BRIEF REPORT

Assessing Immediate Bed Availability and Barriers to Discharge in a United States Children's Hospital

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ABSTRACT

Objectives: The aim of this study was to quantify immediate bed availability (IBA) in a United States children's hospital and treatment needs of hospitalized patients whose needs could be met outside a traditional hospital setting.

Methods: Using a novel tool to capture census, scheduled discharges, and resource needs for hospitalized patients, we surveyed our hospital's 5 non-neonatal inpatient pediatric units on 4 d over 1 y.

Results: Median ward occupancy was 81% (range, 58-79), median intensive care unit occupancy was 80% (range, 7-19), and median IBA was 42% (range, 34-59). A median of 14 patients per day (13% of total capacity) had treatment needs that could be met by providing limited support in a nontraditional setting; the most common reason for requiring ongoing hospitalization in this group of patients was a safe discharge plan.

Conclusions: Our median IBA of 42% exceeds federal recommendations, but varies widely between days surveyed. Even on days when IBA percentage is high, our total number of available beds is unlikely to meet pediatric population needs in a large-scale public health emergency.

Key Words: disaster medicine, emergency preparedness, hospital bed capacity, surge capacity, vulnerable populations

Children comprise 24%[1] of the United States (US) population and represent a significant percentage of victims in natural disasters and other large-scale emergencies. Pediatric patients are physiologically different from adults, and, therefore, have distinct treatment needs.[2,3] Despite this, disaster plans often do not adequately address the needs of children.[2] Recognizing the critical importance of hospitals to a robust disaster response, the US Department of Homeland Security (DHS) recommends that hospitals should have 500 adult beds per 1 million people during infectious disease and trauma emergencies.[4] While DHS does not make recommendations regarding surge capacity for pediatric beds, experts have suggested that bed surge capacity should be 25-30% of a hospital's capacity.[5] This may be unrealistic when pediatric hospitals routinely operate at 90% capacity.[6] To meet these surge goals, hospitals can use strategies to increase immediate bed availability (IBA), such as rapidly discharging patients who can be cared for at home or at a lower-acuity facility without compromising quality of care.[7] However, there have been few studies quantitatively examining IBA or common barriers to discharge.

To guide development of emergency operation plans and quantify IBA, we developed a census tool to measure IBA and identify specific barriers to discharge in a children's hospital in the United States at 4 different time points.

METHODS

Doernbecher Children's Hospital at Oregon Health & Science University is a 145-bed academic children's hospital. Our team included a medical student and a pediatric critical care physician, both with emergency preparedness experience, and a pediatric case manager. We developed a census survey to assess IBA and barriers to discharge (Online Data Supplemental File1). While the tool was developed a priori, the categories of barriers to discharge were developed empirically through conversations between the study team, nursing, and case management staff. The tool captures hospital unit capacity, patient census, discharging patients, and primary barriers to discharge for patients needing ongoing care. We applied this tool in our hospital's 5 non-neonatal inpatient hospital units (1 pediatric intensive care unit [PICU], 1 intermediate care unit, and 3 inpatient medical and surgical pediatric wards) on 4 weekdays from February to December of 2018 to achieve a sample with variation based on season, weekday, and random events. We identified discharge-ready patients and barriers for non–discharge-ready patients through discussion with unit-level case managers between 7 AM and 11 AM each day. This timing

TABLE 1

Children's Hospital Non-neonatal Occupancy and Immediate Bed Availability Over 4 Days in 2018

	Day 1	Day 2	Day 3	Day 4	Median
Season	Winter	Spring	Fall	Winter	
Day of week	Thursday	Tuesday	Wednesday	Monday	
Occupancy					
Inpatient wards (non-PICU)	79/85 (93%)	58/85 (68%)	78/85 (92%)	59/85 (69%)	68.5/85 (81%)
Intermediate care unit	13/16 (81%)	8/16 (50%)	14/16 (87.5%)	12/16 (75%)	12.5/16 (78%)
Ward #1 (Medicine)	24/24 (100%)	24/24 (100%)	23/24 (96%)	20/24 (83%)	23.5/24 (98%)
Ward #2 (Surgery)	22/24 (92%)	16/24 (66.6%)	22/24 (92%)	12/24 (50%)	19/24 (79%)
Ward #3 (Hematology-oncology)	20/21 (95%)	10/21 (47.6%)	19/21 (90%)	15/21 (71%)	17/21 (81%)
PICU	19/20 (95%)	7/20 (35%)	19/20 (95%)	13/20 (65%)	16/20 (80%)
Total (wards and PICU)	98/105 (93%)	65/105 (62%)	97/105 (92%)	72/105 (68.5%)	84.5/105 (80%)
Immediate bed availability ([current open beds + expected discharges]/total beds)					
Inpatient wards total (Non-PICU)	34/85 (40%)	44/85 (52%)	29/85 (34%)	41/85 (48%)	37.5/85 (44%)
Intermediate care unit	8/16 (50%)	12/16 (75%)	8/16 (50%)	11/16 (68.75%)	9.5/16 (59%)
Ward #1 (Medicine)	3/24 (12.5%)	7/24 (29%)	6/24 (25%)	7/24 (29%)	6.5/24 (27%)
Ward #2 (Surgery)	14/24 (58%)	11/24 (46%)	8/24 (33.3%)	15/24 (62.5%)	12.5/24 (52%)
Ward #3 (Hematology-oncology)	9/21 (42%)	14/21 (66.6%)	7/21 (33.3%)	8/21 (38%)	8.5/21 (40%)
PICU	6/20 (30%)	15/20 (75%)	5/20 (25%)	7/20 (35%)	6.5/20 (32.5%)
Total (wards and PICU)	40/105 (38%)	59/105 (56%)	34/105 (32%)	48/105 (45.7%)	44/105 (42%)

Abbreviations: PICU, pediatric intensive care unit

allowed case managers to round with medical and nursing teams to gather updated discharge plans before data collection. If multiple barriers to discharge were present, the patient's case was reviewed to determine the highest-level need preventing discharge. We did not collect identifying patient information. This study was determined to not be human subjects research by our institutional review board.

We defined IBA as the number of currently empty beds plus the number of expected discharges that day. After data collection, discharge barriers in the 4 non-intensive care units (ICUs) were grouped and analyzed. PICU data were not grouped with other units because PICU patients have different care needs and generally transfer to lower-acuity care units before discharge. We categorized barriers to discharge as those that could or could not be reasonably addressed outside of a traditional inpatient hospital setting. Among patients whose barriers could potentially be addressed outside a traditional inpatient setting, we grouped patients according to the barrier requiring the most highly specialized resource. We then identified how much IBA could be created using a strategy of discharging patients who could be cared for by providing specific services outside a traditional hospital setting.

RESULTS

The occupancy and immediate bed availability for each day we completed a census assessment are shown in Table 1. Occupancy peaks were noted at time point 1 and 3 (98/105 and 97/105 total beds, respectively). The same time points also had the lowest IBA (40/105 and 34/105 total beds, 38% and 32%, respectively). Conversely, occupancy was lowest at time point 2 (65/105 beds), which had the highest IBA (59/105 beds, or 56%). Based on the 2018 hospital census, the average daily PICU occupancy during winter, spring, summer, and fall was 77%, 58%, 68%, and 45%, respectively. The 2018 ward occupancy during winter, spring, summer, and fall was 81%, 73%, 68%, and 70%, respectively.

Occupancy on the 4 wards ranged from 58 to 79 of 85 total beds (median: 69/85 beds, 81% occupancy). IBA of the 4 wards ranged from 29 to 44 of 85 total beds (median: 38/85 beds or 44%). Occupancy in the PICU ranged from 7 to 19 of 20 beds (median: 16/20 beds, 80% occupancy). IBA of the PICU ranged from 5 to 15 of 20 beds (median 7/20 beds or 33%).

The 192 non-ICU patients not discharging on the day of the census review were divided into 2 groups (each with 4 subgroups): (1) 54 patients who could be discharged to an alternate care facility or home if specific additional services could be provided, and (2) 138 patients whose needs could not reasonably be met outside the hospital and would continue to require hospital-level care even during an emergency. The specific treatment needs/resources required of each group are described in Figure 1.

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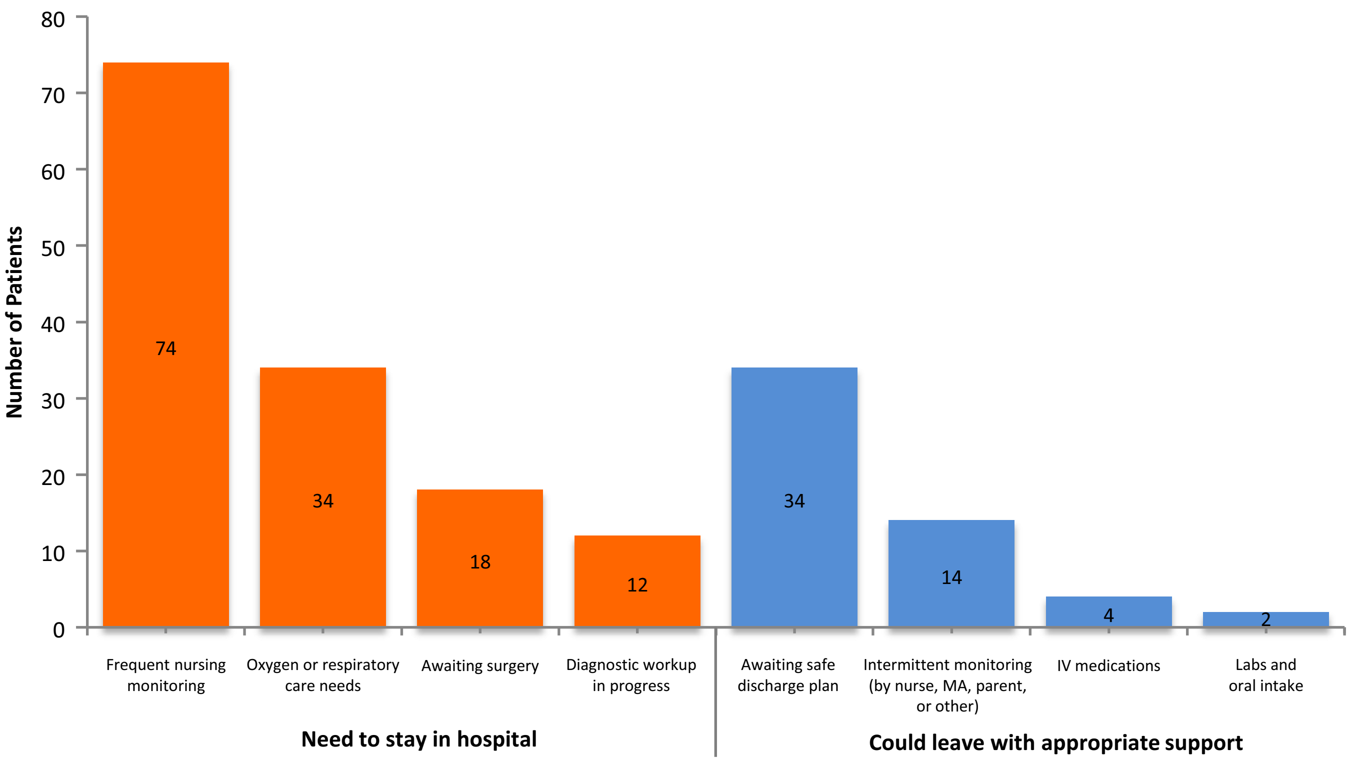
FIGURE 1

Treatment Needs of Patients With Barriers to Discharge ($n = 192$).



The 54 patients who were categorized as having needs that could be met outside of a traditional hospital setting (median, 14 per day; range, 10-19) had the following needs: safe discharge plan (for example equipment and/or medication management training) (34), intermittent monitoring by family member or outpatient support staff (14), intermittent labs and/or increased oral intake (2), and intravenous medications that are traditionally administered outside the hospital or could be changed to enteral formulation (4).

The 138 non-ICU patients who were categorized as having needs requiring ongoing hospitalization were divided into 4 categories by type of treatment needs. Seventy-four patients required frequent nursing monitoring. Examples of this broad category include receiving medications requiring nursing administration, such as chemotherapeutic agents, monitoring and stabilization after complicated or emergency surgery (for example major cardiac surgery), and telemetry monitoring of unstable patients. Thirty-four patients had a new and dynamic need for supplemental oxygen and/or respiratory care such as aggressive airway clearance therapies. Eighteen patients were scheduled for or were known to need surgical procedures within 36 h that would require inpatient postoperative care. Twelve patients were still undergoing workup of illnesses potentially requiring emergent care (eg, acute gastrointestinal bleed) and, therefore, needed immediate, inpatient care including imaging, labs, and the oversight of a physician or higher-level provider.

DISCUSSION

This is the first study to date to quantify IBA at a US children's hospital. We found median IBA for inpatient pediatric wards exceeded the recommended 25-35% surge capacity, but this number varied substantially between days, as did the daily census calculated from total equivalent census days. We also found that our hospital could gain up to 18% additional surge capacity by providing limited treatments and support outside of a traditional hospital setting. Even with this increased IBA, our total hospital capacity is unlikely to meet population needs in a large-scale public health emergency, such as a mass casualty incident, highlighting a key deficiency in our region's ability to care for a surge of ill or injured children.

Common strategies to increase surge capacity include rapidly discharging patients, creating alternate care facilities, and altering standards of care.[8] Studies suggest early discharge could be used to make 1/3 of hospital beds available in

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24 h.[7] We identified 3 strategies to increase IBA beyond currently empty beds and planned discharges: developing safe discharge plans, providing some care not requiring nursing expertise, and providing advanced care by a nurse or other licensed medical professional. The largest gain in IBA in our hospital would be accomplished by providing a safe area for children to continue to receive some basic care requiring minimal medical personnel while caregiver training and discharge planning was completed. This strategy would require significant care management and social work involvement. While providing more complex medical care could increase IBA further, the additional IBA gained using these strategies was low, and this resource-intensive strategy would likely only be used after exhausting other options.

Pediatric inpatient care is highly regionalized and centralized[9] and a relatively small number of children's hospitals provide a significant percentage of all pediatric inpatient care in the United States.[10] While our results indicate that our hospital could achieve a high percentage of IBA on many days, especially if using a system to provide increased outpatient support, our modest number of beds available is unlikely to meet population needs in a mass casualty incident or other public health emergency. Together, Oregon and Southwest Washington's hospitals have no more than 300 combined pediatric ICU and acute care beds (Personal Communication, Northwest Oregon Health Preparedness Organization) for just over 1 million children[1]; to meet federal recommendations of 500 available inpatient beds per 1 million people, these hospitals would have to almost double their capacity. As a result, increasing IBA in children's hospitals is an essential but insufficient action to meet our population's needs in a large-scale public health emergency, and additional strategies must also be used.

In addition to maximizing IBA in children's hospitals, we have recommended that our region's developing pediatric surge plan use resources generally not used for inpatient pediatric care. This includes coordinating resources with regional hospitals and public health authorities, establishing a tiered response that uses neonatal resources to care for the youngest children, uses adult resources to care for older and less severely ill or injured children with support from pediatric experts, and uses children's hospitals for patients who are younger (although not neonatal) and have more complex treatment needs. As part of this plan, each individual hospital must have a robust staffing plan to adequately care for an increased number of patients. However, this plan is incomplete without accounting for the needs of patients already hospitalized. We found a large group of hospitalized children requiring frequent bedside care from nurses or respiratory therapists, more intensive monitoring, and close physician involvement and, therefore, are unlikely to have their needs met outside of a traditional hospital setting. These patients may be immunocompromised or have other conditions, placing them at high risk for deterioration or death, which must be accounted for in planning for a public health emergency such as an influenza pandemic. Notably, surge planning often fails to include this important group of already hospitalized patients and their significant resource needs, and they are often absent from interjurisdictional agreements and crisis care guidelines.

This study has several limitations. First, there were few days surveyed, and the identified IBA will not be representative of all days. Second, IBA relies on rapid discharge, efficient room turnover, proactive discharge planning, and adequate staffing; our study did not evaluate these factors. Third, we did not account for new admissions in this study, which is a component of the "off-loading of low-risk patients" pillar of IBA.[4] While nonurgent admissions could be canceled, patients with urgent problems or undergoing surgery at the time of the emergency would need hospital care, which would negatively impact IBA. Fourth, our IBA numbers reflect the mix of patients cared for in our hospital and may not be representative of other hospitals' experiences. In particular, this tool may need considerable adaptation to function effectively in societies and health systems that differ considerably from those in the United States. Future work should be directed at refining the tool for use in different hospitals and using results to guide emergency plan development. Fifth, this study did not account for the variation in bed and resource needs due to the nature of the emergency, and that this may in turn affect criteria for discharge. Last, this study did not evaluate neonatal beds, which could provide additional capacity during an emergency.

CONCLUSIONS

Using a novel census tool, we identified that while IBA at our hospital meets US federal recommendations, the absolute number of available beds falls far short of potential population needs arising in a large-scale emergency. Most hospitalized patients in the United States have resource needs that truly require a hospital environment, but providing some basic care in a nonhospital setting could increase our hospital's capacity by almost 20%.

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Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/dmp.2020.62

REFERENCES

1. US Census Bureau. Age and sex composition: 2010. https://www.census.gov/prod/cen2010/briefs/c2010br-03.pdf. Published May 2011. Accessed May 1, 2019.
2. Allen GM, Parrillo SJ, Will J, et al. Principles of disaster planning for the pediatric population. *Prehosp Disaster Med*. 2007;22(6):537-540.
3. Bothe D, Olness K, Reyes C. Overview of children in disasters. *J Dev Behav Pediatr*. 2018;39(8):652-662.
4. US Department of Health and Human Services. Immediate bed availability. https://www.phe.gov/Preparedness/planning/sharper/Pages/iba.aspx. Published July 16, 2014. Accessed May 31, 2019.
5. Toerper M, Kelen G, Sauer L, et al. Hospital surge capacity: a web-based simulation tool for emergency planners. *Disaster Med Public Health Prep*. 2018;12(4):513-522.
6. Fieldston ES, Ragavan M, Jayaraman B, et al. Scheduled admissions and high occupancy at a children's hospital. *J Hosp Med*. 2011;6(2):81-87.
7. Kanter RK, Moran JR. Pediatric hospital and intensive care unit capacity in regional disasters: expanding capacity by altering standards of care. *Pediatrics*. 2007;119(1)94-100.
8. Frogel M, Flamm A, Sagy M, et al. Utilizing a pediatric disaster coalition model to increase pediatric critical care surge capacity in New York City. *Disaster Med Public Health Prep*. 2017;11(4):473-478.
9. França U.L, McManus ML. Trends in regionalization of hospital care for common pediatric conditions. *Pediatrics*. 2018;141(1): e20171940.
10. Berry JG, Hall M, Hall DE, et al. Inpatient growth and resource use in 28 children's hospitals: a longitudinal, multi-institutional study. *JAMA Pediatr*. 2013;167(2):170-177.

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