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Declines in the utilization of hospital-based care during COVID-19 pandemic

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Abstract

The disruptions of the coronavirus disease 2019 (COVID-19) pandemic impacted the delivery and utilization of healthcare services with potential long-term implications for population health and the hospital workforce. Using electronic health record data from over 700 US acute care hospitals, we documented changes in admissions to hospital service areas (inpatient, observation, emergency room [ER], and same-day surgery) during 2019–2020 and examined whether surges of COVID-19 hospitalizations corresponded with increased inpatient disease severity and death rate. We found that in 2020, hospitalizations declined by 50% in April, with greatest declines occurring in same-day surgery (−73%). The youngest patients (0–17) experienced largest declines in ER, observation, and same-day surgery admissions; inpatient admissions declined the most among the oldest patients (65+). Infectious disease admissions increased by 52%. The monthly measures of inpatient case mix index, length of stay, and non-COVID death rate were higher in all months in 2020 compared with respective months in 2019.

INTRODUCTION

During the early coronavirus disease 2019 (COVID-19) pandemic period, utilization of hospital care may have been altered due to avoidance of care during stay-at-home orders, fear of becoming infected with the virus, and limiting of elective procedures.[1,2] Studies of specific patient cohorts and geographic locations have already reported decreased hospitalizations[3] and emergency room (ER) visits[4,5] during the first months of the pandemic. However, less is known about the utilization of hospital care across different hospital services and population groups, and how those changes impacted patient care and outcomes.

In this study of a nationwide cohort of US acute care hospitals, we used electronic administrative and health record data to describe changes in healthcare utilization in 2019–2020 across four hospital-based acute care services (inpatient, observation, ER, and same-day surgery). In addition, we examined the reasons for hospitalization and how they changed compared to the prepandemic year. Lastly, since the declines in hospitalizations along with surges of COVID-19 admissions may have impacted the characteristics of hospitalized

patients, we investigated whether the surges corresponded with increased inpatient disease severity and mortality.

DATA AND METHODS

We used Premier Healthcare Database,[6] Special Release (PHD-SR) (05/31/2021) from January 1, 2019, to December 31, 2020, to analyze adult and pediatric admissions to the acute care hospitals in four service areas: inpatient, observation, ER, and same-day surgery. For this, we included records from over 700 general, acute care hospitals consistently reporting data to the PHD-SR to describe monthly admissions by facility (bed size, teaching status, urban/rural location, and census division) and patient (age, race/ethnicity, sex, admission type, and discharge status) characteristics.

For inpatient admissions, we examined changes in the reason for hospitalization by grouping principal discharge diagnoses into 21 mutually exclusive clinical disease categories using Clinical Classifications Software (CCSR).[7] We calculated monthly measures of mean length of stay (LOS), case mix index (CMI)[8], and death rates. CMI was calculated by adding up the relative Medicare Severity Diagnosis Related Group weights and dividing by the total number of discharges. Using inpatient discharge status, we calculated two in-hospital death rates: COVID-19 case fatality rate (CFR) and pooled non-COVID-19 death rate. COVID-19 CFR was calculated for March–December 2020 as the number of in-hospital deaths among patients diagnosed with COVID-19 over the total number of COVID-19 discharges. The pooled non-COVID-19 death rate was calculated for all months of 2019–2020 as the total number of deaths among patients *not* diagnosed with COVID-19 over the total number of non-COVID discharges. We generated severity-adjusted non-COVID death rates using a multivariable generalized estimating equation negative binomial model offset by the natural log of the number of non-COVID discharges and adjusting for calendar year and month, hospital characteristics, and monthly measures of mean LOS, the proportion of patients aged ≥65, the proportion of male patients, mean CMI, and COVID-19 hospitalization rate.

COVID-19 hospitalizations were identified by searching primary or secondary diagnosis codes for COVID-19 (*ICD-10-CM* code U07.1) during April–December 2020. For discharges prior to April 1, 2020, we used *ICD-10-CM* code B97.29, indicating "other coronavirus as the cause of diseases classified elsewhere."[9] Monthly admission counts in 2020 were compared to admission counts in respective months in 2019 using percent change, prevalence ratios, and Wilcoxon signed rank test for median difference. Prevalence ratios were calculated as a proportion of admissions in 2020 over the proportion of admissions in 2019 and the ratio of means.

To assess whether surges of COVID-19 hospitalizations may have had an impact on non-COVID-19 inpatient mortality and corresponded with changes in CMI and LOS, each pandemic hospital-month was categorized into five COVID-19 burden categories (more detail in Table 1 Notes): no COVID-19, low, moderate, moderate-to-high, and high. Hospital months with >0 COVID-19 cases were grouped into four burden categories based on the overall COVID-19 rate distribution: low (0.49–19.87), moderate (19.88–49.94), moderate to high (49.95–115.37), and high (≥115.38). As the hospital-specific COVID-19 rate changed month to month, a hospital could appear in different categories for different months.

This activity was reviewed by the Centers for Disease Control and Prevention (CDC) and was conducted consistently with applicable federal law and CDC policy (see the following: 45C.F.R. part 46; 21C.F.R. part 56; 42 U.S.C. §241(d), 5 U.S.C. §552a, 44 U.S.C. §3501 et seq.). All data were analyzed using PySpark (Python) on the Data Collation and Integration for Public Health Event Response (DCIPHER) platform and SAS version 9.4 (SAS Institute Inc.).

RESULTS

In 2019–2020, there were 76,914,760 admissions to the hospital service areas, including inpatient, observation, ER, and same-day surgery. Sharp declines in admissions to these settings in March 2020 were followed by a nadir in April 2020 (Figure 1, Supporting Information: Appendix Figure 1). Although declines in April 2020 were greatest in same-day surgery admissions (−73.3% when compared to the number of same-day surgery admissions in April 2019), they rebounded to prepandemic level by September. Such a degree of return was not observed in other settings. Summing all cases for the year, same-day surgery admissions in 2020 were 13.8% below the 2019 baseline, compared with approximately 20% and 22% lower levels in observation and ER admissions, respectively (Supporting Information: Appendix Table 1). During the early pandemic period, the youngest patients (0–17 years old) experienced largest declines in admissions to ER (−51.2%), observation (−40.6%), and same-day surgery (−27.4%); inpatient admissions declined the most among the oldest patients (aged ≥65 years old) (−13.7%) (Supporting Information: Appendix Figure 2).

Regional variability in admissions was observed, where inpatient admissions in the Mountain region increased by 3.6% and South Atlantic same-day surgery admissions declined by only 6.5% (Supporting Information: Appendix Table 2). In general, same-day surgery admissions declined more in urban than rural hospitals (−15.1% vs. −9%), with no differences by teaching status.

The pandemic-related declines in inpatient admissions affected every clinical disease category, but especially respiratory diseases (−37.4%), musculoskeletal and connective tissue diseases (−35%), and diseases of the ear and mastoid process (−28.4%) (Supporting Information: Appendix Table 3). Inpatient admissions for pregnancy-related and perinatal conditions were not as affected and declined only 4.8%. The only increase in admissions was seen for infectious diseases, which increased 52%

TABLE 1 Inpatient outcomes in March–December 2019 and March–December 2020 by hospital COVID-19 burden in 2020

	Hospital COVID-19 burden[a,b]				
	No COVID-19	Low (0.49–19.87)	Moderate (19.88–49.94)	Moderate to high (49.95–115.37)	High (≥115.38)
Total hospital months	1162	1682	1682	1679	1685
COVID-19 hospital admission rate per 1000 discharges, 2020					
Mean (SE)	0	9.83 (0.13)	33.20 (0.21)	76.78 (0.45)	220.25 (2.81)
Median (interquartile range)	0	9.43 (5.21–14.4)	32.40 (25.82–40.31)	74.69 (60.61–90.91)	184.21 (143.83–253.33)
COVID-19 case fatality rate per 100 COVID-19 discharges					
Mean (SE)	0	10.04 (0.45)	9.86 (0.25)	10.77 (0.20)	11.44 (0.22)
Median (Interquartile range)	0	0 (0–14.29)	8.33 (0–14.81)	10.00 (4.76–15.56)	10.79 (5.56–16.18)
Non-COVID-19 in-hospital death rate per 1000 non-COVID discharges					
2019					
Mean (SE)	15.89 (0.79)	17.48 (0.32)	16.49 (0.26)	17.25 (0.28)	16.75 (0.34)
Median (interquartile range)	7.44 (0–22.18)	16.48 (9.9–23.87)	15.73 (9.52–22.28)	16.09 (9.99–23.29)	15.85 (8.03–23.43)
2020					
Mean (SE)	15.56 (0.94)	19.29 (0.29)	19.24 (0.32)	20.44 (0.31)	23.97 (0.63)
Median (interquartile range)	0.00 (0–21.43)	18.35 (10.99–26.09)	17.79 (11.43–25.68)	19.82 (12.49–27.32)	21.95 (10.78–31.25)
p Value	<.016	<.0001	<.0001	<.0001	<.0001
Overall death rate per 1000 discharges					
2019					
Mean (SE)	15.89 (0.79)	17.48 (0.32)	16.49 (0.26)	17.25 (0.31)	16.75 (0.34)
Median (interquartile range)	7.44 (0–22.18)	16.48 (9.90–23.87)	15.73 (9.52–22.28)	16.09 (9.99–23.29)	15.85 (8.03–23.43)
2020					
Mean (SE)	15.56 (0.94)	20.05 (0.30)	21.91 (0.34)	27.17 (0.37)	43.39 (0.87)
Median (interquartile range)	7.34 (0–21.43)	16.48 (11.56–27.36)	15.73 (13.37–28.89)	16.09 (17.51–35.82)	15.85 (23.64–54.99)
p Value	<.016	<.0001	<.0001	<.0001	<.0001
Mean case mix index[c]					
2019					
Mean (SE)	1.31 (0.02)	1.49 (0.01)	1.48 (0.01)	1.47 (0.01)	1.40 (0.01)
Median (interquartile range)	1.18 (1.03–1.37)	1.46 (1.30–1.63)	1.46 (1.28–1.63)	1.45 (1.29–1.62)	1.40 (1.22–1.57)
2020					
Mean (SE)	1.36 (0.02)	1.53(0.01)	1.54 (0.01)	1.56 (0.01)	1.59 (0.01)
Median (interquartile range)	1.17 (1.01–1.38)	1.50 (1.32–1.69)	1.51 (1.34–1.72)	1.54 (1.37–1.72)	1.58 (1.39–1.75)
p Value	.742	<.0001	<.0001	<.0001	<.0001
Mean length of stay in days					
2019					
Mean (SE)	3.51 (0.07)	4.01 (0.03)	4.02 (0.03)	4.03 (0.02)	3.86 (0.03)
Median (interquartile range)	3.05 (2.61–3.70)	3.92 (3.40–4.47)	3.94 (3.39–4.52)	3.95 (3.46–4.57)	3.79 (3.19–4.43)

(Continued)

TABLE 1 (Continued)

	Hospital COVID-19 burden[a,b]				
	No COVID-19	Low (0.49–19.87)	Moderate (19.88–49.94)	Moderate to high (49.95–115.37)	High (≥115.38)
2020					
Mean (SE)	3.46 (0.07)	4.09 (0.04)	4.21 (0.03)	4.36 (0.02)	4.60 (0.03)
Median (interquartile range)	3.00 (2.46–3.75)	4.00 (3.40–4.61)	4.11 (3.56–4.72)	4.32 (3.74–4.96)	4.54 (3.84–5.24)
p Value	.004	<.0001	<.0001	<.0001	<.0001

Note: Where appropriate, inpatient outcomes in 2020 are compared with respective months in 2019 using *p* values from Wilcoxon signed rank tests for median differences.

Abbreviation: SE, standard error.

[a]Each hospital month during March–December 2020 was categorized into COVID-19 burden categories based on the rate of COVID-19 cases per 1000 discharges. "No COVID-19" burden category represents hospital months with 0 COVID-19 cases. The cutoff points for grouping hospital months with >0 COVID-19 cases into burden categories represent quartile values of the overall COVID-19 rate per 1000 discharges, excluding hospital months with 0 COVID-19 cases. As hospital COVID-19 hospitalization rate changed over time, a hospital could appear in one burden category for 1 month and another category for a different month. Where appropriate, matched facility data from March–December 2019 was compared to 2020 using *p* values based on Wilcoxon signed rank tests for median differences.

[b]*p* Values for comparison of mean COVID-19 hospital admission rate, COVID-19 case fatality rate, non-COVID-19 in-hospital death rate, and overall death rate across COVID-19 burden categories were obtained using generalized estimating equation logistic regression models. For median case mix index and median length of stay, *p* values were obtained from median regression models using the SAS QUANTREG procedure. All *p* values were <.0001 and not included in the table.

[c]Overall case mix index reflects the complexity and severity of patient illnesses treated at a given hospital and was calculated for each hospital month by adding up the relative Medicare Severity Diagnosis Related Group (MS-DRG) weight and dividing by the total number of discharges.

from 499,641 to 758,752 admissions. The pooled in-hospital death rate among non-COVID patients was higher in March–April 2020 (20.38–25.4/non-COVID discharges) as compared with the crude in-hospital death rate in March–April 2019 (18.49–17.8/1000 total discharges) (Figure 1, Supporting Information: Appendix Table 4). The second increase in the non-COVID death rate was in November–December 2020 when respective rates were 20.7–23.7 per 1000 non-COVID patients. The model-derived adjusted death rates among non-COVID inpatients were higher during all months of 2020 when compared with inpatient death rates in 2019. When compared across COVID-19 burden categories, in 2020, the mean non-COVID death rate increased from 15.56 during "No COVID-19" hospital months to 23.97/1000 non-COVID discharges during "High COVID-19 Burden" ($p < .0001$) (Table 1). The mean COVID-19 CFR per 100 COVID-19 discharges increased from 10.04 in the low burden category to 11.44 in the high burden category ($p < .0001$). Mean CMI and LOS were higher in March–December 2020 compared to the respective months in prepandemic period (Supporting Information: Appendix Table 4) and increased with each increase in hospital COVID-19 burden.

DISCUSSION

Among over 700 US acute care hospitals, representing about 25% of hospital discharges nationwide, we documented dramatic declines in admissions for all hospital-based services during the early COVID-19 pandemic period, but especially during March–April of 2020. While same-day surgery admissions returned to prepandemic levels by the end of 2020, admissions to inpatient, observation, and ER settings did not. The declines were greatest among the youngest (0–17 years old) and the oldest (≥65 years old). The complexity and severity of illness among hospitalized patients were higher during the pandemic months compared to prepandemic months, as evidenced by an increased death rate among non-COVID-19 patients. This indicates that while there were fewer admissions, healthcare providers dealt not only with surges in COVID-19 patients but also sicker non-COVID-19 patients. Furthermore, as the hospital burden of COVID-19 increased during the early pandemic period, there was a parallel increase in mortality among non-COVID patients and overall patient severity.

In general, the observed declines in acute care admissions corresponded with national surges of COVID-19 infections.[10] This was true not only for same-day surgery, where hospitals may have canceled admissions but also for emergency care, suggesting that personal decisions to avoid care were linked with the level of community transmission of COVID-19. In addition, largest declines in inpatient admissions among the oldest (65-year-old and older), as well as largest declines in admissions to other settings (ER, observation, and same-day surgery) among the youngest (0–17-year-old), are of concern as delays in needed care for those patients could have a greater adverse impact on their health. Further, although many clinical admission categories decreased in 2020, the increase in overall infectious disease admissions likely led to increased demand for related services, such as infectious disease specialists, infection control providers, and antimicrobial stewardship. Strengthening these services as well as enhanced education and training in infection control may help address both present and future challenges posed by the pandemic.

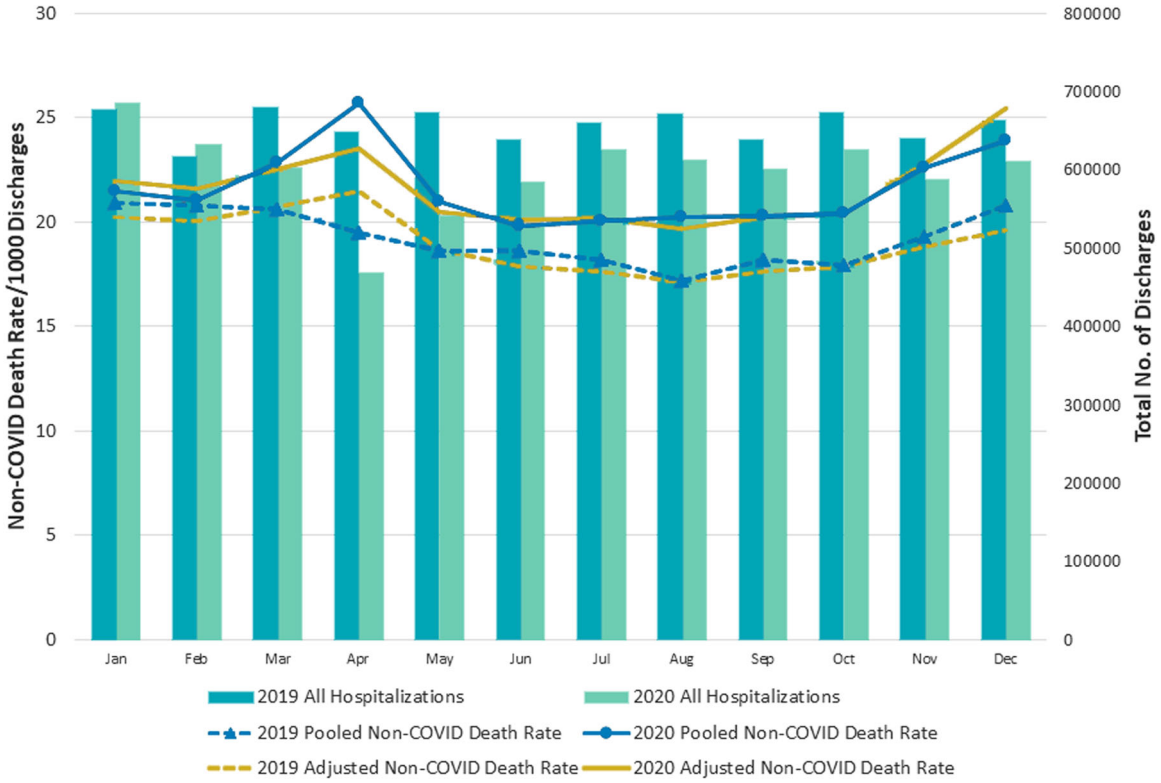

FIGURE 1 In-hospital death rates (pooled and adjusted) among non-COVID patients and the total number of hospitalizations in premier acute care hospitals consistently reporting data to the Premier Healthcare Database in 2019–2020. Pooled non-COVID death rates were calculated as the total number of deaths among patients *not* diagnosed with COVID-19 over the total number of non-COVID discharges. Adjusted non-COVID death rates were generated using a multivariable GEE negative binomial model offset by the natural log of the number of non-COVID discharges and adjusting for hospital characteristics (bed size, teaching status, region, and urban/rural location), and monthly measures of mean LOS, the proportion of patients aged ≥65, the proportion of male patients, mean CMI, and COVID-19 hospitalization rate. COVID, coronavirus disease 2019; GEE, generalized estimating equation; LOS, length of stay.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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