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Changes in the Number of Intensive Care Unit Beds in U.S. Hospitals During the Early Months of the COVID-19 Pandemic, as reported to the National Healthcare Safety Network's COVID-19 Module

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Abstract

Using data from the National Healthcare Safety Network (NHSN), we assessed changes to intensive care unit (ICU) bed capacity during the early months of the COVID-19 pandemic. Changes in capacity varied by hospital type and size. ICU beds increased by 36%, highlighting the pressure placed on hospitals during the pandemic.

BACKGROUND

The National Healthcare Safety Network (NHSN), managed by the Centers for Disease Control and Prevention (CDC), is the largest U.S. surveillance system for healthcare-associated infections and has been in use for over 15 years. In response to the coronavirus disease 2019 (COVID-19) pandemic, NHSN developed the COVID-19 Module¹ to track daily hospitalizations and hospital capacity measures. As COVID-19 spread, hospitals were challenged to adjust their capacity, clinical resources, and business practices. Many hospitals decreased the number of elective procedures and average length of stay for non-COVID-19 patients while preparing for a surge in intensive care unit (ICU) patients and ventilator use.^{2–5} Given the nature and characteristic disease progression of COVID-19, the availability of ICU beds is critical to a hospital's ability to respond to the outbreak and provide

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necessary care to patients. To assess the frequency and extent of changes that U.S. hospitals made to their ICU capacities during 2020, data reported to NHSN during and prior to the pandemic were analyzed.

METHODS

The maximum number of ICU beds during 2019 were reported by almost all U.S. hospitals via NHSN's 2019 Annual Facility Survey, which serves as a baseline value of ICU capacity prior to the pandemic.⁶ NHSN's Patient Impact and Hospital Capacity (PIHC) Pathway of the COVID-19 Module collected daily reports between April 13 - July 14, 2020 on the number of ICU beds, inclusive of any surge ICU beds. In both reporting modules, "ICU beds" were defined as the total number of ICU beds that were set-up and staffed in the hospital.^{1,6} Daily ICU bed counts reported in PIHC were compared to 2019 annual values among acute care hospitals (ACHs) and long-term acute care hospitals (LTACHs). In addition, daily reports from 2020 were assessed to determine ICU capacity changes during the COVID-19 surveillance period.

Data reported under the following implausible scenarios were excluded: 100% hospital occupancy on every daily record, 0 total inpatient beds, or, in hospitals with ≥ 25 ICU beds, a $\geq 400\%$ increase or $\geq 75\%$ decrease in ICU beds compared to 2019. Inpatient rehabilitation and psychiatric facilities, records with missing data, health systems with confirmed data inaccuracies, and hospitals without an annual survey (e.g., hospitals that became newly operational in 2020), were excluded.

Percent change in ICU beds was calculated for each hospital, and each reporting day, as:

$$\frac{(\text{ICU beds reported in PIHC} - \text{ICU beds reported on the 2019 survey})}{\text{ICU beds reported on the 2019 survey}} \times 100$$

Each hospital's largest percent increase and percent decrease in ICU beds, compared to 2019, were used to describe changes in capacity. The largest percent change value, regardless of direction, was used to describe the maximum impact of COVID-19 on each hospital's ICU capacity.

Figure 1 was limited to consistent reporters, defined as hospitals reporting a PIHC record 5 out of every 7 days. Changes in ICU capacity were evaluated by geographic region.⁷ Data were analyzed in SAS 9.4.

RESULTS

There were 429 hospitals excluded from this analysis for data quality-related reasons. This included 150 hospitals missing an annual survey, 9 hospitals that reported 0 total beds, 121 hospitals from health systems with broad quality issues, 121 hospitals with missing data, and 28 hospitals that reported implausible data as defined above. After applying these exclusions, data from 3,867 hospitals remained for analysis, which represented 68% (out of 5,727) of all eligible hospitals that were active in NHSN as of July 14, 2020. Hospitals reported changes to their ICU capacities during 2020, with 1,512 (39%) hospitals reporting

an increase, and 1,358 (35%) reporting a decrease, compared to 2019 (Table 1). Overall, 30,279 (36%) ICU beds were added, and 21,507 (25%) ICU beds were removed, resulting in a net increase of 8,772 beds compared to 2019.

About 61% of large hospitals (> 221 beds) and 16% of small hospitals (< 25 beds) increased their ICU capacities between April – July 2020. Compared to other hospital types, general ACHs were most likely to increase their ICUs; 48% of general ACHs reported an increase in ICU beds. The volume of ICU beds added during the pandemic varied by hospital type, with LTACHs reporting the largest surge in capacity (156%). Conversely, surgical and orthopedic hospitals reported a 53% drop in ICU beds. Almost half of general ACHs, children's, and some specialty hospitals reported a drop in ICU capacity at least once during this period.

The Upper and Middle Northeast saw the greatest surge in ICU beds, with each region reporting a 76% increase from 2019. The median percent change in ICU beds in Region 2 (e.g., New York) was a 64% increase. While 72% of hospitals in the Middle Plains never reported an increase in ICU capacity, the remaining 28% (n=110) expanded their ICUs by 53%.

The timing of peak ICU capacity varied by region (Figure 1). The Northeast, Great Lakes, and Middle Plains reported ICU bed counts above 2019 levels almost daily between April – July 2020. The highest peak in ICU capacity represented a 59% increase above the 2019 value and occurred in the Upper Northeast on May 8th. The Southeast, South Central, Northern Plains, and the West reported decreased ICU capacities between April - May 2020 and increased capacities between June - July 2020, compared to 2019. The greatest daily drop in ICU beds (32%) was reported by the Northern Plains on April 15th; this region later reported an 11% surge on July 11th. Similarly, ICU capacity in the Northwest ranged from a 19% drop on April 14th to a 12% surge on July 13th.

DISCUSSION

Critical care capacity is a significant factor in the resilience of a healthcare delivery system during catastrophic public health events. This descriptive analysis is the first to address national changes in ICU capacity from hospitals across the country.

ICU capacity generally peaked when local COVID-19 hospitalizations were also increasing. New York had their largest volume of COVID-19 inpatients and ventilators in use on April 24.⁸ ICU capacity in Region 2 peaked during that same week. As the pandemic shifted to other parts of the country in June and July, surges in ICU capacity were seen in the same regions that reported increases in ventilated COVID-19 patients (i.e., regions encompassing Texas, California, and Florida).⁸

More than half of hospitals with > 100 beds reported an increase in ICU capacity at least once during this surveillance period, compared to 32% of hospitals with < 100 beds. This finding is consistent with NHSN's COVID-19 hospitalization data, which show that most ventilated COVID-19 patients were cared for in ACHs with > 100 beds.⁸ LTACHs reported a substantial increase in their ICU size, likely in preparation for long-term ventilation of COVID-19 patients.^{9,10}

Despite the national 36% increase in ICU beds during this time, hospitals in all regions reported declines in ICU capacity compared to 2019. For example, surgical and orthopedic hospitals closed more than half of their ICU beds. As the demand for elective services decreased, some hospitals may have significantly reduced their ICU bed counts to align with a lower patient census.

This analysis has limitations. Data were self-reported to NHSN and do not reflect recent COVID-19 surges. Different personnel may have completed NHSN's annual survey and PIHC Pathway, resulting in differences in the interpretation of data elements. Temporary hospitals created during the pandemic were not included, and not all NHSN-enrolled hospitals chose to report data to NHSN's COVID-19 Module; thus, our results may underestimate the number of and changes to ICU beds in the country.

Our findings highlight one way that hospitals responded to changes in the type of, and demand for, healthcare services during the early months of a global pandemic. As large ACHs and LTACHs increased their ICU capacity, smaller hospitals and those that provide primarily elective services may have experienced declines in patient visits, resulting in the same or fewer ICU beds maintained by these hospitals.

These results can be used to inform future emergency planning initiatives and resource allocation. Given the likely increase in the volume of ICU patients seen during a large-scale public health emergency, large ACHs and LTACHs may require additional human resources, supplies (e.g., medical devices, ventilators), and logistical support as they expand the size of their ICUs to meet the increasing demand for services. Infection prevention and control practitioners in these types of facilities should be aware of the potential for a surge in ICU capacity and be prepared to emphasize appropriate infection control measures; just-in-time trainings may be necessary for ICU staff in these scenarios.

ACKNOWLEDGMENTS

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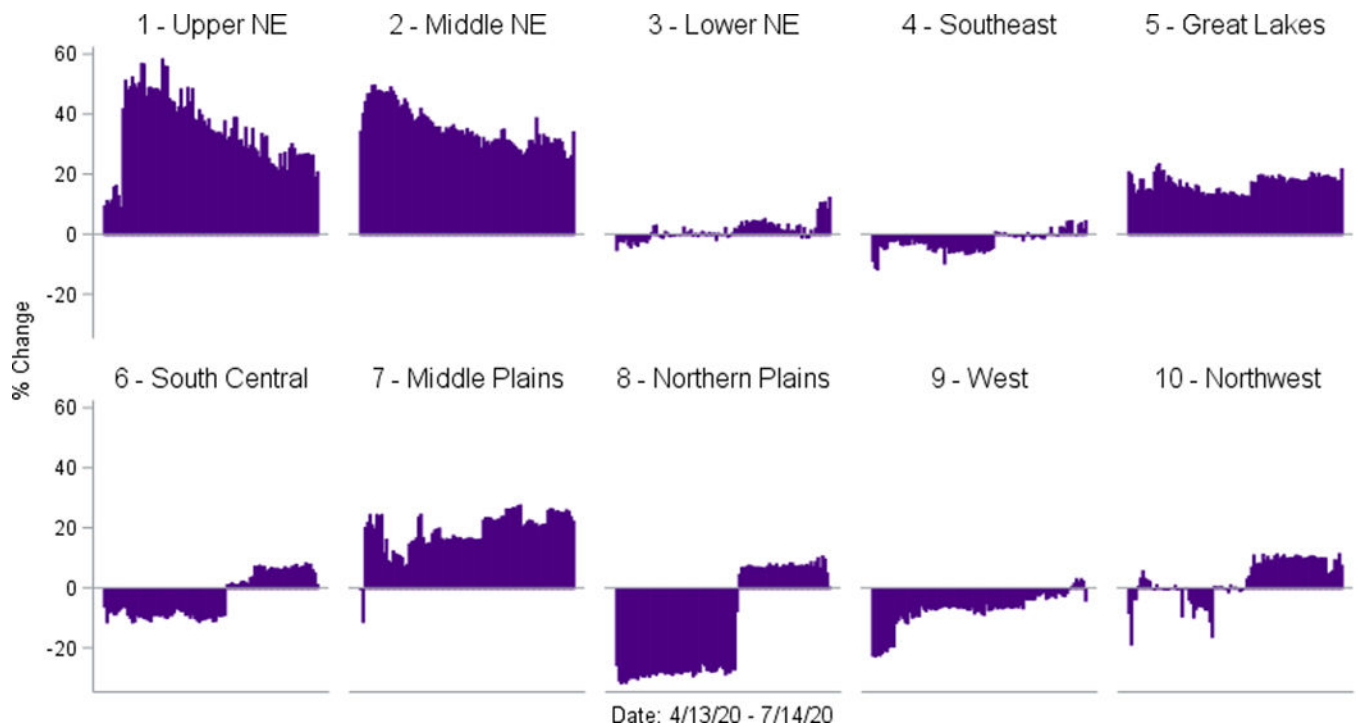


Figure 1. Percent change in intensive care unit beds reported to the National Healthcare Safety Network's (NHSN) COVID-19 Module compared to the NHSN 2019 Annual Survey, by HHS region, April 13 – July 14, 2020

This figure depicts the overall percent change in the number of ICU beds reported each day, between April 13 – July 14 2020, compared to the number of ICU beds reported in 2019. A negative percent change indicates that fewer ICU beds were reported in the 2020 surveillance period, compared to 2019. Data are shown for each of the 10 regions identified by the U.S. Department of Health and Human Services (HHS).

Note. NE: Northeast.

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Table 1.

National and hospital-level changes in the number of intensive care unit (ICU) beds in U.S. hospitals during the COVID-19 pandemic, as reported to the National Healthcare Safety Network (NHSN), April 13 – July 14 2020

Characteristic	Hospitals Reporting into NHSN's COVID-19 Module			Changes in ICU beds during COVID-19, compared to the 2019 annual survey				Hospital-level distribution of maximum impact: Percent change in ICU capacity ⁷					
	Reporting hospitals ²	Hospitals that increased ICU capacity ³ n (%)	Hospitals that decreased ICU capacity ⁴ n (%)	No. ICU beds in 2019	ICU beds added ⁵ n (%)	ICU beds removed ⁵ n (%)	5%	10%	25%	50%	75%	90%	95%
All Hospitals	3,867	1,512 (39.1)	1,358 (35.1)	84,631	30,279 (35.8)	21,507 (25.4)	-74.5	-60.0	-18.8	0.0	37.9	100.0	175.0
Hospital Type													
General acute care	2,575	1,246 (48.4)	1,176 (45.7)	76,577	27,581 (36.0)	19,268 (25.2)	-73.4	-62.5	-33.3	0.0	53.8	125.0	213.0
Critical access	905	142 (15.7)	104 (11.5)	990	579 (58.5)	320 (32.3)	-100.0	-16.7	0.0	0.0	0.0	100.0	100.0
Long-term acute care	195	75 (38.5)	13 (6.7)	582	910 (156.4)	56 (9.6)	-6.3	0.0	0.0	0.0	100.0	100.0	166.7
Surgical	74	10 (13.5)	15 (20.3)	351	273 (77.8)	178 (50.7)	-93.3	-50.0	0.0	0.0	0.0	50.0	100.0
Children's	65	24 (36.9)	29 (44.6)	4,731	774 (16.4)	1,361 (28.8)	-69.4	-60.1	-47.5	0.0	0.0	45.1	100.0
Orthopedic	18	1 (5.6)	4 (22.2)	50	11 (22.0)	36 (72.0)	-100.0	-100.0	0.0	0.0	0.0	0.0	100.0
Other ⁶	35	14 (40.0)	17 (48.6)	1,350	151 (11.2)	288 (21.3)	-100.0	-100.0	-58.7	0.0	0.0	100.0	112.0
Hospital Size in 2019⁷													
25 beds	1,045	163 (15.6)	99 (9.5)	906	808 (89.2)	323 (35.7)	-100.0	0.0	0.0	0.0	0.0	100.0	100.0
26 – 100 beds	1,068	360 (33.7)	312 (29.2)	6,453	3,736 (57.9)	1,501 (23.3)	-100.0	-66.7	0.0	0.0	50.0	100.0	212.5
101–220 beds	836	433 (51.8)	387 (46.3)	16,181	7,090 (43.8)	3,862 (23.9)	-71.4	-61.9	-34.7	0.0	63.4	141.7	250.0
221 beds	918	556 (60.6)	560 (61.0)	61,091	18,645 (30.5)	15,821 (25.9)	-69.7	-61.7	-42.5	0.0	53.1	123.1	178.6
HHS Region													
1 - Upper northeast	145	75 (51.7)	42 (29.0)	2,524	1,930 (76.5)	422 (16.7)	-64.3	-50.0	0.0	0.0	100.0	181.3	275.0

Characteristic	Hospitals Reporting into NHSN's COVID-19 Module			Changes in ICU beds during COVID-19, compared to the 2019 annual survey			Hospital-level distribution of maximum impact: Percent change in ICU capacity ¹						
	Reporting hospitals ²	Hospitals that increased ICU capacity ³ n (%)	Hospitals that decreased ICU capacity ⁴ n (%)	No. ICU beds in 2019	ICU beds added ⁵ n (%)	ICU beds removed ⁵ n (%)	5%	10%	25%	50%	75%	90%	95%
2 - Middle northeast	173	118 (68.2)	59 (34.1)	5,127	3,917 (76.4)	991 (19.3)	-71.4	-55.6	0.0	63.9	116.1	221.4	286.4
3 - Lower northeast	280	123 (43.9)	110 (39.3)	7,417	1,914 (25.8)	1,718 (23.2)	-77.2	-60.2	-30.0	0.0	39.1	111.1	200.0
4 - Southeast	708	259 (36.6)	247 (34.9)	18,957	5,927 (31.3)	3,825 (20.2)	-66.7	-50.0	-16.0	0.0	17.1	100.0	166.7
5 - Great Lakes	715	317 (44.3)	234 (32.7)	13,617	6,012 (44.2)	3,464 (25.4)	-100.0	-60.3	0.0	0.0	64.3	116.7	200.0
6 - South Central	606	203 (33.5)	207 (34.2)	13,057	3,795 (29.1)	3,665 (28.1)	-72.4	-59.5	-21.1	0.0	17.2	100.0	127.3
7 - Middle Plains	390	110 (28.2)	87 (22.3)	4,847	2,550 (52.6)	1,052 (21.7)	-90.0	-48.7	0.0	0.0	0.0	100.0	111.5
8 - Northern Plains	208	55 (26.4)	59 (28.4)	2,310	409 (17.7)	1,078 (46.7)	-100.0	-66.7	-18.0	0.0	0.0	100.0	121.4
9 - West	475	191 (40.2)	259 (54.5)	14,051	3,186 (22.7)	4,506 (32.1)	-75.0	-66.7	-50.0	0.0	12.5	100.0	129.6
10 - Northwest	167	61 (36.5)	54 (32.3)	2,724	639 (23.5)	786 (28.9)	-73.6	-52.5	0.0	0.0	35.7	100.0	150.0

Note. ICU: intensive care unit. HHS: Department of Health and Human Services. NHSN: National Healthcare Safety Network

Footnotes

- ¹Percent change in ICU capacity was calculated as: [(ICU beds reported on COVID-19 record – ICU beds reported on 2019 annual survey) / ICU beds reported on 2019 annual survey] x 100. Each hospital's largest percent change value for ICU bed size, regardless of direction, was used to describe the maximum impact of COVID-19.
- ²The number of hospitals that reported ICU capacity data to NHSN's COVID-19 Module
- ³Hospitals that reported a larger number of ICU beds on at least 1 COVID-19 record, compared to the value reported on the 2019 annual survey
- ⁴Hospitals that reported a smaller number of ICU beds on at least 1 COVID-19 record, compared to the value reported on the 2019 annual survey
- ⁵Each hospital's largest increase and largest decrease in ICU beds, compared to 2019, was used to populate these columns. These data are interpreted to represent temporary increases and decreases in the number of staffed ICU beds.
- ⁶Consists of military, oncology, women's, and women's/children's hospitals

⁷Based on the total number of inpatient beds (inclusive of ICU beds) reported on the 2019 annual survey, interpreted as each facility's total bed size prior to the COVID-19 pandemic

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