospitalized cohort had an inpatient claim with a COVID-19 diagnosis, whereas the nonhospitalized cohort did not have the inpatient claim. Patients who were pregnant were excluded.

The index date for each patient was the earliest of their first positive COVID-19 PCR test result, outpatient claim with a COVID-19 diagnosis or inpatient claim with a COVID-19 diagnosis. To allow the initial COVID-19 episode and potential COVID-19 associated spending to resolve, we define clean periods that start 30-, 60-, and 120-days after the patient's initial index date to exclude expenditures associated with the initial episode of the illness. These clean periods are the time spans where all medical expenditures are ignored and no spending is attributed to either the initial or post COVID-19 episode. After these clean periods, a new compilation of spending for each patient was summed through the end of 2020. Medical expenditures comprised payments made by insurance providers and individuals. Negative medical expenditures were converted to missing values. Separately, summation for 3 different spending types: outpatient, inpatient, and drugs were calculated. Expenditures in each of the 3 categories of medical services, as well as a combination of the totals for these sectors were analyzed. The sample was separated into 2 cohorts: case subjects, patients with inpatient hospitalization for COVID-19 and control subjects, who have no documented inpatient hospitalization for COVID-19. Because vaccinations were associated with decreased COVID-19 hospitalization risk, this study sample is unique because vaccines were not available until early December of 2020.

The Institutional Review Board (IRB) from the University of Illinois at Chicago reviewed the protocol for this project and determined it did not meet the definition of human subject research (Protocol # 2020-1558).

Analysis

A propensity score matching method was implemented to compare case subjects (hospitalized for COVID-19) to control subjects (not hospitalized for COVID-19). This model aimed to account for unobservables and obtain an unbiased and accurate measure of costs attributed to COVID-19 hospitalization. Matched subjects who were not hospitalized for COVID-19 must be similar to the case subjects who were hospitalized, such that the only difference is attributed to the effects of the virus.

The matching model in this analysis controlled for as many demographic characteristics that were available in the dataset including: patient age, sex, region, employee classification, employment status. Health status was measured by matching based on prevalence of cardiovascular disease related conditions and cancer in 2019 including: hypertension, diabetes, chronic obstructive pulmonary disease, congestive heart failure, cancer diagnosis (includes ICD-10 codes E10, E11, E13, I10, J440, J441, J449, F32, F33, I50.2, I50.3, I50.4, Z34, O09, and C) in 2019. Month of initial COVID-19 encounter in 2020 was also included to control for time frame remaining to accumulate expenditures and virulence of COVID-19 (or other illnesses) which shifted over the course of the year. A subset analysis was also conducted for patients with hypertension and/or diabetes relative to their counterparts. The subset analysis excludes hypertension, diabetes, and congestive heart failure diagnoses as controls in the matching model.

The average treatment effect on the treated was calculated using a probit model for probability of treatment. Statistical significance was defined as a P value <0.05 for the z-statistic. All analyses were conducted using SAS 9.4 (SAS Institute Inc. Cary, NC) and STATA 17 (StataCorp LP, College Station, TX).

Results

The descriptive characteristics of the population under study (n = 567,320), the 7633 case subjects with a positive COVID-19 encounter and were hospitalized for the illness, and the 559,687 control subjects with COVID-19 that were not hospitalized are presented in Table 1. Among the population of adult patients, 37% were between the ages of 18 to 34 years with roughly equal percentages of patients in the older age brackets. However, almost half of those that were hospitalized were between the ages of 55 to 64 years (47%) with the fewest between the ages of 18 to 34 years (8%). In addition, sample distribution by sex for the full sample shows a slightly higher proportion of females (55%), however 54% of those hospitalized were male. The sample is heavily concentrated in the south and northeast geographic regions (75%) which also has the highest rates of hospitalization (79%). Among employee classification, hourly employees were more likely to be hospitalized, unfortunately 79% of data for this variable were unknown or missing. More than 74% were actively employed, but data for another 23% were unknown or missing. The proportions of demographic data were similar among the full sample and the breakouts between case and control subjects for employment. Month of COVID-19 encounter shows a similar distribution between case and control subjects. Univariate Chi-square test shows all demographic characteristics were associated with COVID-19 encounter ($P < .001$).

Table 2 shows average medical expenditures in 2020 by category for case subjects, and both the unmatched and matched samples. In addition to computing the difference in spend for the unmatched sample, it also estimates the average treatment effects using propensity score matching to match a control subject who was not hospitalized for COVID-19 to a case subject who was hospitalized based on the covariates used in the model. There is a differential in spending between these groups, which is slightly truncated with the matching method. There was a statistically significant spending differential between the 2 groups in all expenditure categories of the matched sample based on the z-score ($P < .05$) and the unmatched model (results not shown). Comparisons of the declines in mean bias for all iterations for the unmatched sample to the matched sample, coupled with high percent reduction in bias for all covariates (results not shown) indicate the match was successful at reducing the bias between the 2 groups.

Average total medical expenditures were 96% higher for individuals who were hospitalized for

Table 1. Baseline Characteristics of the COVID-19 Patients in the Cohort

	Full Sample N (%)	Hospitalized N (%)	Not Hospitalized N (%)	Chi-sq *p*-Value
Total Sample	567,320 (100)	7,633 (1)	559,687 (99)	
Sex				<0.001
Male	254,360 (45)	4,088 (54)	250,272 (45)	
Female	312,960 (55)	3,545 (46)	309,415 (55)	
Age				<0.001
18 to 34 years	211,392 (37)	631 (8)	210,761 (38)	
35 to 44 years	116,553 (21)	1,034 (14)	115,519 (21)	
45 to 54 years	125,308 (22)	2,375 (31)	122,933 (22)	
55 to 64 years	114,067 (20)	3,593 (47)	110,474 (20)	
Region				<0.001
Northeast	194,057 (34)	1,934 (25)	192,123 (34)	
North Central	54,685 (10)	831 (11)	53,854 (10)	
South	238,016 (42)	4,097 (54)	233,919 (42)	
West	80,132 (14)	766 (10)	79,366 (14)	
Unknown	430 (<1)	5 (<1)	425 (<1)	
Employee classification				<0.001
Salary Non-union	44,025 (8)	497 (7)	43,708 (8)	
Salary Union	522 (<1)	11 (<1)	511 (<1)	
Salary Other	17,532 (3)	134 (2)	17,398 (3)	
Hourly Non-union	12,115 (2)	215 (3)	11,900 (2)	
Hourly Union	17,982 (3)	516 (7)	17,466 (3)	
Hourly Other	22,293 (4)	447 (6)	21,846 (4)	
Non-union	5,358 (<1)	104 (1)	5,254 (1)	
Union	422 (<1)	23 (<1)	399 (<1)	
Unknown	446,891 (79)	5,686 (74)	441,205 (79)	
Employee status				<0.001
Active full-time	419,673 (74)	4,153 (54)	415,520 (74)	
Active part-time or seasonal	4,868 (<1)	80 (1)	4,788 (<1)	
Early Retiree	7,818 (1)	261 (3)	7,557 (1)	
Medicare Eligible Retiree	1,355 (<1)	84 (1)	1,271 (<1)	
Retiree (status unknown)	41 (<1)	0 (0)	41 (<10)	
COBRA Continuee	1,793 (<1)	29 (<1)	1,764 (<1)	
Long Term Disability	341 (<1)	33 (<1)	308 (<1)	
Surviving Spouse/Depend.	739 (<1)	33 (<1)	706 (<1)	
Other/Unknown	130,692 (23)	2,960 (39)	127,732 (23)	
Month of encounter				<0.001
January	34 (<1)	0 (0)	34 (<1)	
February	45 (<1)	1 (<1)	44 (<1)	
March	6,577 (1)	476 (6)	6,101 (1)	
April	23,281 (4)	1,160 (15)	22,121 (4)	
May	52,120 (9)	360 (5)	51,760 (9)	
June	76,540 (13)	603 (8)	75,937 (14)	
July	82,929 (15)	891 (12)	82,038 (15)	
August	49,334 (9)	506 (7)	48,828 (9)	
September	46,767 (8)	385 (5)	46,382 (8)	
October	56,784 (10)	617 (8)	56,167 (10)	
November	81,066 (14)	1,147 (15)	79,919 (14)	
December	91,843 (16)	1,487 (19)	90,356 (16)	

Continued

Table 1. Continued

	Full Sample N (%)	Hospitalized N (%)	Not Hospitalized N (%)	Chi-sq *p*-Value
Other conditions (not mutually exclusive)[a,b]				
Hypertension	73,278 (13)	2,981 (39)	70,297 (13)	<0.001
Diabetes	33,346 (6)	1,959 (26)	31,387 (6)	<0.001
Depression	29,759 (5)	611 (8)	29,148 (5)	<0.001
CHF	156 (<1)	12 (<1)	144 (<1)	<0.001
COPD	3,099 (<1)	179 (2)	2,920 (<1)	<0.001
Cancer	11,771 (2)	342 (4)	11,429 (2)	<0.001

[a]Column percentage displayed are compared with those without the diagnosis of the condition (results not shown).
[b]Chi-sq *p*-values are computed including those without the diagnosis of the condition (results not shown).
Abbreviations: COBRA, consolidated omnibus budget reconciliation act; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease.

COVID-19 starting 30 days after initial encounter based on a diagnosis or test and continues to be almost 70% higher starting 120 days after based on the propensity score matching. The average treatment effect on the treated finds the differential in total expenditures between case and control subjects is $11,242 for spending starting 30 days after initial encounter through the end of the year and $4959 starting 120 days after initial encounter. This effect is highest among inpatient admissions and services starting 60 days after initial encounter at $56,862 and lowest among pharmaceuticals starting 120 days after initial encounter at $329.

The results shown in Table 3 confirm the spending differential between the 2 groups among patients with hypertension or diabetes. The total medical expenditures for this group were 101% higher starting 30 days after initial encounter, 102% higher starting 60 days after initial encounter, 70% higher 120 days after initial

Table 2. Average Medical Expenditures by Sector for COVID-19 Patients with Initial COVID-19 Hospitalization and COVID-19 Diagnosis but No Hospitalization

		Unmatched		Matched Treatment Effect	
	Case Subjects $ (n)	Control Subjects $ (n)	Difference $ (%)	Control Subjects $	Difference $ (%)
Outpatient services					
30 days	6,458 (4843)	2,856 (315,888)	3,602 (77)	3,477	2,981*** (60)
60 days	6,386 (3724)	2,610 (257,627)	3,776 (84)	3,342	3,044*** (63)
120 days	4,872 (2622)	1,934 (166,900)	2,937 (86)	2,922	1,950*** (50)
Inpatient admissions and services					
30 days	93,597 (512)	46,381 (5294)	47,216 (67)	48,756	44,841*(63)
60 days	105,524 (333)	45,584 (4034)	59,940 (79)	48,662	56,862* (74)
120 days	67,404 (171)	42,691 (2050)	24,714 (45)	44,204	23,200** (42)
Pharmaceuticals					
30 days	2,533 (4000)	1,600 (248,703)	933 (45)	2,054	479** (21)
60 days	2,438 (3159)	1,476 (202,328)	963 (49)	1,974	464** (21)
120 days	1,854 (2232)	1,120 (130,261)	734 (49)	1,525	329* (19)
Total					
30 days	17,329 (5155)	4,380 (352,895)	12,949 (119)	6,087	11,242*** (96)
60 days	16,486 (4041)	4,005 (288,316)	12,481 (122)	6,093	10,393*** (92)
120 days	9,729 (2923)	2,897 (192,065)	6,832 (108)	4,770	4,959*** (68)

Notes: Statistical significance (*$P<.05$, **$P<.01$, ***$P<.001$) using z-score; All spending is assessed 30, 60 or 120 days after the COVID-19 index data till the end of the calendar year. The difference for control subjects in both the unmatched and matched models is relative to the cases subjects.

Table 3. Average Medical Expenditures by Sector for COVID-19 Patients with Hypertension and/or Diabetes with Initial COVID-19 Hospitalization and COVID-19 Diagnosis but No Hospitalization

		Unmatched		Matched Treatment Effect	
	Case Subjects $ (n)	Control Subjects $ (n)	Difference $ (%)	Control Subjects $	Difference $ (%)
Outpatient services					
30 days	7,222 (2161)	4,157 (53,101)	3,064 (54)	4,073	3,149*** (56)
60 days	6,938 (1721)	3,759 (44,857)	3,180 (59)	4,083	2,855*** (52)
120 days	5,290 (1245)	2,705 (31,297)	2,586 (65)	3,120	2,170*** (52)
Inpatient admissions and services					
30 days	110,933 (270)	50,097 (1703)	60,836 (76)	45,475	65,458 (84)
60 days	123,336 (189)	49,886 (1324)	73,450 (85)	45,318	78,018 (93)
120 days	70,525 (96)	46,972 (707)	23,553 (40)	59,004	11,521 (18)
Pharmaceuticals					
30 days	3,090 (1887)	2,382 (48,597)	708 (26)	2,574	516 (18)
60 days	2,993 (1522)	2,150 (40,666)	843 (33)	2,280	713** (27)
120 days	2,241 (1104)	1,533 (28,691)	708 (38)	1,818	423 (21)
Total					
30 days	22,285 (2306)	7,704 (59,635)	15,211 (97)	7,327	14,958*** (101)
60 days	21,424 (1858)	6,407 (50,274)	15,018 (108)	6,953	14,471** (102)
120 days	11,464 (1381)	4,452 (36,348)	7,011 (88)	5,502	5,962*** (70)

Notes: Statistical significance ($*P < .05$, $**P < .01$, $***P < .001$) using z-score; All spending is assessed 30, 60 or 120 days after the COVID-19 index data till the end of the calendar year. The difference for control subjects in both the unmatched and matched models is relative to the cases subjects.

encounter based on the propensity score matching. The average treatment effect on the treated for total expenditures is $14,958 starting 30 days after initial encounter, and $5962 starting 120 days after initial encounter. The magnitude of the difference is substantially higher for those with these chronic conditions compared with those without who saw a $8627 difference starting 30 days after initial encounter and $4795 difference starting 120 days after initial encounter (results shown in Table 4).

Discussion

The results of this study indicate that increased health care costs were an important, if previously unrecognized, outcome after hospitalization for COVID-19. Given the wide-ranging and extensive list of symptoms and outcomes associated with PASC, it is likely that much of these increased health care costs were the result of COVID-19. It should be noted that the relative costs for patients who were hospitalized were more than 100% higher, regardless of the starting days after the initial encounter, than for patients who were not hospitalized during their initial COVID-19 episode. This suggests strategies to reduce readmissions after hospitalization for COVID-19 should be explored to reduce likelihood of readmission and expenditures. Of the 7633 patients hospitalized for COVID-19, we found second inpatient visits for 494 patients (6.5%) 30 days after initial encounter, 259 patients (3.4%) 60 days after initial encounter, and 105 patients (1.4%) 120 days after initial encounter.

These findings point to the value of preventing COVID-19 hospitalizations to improve health outcomes in addition to mitigating the economic costs associated with severe illnesses. The results show hospitalized patients have persistently higher medical expenditures over time compared with their nonhospitalized counterparts. A COVID-19 hospitalization is a preventable risk factor according to data on COVID-19 vaccination and outpatient COVID-19 treatments such as nirmatrelvir-ritonavir.[20,21] Individuals who were vaccinated for COVID-19 were significantly less likely to be hospitalized than those who were not vaccinated, and the same is true for individuals with COVID-19 treated with nirmatrelvir-ritonavir compared with

Table 4. Average Medical Expenditures by Sector for COVID-19 Patients without Hypertension and/or Diabetes with Initial COVID-19 Hospitalization and COVID-19 Diagnosis but No Hospitalization

		Unmatched		Matched Treatment Effect	
	Case Subjects $ (n)	Control Subjects $ (n)	Difference $ (%)	Control Subjects $	Difference $
Outpatient services					
30 days	5,844 (2682)	2,593 (262,787)	3,250 (77)	3,000	2,844*** (64)
60 days	5,911 (2003)	2,367 (212,770)	3,543 (86)	2,960	2,951*** (67)
120 days	4,493 (1377)	1,757 (135,603)	2,737 (88)	2,329	2,164*** (63)
Inpatient admissions and services					
30 days	74,255 (242)	44,618 (3591)	29,637 (50)	45,852	28,403** (47)
60 days	82,144 (144)	43,482 (2710)	28,662 (62)	49,138	33,006* (50)
120 days	63,409 (75)	40,436 (1343)	22,972 (44)	49,595	13,814 (24)
Pharmaceuticals					
30 days	2,035 (2113)	1,410 (200,106)	625 (36)	1,614	421* (23)
60 days	1,923 (1637)	1,306 (161,662)	617 (38)	1,539	384* (22)
120 days	1,475 (1128)	1,004 (101,570)	471 (38)	1.191	284 (21)
Total					
30 days	13,317 (2849)	3,832 (293,260)	9,486 (111)	4,690	8,627*** (96)
60 days	12,283 (2183)	3,498 (238,012)	8,786 (111)	4,327	7,956*** (96)
120 days	8,175 (1542)	2,533 (155,717)	5,641 (105)	3,380	4,795*** (83)

Notes: Statistical significance (*$P < .05$, **$P < .01$, ***$P < .001$) using z-score; All spending is assessed 30, 60 or 120 days after the COVID-19 index data till the end of the calendar year.

those who were not treated. Because the time period in this study is one where COVID-19 vaccination and effective outpatient treatment was not available in the US, it allows us to investigate the implications of a COVID-19 hospitalization without the potential confounding variable of vaccinations or newer pharmacotherapy.

There is also evidence that the risk of poor outcomes and increased costs is increased with certain underlying medical conditions, including coronary artery disease and diabetes.[22–25] The current study shows expenditures after COVID-19 infection were higher for patients with hypertension or diabetes compared with those without. In addition, the differential in these expenditures between hospitalized and nonhospitalized COVID-19 patients is significantly higher for patients with hypertension or diabetes compared with those without these chronic diseases. The findings presented in this study suggest that patients with hypertension or diabetes were likely to experience more severe sequelae from COVID-19 and incur substantially higher health care-related costs. This suggests that substantial potential health care cost savings might be brought about through greater attention toward the prevention and treatment of these chronic diseases.

There were several strengths and limitations to this study. A strength of the study is that the data are confined to a time when vaccines were not widely available. In addition, the database represents the entire United States. However, there may be regional differences in health care utilization, so the results were adjusted for regional differences. A potential limitation of the study is that study participants were adults under age 65. Older adults were at greater risk for poor COVID-19 outcomes. Health care cost differentials may have been even higher in an older population. However, by showing a relationship between COVID-19 hospitalization and increased downstream health care costs in a younger population, the costs would be higher for the elderly and point to the need for prevention of COVID-19 hospitalization in all adults. Furthermore, we were restricted to the use of claims data and were unable to capture clinical details for these patients which would allow us to measure the common drivers of expenditures between the hospitalized and nonhospitalized groups along with parsing out cases of incidental COVID-19. Although it was out of the scope of this study, it would be an interesting area for further investigation. Finally, the data are limited to the 2020 calendar year, and expenditures for those diagnosed later in the year may not account for medical care costs that trickled into 2021. A quarterly subset analysis was conducted to check for any major outliers in spending patterns, but none were found.

In conclusion, we provide additional information on the increased downstream health care costs post recovery for patients with an initial COVID-19 hospitalization. Prevention of COVID-19 hospitalization has many benefits in terms of initial COVID-19 outcomes and costs and should therefore be prioritized in public health policy.

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