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Association of Hospital System Affiliation with COVID-19 Capacity Burden

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Abstract

What is the message? The COVID-19 pandemic exposed the highly variable and uncoordinated responses by hospitals. The authors found that while the non-top ten system affiliated hospitals had a larger COVID-19 share index relative to independent hospitals, top-ten system hospitals did not. Nonprofit status was also associated with higher COVID-19 patient share relative to the share of hospital beds, and hospitals in counties with a higher percentage of poverty and Black populations had a lower share of COVID-19 patients when hospital markets had low market concentration (more competitive hospital markets). The results suggest that proactive planning could help spread the COVID-19 burden on hospitals through resource allocations.

What is the evidence? Regression analysis of data from the Department of Health and Human Services (HHS) and the American Hospital Association's 2020 Annual Survey.

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Introduction

Hospital capacity, particularly in the ICU, during the height of the COVID-19 surges was predictive of patient mortality.[1,2] Although there were opportunities for greater resource sharing, hospital responses were highly variable and uncoordinated.[3,4] We investigated the association of hospital characteristics and their share of regional COVID-19 patients.

Data and Methods

We used data on 7-day averaged hospitalizations for COVID-19 from the Department of Health and Human Services (HHS) during the four weeks between 12/18/2020-1/14/2021, the first substantial peak nationally for COVID-19 hospitalizations. We matched each hospital to its Hospital Referral Region (HRR) based on zip code. For each hospital, we linked hospital characteristics (rural, available pediatric ICU unit, trauma center, ICU availability, for-profit/non-profit/government ownership, system affiliation) from the American Hospital Association's 2020 Annual Survey. We accounted for heterogeneity in population by linking county demographics (income, poverty, race/ethnicity, and population over 65), and 2-week lag of COVID-19 infections.

Our outcome variable for each hospital-week was the COVID-19 share index at the HRR level: the ratio of the hospital's share of patients hospitalized for COVID-19 in the HRR divided by that hospital's share of total licensed beds in the HRR. We estimated multivariate regression models, stratifying hospitals by their market concentration using the Herfindahl–Hirschman Index (HHI) as low (HHI < 1,500) and moderate/high concentration (HHI > 1,500) – with these cutoffs being consistent with how the U.S. Department of Justice characterizes market competition. Additional analyses accounted for the interaction between ownership and system affiliation. All models included week and state indicators.

Results

Over the four-week period, 2,901 unique hospitals reported an average of 45.7 COVID-19

patients each day (**Table 1**). Several types of hospitals that are not represented in these data from the HHS include the U.S. Department of Veterans Affairs (VA) hospitals, Defense Health Agency (DHA), Indian Health Services (IHS) hospitals and psychiatric and rehabilitation hospitals. In addition, hospitals in the data are identified by their contract number with Medicare (CCN number), and some hospitals may not have a CCN number, while some individual hospital facilities may share the same CCN number. Finally, cell suppression is applied by HHS, which means that a hospital-week observation with fewer than 5 COVID-19 patients are redacted.

Affiliation with a top ten largest hospital system nationally (relative to independent status) was not associated with the COVID-19 patient share index ($p < 0.001$) after adjusting for all hospital and geographic characteristics described above (**Table 2**). Affiliation with other systems (relative to independent status), and nonprofit status (relative to for-profit), was associated with higher COVID-19 patient share relative to their share of hospital beds ($p < 0.001$). In a sensitivity analysis that included interaction of system affiliation with ownership type, the association between system affiliation and COVID-19 share index did not vary significantly at p-value of less than 0.05 by ownership type.

Presence of pediatric and trauma units was associated with lower share of COVID-19 hospitalizations in moderate/high concentration markets. Hospitals in counties with higher percentage of poverty and Black population had a lower share of COVID-19 patients in low concentration markets. On the other hand, higher percentage of Hispanic county population was associated with higher COVID-19 hospitalization share independent of hospital concentration.

Discussion

Health system size has been linked to higher prices[5], with no significant improvement in quality on average compared with non-system physicians and hospitals.[6] We hypothesized that large systems could share COVID-19 hospital burdens due to the potential for greater integration. Our study examined the first major peak during the COVID-19 pandemic, one of the most capacity constrained periods for hospitals. We found that while the non-top ten system affiliated hospitals had larger COVID-19 share index relative to independent hospitals, top-ten system hospitals did not.

Our predicted outcome variable, hospital COVID-19 share index in low market concentration

markets was 1.14 for non-top ten system affiliated hospitals, 1.03 for independent hospitals and for top ten system hospitals (based on estimates reported in Table 2, adjusting for all other hospital characteristics). An average non-top ten system hospital had 5.47% of licensed beds in its HRR (denominator of the COVID-19 share index). Our estimates suggest that its share of COVID-19 patients in the HRR (numerator of the COVID-19 share index) was 6.23% (multiplying predicted outcome variable 1.14 with 5.47%). At an average HRR with 1,014 COVID-19 patients in a week, this corresponds to 63 COVID-19 patients cared for by an average non-top ten system hospital. In contrast, our results imply that an average independent hospital's share of COVID-19 patients was 5.04% while their share of licensed beds was 4.90% in their HRR. Similar to independent hospitals, an average top ten system hospital's share of CCOVID-19 patients was 5.01% and their share of licensed beds in the HRR was 4.84%.

Our study has several limitations. Although our data did not allow their identification, nonprofit and non-top ten system affiliated hospitals were more likely to be designated as COVID-19 specialized hospitals, leveraging possible economies of scale. The geographic market, HRR, is commonly used in the hospital market literature, but our findings could differ by alternative definitions of geographic areas.

It is alarming that Black Americans, who have the highest rate of death due to Covid-19[6], access to hospitals was predictive of mortality,[1,2] and our data showed that hospitals in counties with higher percentage of poverty and Black population had a lower share of COVID-19 patients in low hospital concentration markets.

Conclusion

These results suggest that proactive planning could help spread the COVID-19 burden among hospitals through resource allocations.

Acknowledgements: *This research uses publicly available data from the Department of Health & Human Services, accessed August 29, 2022 at:*
https://healthdata.gov/dataset/covid-19-reported-patient-impact-and-hospital-capacity-facility

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Endnotes

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Table 1: Characteristics of the Hospital Sample

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	All	Low Market Concentration	Medium/High Market Concentration
		(HHI < 1,500)	(HHI >= 1,500)
Mean HHI	1,768	836	2,877
Has ICU (%)	89.1%	91.3%	86.6%
Rural Hospital (%)	14.1%	10.5%	18.3%
Pediatric Unit (%)	39.2%	35.1%	44.1%
Obstetric Unit (%)	62.0%	61.7%	62.4%
Trauma Hospital (%)	39.5%	37.1%	42.4%
Non-Profit (%)	67.7%	67.0%	68.6%
Government Run (%)	13.5%	12.7%	14.3%
Top Ten System Affiliated (%)	21.6%	22.9%	20.1%
Non-top Ten System Affiliated (%)	54.8%	55.4%	54.2%
Median Household Income ($1,000s)	64.5	68.5	59.7
% Poverty in county	13.3%	12.5%	14.2%
% Hispanic in county	15.7%	16.6%	14.7%
% Black in county	13.3%	14.7%	11.6%
% Aged 65+ in county	17.0%	16.4%	17.8%
Lagged 2 Week COVID Cases (1,000s)	4.8	7.6	1.5
Average daily hospitalized COVID-19 patients	45.7	51.1	39.0
Average daily hospitalized COVID-19 ICU patients	11.8	12.8	10.5
Unique hospitals	2,901	1,582	1,319
Independent and non-profit	365	188	177
Non-top ten system and non-profit	1296	694	602
Top-ten system and non-profit	298	174	124
Independent and for-profit	73	40	33
Non-top ten system and for-profit	152	96	56
Top-ten system and for-profit	325	189	136
Independent and government	248	117	131
Non-top ten system and government	138	82	56
Top-ten system and government	6	2	4

Notes:

HHI: Herfindahl–Hirschman Index in the Hospital-Referral Region

Top 10 largest systems in the United States, were identified based on (https://www.hospitalmanagement.net/analysis/top-ten-largest-health-systems-in-the-us-by-number-of-hospitals-affiliated/): Advent, Prime, LifePoint, Ascension, Common Spirit, CHS, HCA, Providence, Trinity, Tenet.

Data Sources:

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Table 2: Association of hospital, organizational and county characteristics with hospital COVID-19 share index

	Low Market Concentration	Moderate/High Market Concentration
Hospital Characteristics		
Rural Hospital	0.001	-0.032
	(-0.078 – 0.080)	(-0.108 – 0.045)
Pediatric Unit	-0.017	-0.126***
	(-0.073 – 0.039)	(-0.189 – -0.063)
Obstetric Unit	-0.056*	-0.025
	(-0.117 – 0.006)	(-0.093 – 0.043)
Trauma Unit	-0.042	-0.102***
	(-0.098 – 0.014)	(-0.166 – -0.037)
ICU Unit	0.037	0.019
	(-0.100 – 0.175)	(-0.099 – 0.137)
Organizational Characteristics		
Non-Profit (Relative to For-Profit)	0.101***	0.124***
	(0.032 – 0.170)	(0.040 – 0.207)
Government (Relative to For-Profit)	0.034	0.031
	(-0.061 – 0.129)	(-0.082 – 0.144)
Top-Ten System (Relative to Independent)	0.004	-0.050
	(-0.075 – 0.083)	(-0.142 – 0.043)
Non-top Ten System (Relative to Independent)	0.094***	0.076**
	(0.032 – 0.156)	(0.004 – 0.148)
County Characteristics		
Median Household Income ($1,000s)	-0.001	0.002
	(-0.005 – 0.003)	(-0.003 – 0.007)
% Poverty	-0.014**	0.004
	(-0.026 – -0.002)	(-0.010 – 0.018)
% Hispanic	0.005**	0.006**
	(0.001 – 0.009)	(0.000 – 0.011)
% Black	-0.004***	-0.002
	(-0.007 – -0.001)	(-0.007 – 0.002)
% 65+	0.003	-0.010*
	(-0.005 – 0.012)	(-0.021 – 0.002)
Lagged 2 Week COVID Cases (1000s)	-0.001	-0.006
	(-0.004 – 0.002)	(-0.020 – 0.009)
Observations	5,070	4,141
R-squared	0.114	0.180
FE	State Week HRR	State Week HRR
Outcome variable (Mean)	1.093	1.090

Notes:

*** *p<0.01*, ** *p<0.05*, * *p<0.1*

The outcome variable hospital COVID-19 share index is measured at the hospital-week level as the ratio of patients hospitalized for COVID-19 divided by that hospital's share of total beds in the HRR, separately for total licensed beds and ICU beds.