

Article

Trends in COVID-19 Inpatient Cases and Hospital Capacities during the Emergence of the Omicron Variant in the United States

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Abstract: Introduction: The purpose of this study was to analyze hospital capacities in terms of hospital beds and staffing in the United States and explore the trends of hospital capacities during the Omicron variant emergence. Methods: Using data collected by the United States Department of Health and Human Services, this study examined hospitalization rates from 15 December 2021 to 13 February 2022. Graphical trends were plotted for visualization of hospital bed usage and coronavirus disease 2019 (COVID-19) inpatient cases. A Pearson correlation test was used to explore the relationship between critical staffing shortage and COVID-19 death cases. Descriptive statistics of all hospital data were calculated. Results: At the peak of the Omicron variant surge, approximately one-third of the adult intensive care unit beds were used for COVID-19 patients in the United States. The total number of COVID-19 death cases increased as the number of hospitals with critical staffing shortages increased ($p < 0.05$). Discussion: This study can inform hospital administrators and public health policymakers on how to modify the use of existing hospital and human resources as the continually evolving pandemic taxes hospital capacity. Future studies need to be conducted to determine the long-term trend and how the COVID-19 pandemic continues to change rapidly.

Keywords: pandemic; COVID-19; hospital capacity; omicron; staff shortage; medicine



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1. Introduction

In December 2019, people in Wuhan, China, began to show symptoms of a strange new disease. It was the beginning of a novel, highly contagious infectious virus: severe acute respiratory syndrome coronavirus 2 [1]. The entire world was then put through a vigorous new era of confusion, doubt, and uncertainty. The public health sector was hit hard, and hospitals around the world struggled to adapt to the changes brought about by the new virus [2], leading to many hospitals having issues with their hospital capacities (e.g., shortage in hospital beds and staff such as physicians and nurses). Prior to the coronavirus disease 2019 (COVID-19) pandemic, hospitals in the United States (US) already had limited capacities due to the shortage of physicians and nurses nationwide [3]. Throughout the COVID-19 pandemic, hospital capacities in the United States have been thin and seen constant hospitalization variations mostly associated with peaks of infection from different COVID-19 variants [4]. For instance, at the start of the pandemic, regular hospital capacities and admissions for acute illnesses decreased drastically [5]. In contrast, during the midst of the Omicron and Delta variants, the number of intensive care unit (ICU) beds available for most hospitals has reportedly been on the brink of collapse [6]. Yet, there is a lack of

empirical study examining the trend of hospital capacities throughout the emergence of the Omicron variant.

Many different views on hospital capacities since the outbreak of COVID-19 have been formulated and internalized by popular news sources [7]. Popular news outlets such as Fox News and National Broadcasting Company have been reporting drastically varied information about the current capacities of hospitals [7]. With the mass news outlets reaching thousands across the US, it is important to have accurate information. The reality of the situation is that hospital capacities have been changing daily due to the complexity of the virus. Kokudo and colleagues demonstrated that hospital capacities fluctuated over time [8]. As a result, public misconception and misinformation have been widespread about overall hospital capacities during this pandemic [7]. Since there is a lack of research in the literature tracking the trend of hospital capacities during the Omicron variant emergence, this study aimed to examine the trends of the inpatient COVID-19 cases and the hospital capacities throughout the emergence of the Omicron variant across the US. The findings of this study can provide insight for medical resources utilization and help hospitals to plan ahead and adapt their hospital staffing and beds to meet the changing demands in public health crisis.

2. Methods

The data came from the Department of Health and Human Services (HHS), which were downloaded for this study bi-weekly from <https://catalog.data.gov/dataset/covid-19-reported-patient-impact-and-hospital-capacity-by-state-b528c> (accessed on 15 December 2021), for the period 15 December 2021 to 13 February 2022. This dataset was made available for public access for free from collaborative efforts of hospital, state, and federal personnel in the US, who meet daily to fulfill data reporting requirements and submit the data to the HHS. The HHS provided these state-aggregated data on hospital utilization beginning 1 January 2020. These non-human subject research data were derived from reports with facility-level granularity across three main sources: (1) HHS TeleTracking, (2) reporting provided directly to HHS Protect by state/territorial health departments on behalf of their healthcare facilities, and (3) National Healthcare Safety Network (before 15 July 2020). The data were updated regularly and provided the latest values reported by each facility within the last four days at each update. This reporting method provides a comprehensive picture of hospital utilization within a state in the US by ensuring all hospitals were represented, even if they missed a single day of reporting.

2.1. Variables

Variables used in this study included the following: (1) percent of inpatients with COVID-19, (2) percent of inpatient bed utilization, (3) percent of beds for COVID utilization, (4) percent of ICU bed utilization, (5) percent of adult ICU beds for COVID utilization, (6) number of hospitals reporting a critical staffing shortage, (7) number of patients with suspected or confirmed COVID-19 who died, (8) date of record, and (9) name of the state.

2.2. Data Analyses

Graphs were plotted to examine the trend of the following seven variables across time, from 15 December 2021 to 13 February 2022: (1) percent of inpatients with COVID-19, (2) percent of inpatient bed utilization, (3) percent of bed for COVID utilization, (4) percent of ICU bed utilization, (5) percent of adult ICU bed for COVID utilization, (6) number of hospitals reporting a critical staffing shortage, and (7) number of patients with suspected or confirmed COVID-19 who died. Pearson correlation tests were used to examine the relationship between the total number of hospitals reporting a critical staffing shortage and the total number of patients with suspected or confirmed COVID-19 who died. A p -value of <0.05 was considered as statistically significant.

3. Results

The data included a total of 54 states and territories in the US. Figure 1 displays the mean percentage of inpatients with COVID-19 and the mean percentages of inpatient beds utilization among hospitals per day during the first two months of the Omicron variant emergence in the US. The percentage of inpatient beds for COVID-19 utilization, the percent of inpatients with COVID-19, and the percent of adult ICU beds for COVID-19 utilization all peaked in late January 2022, at 18%, 24%, and 32%, respectively, then waned in mid-February 2022. However, the average percentage of inpatient bed utilization per hospital and the average percentage of adult ICU bed utilization per hospital fluctuated over time (Figure 1).

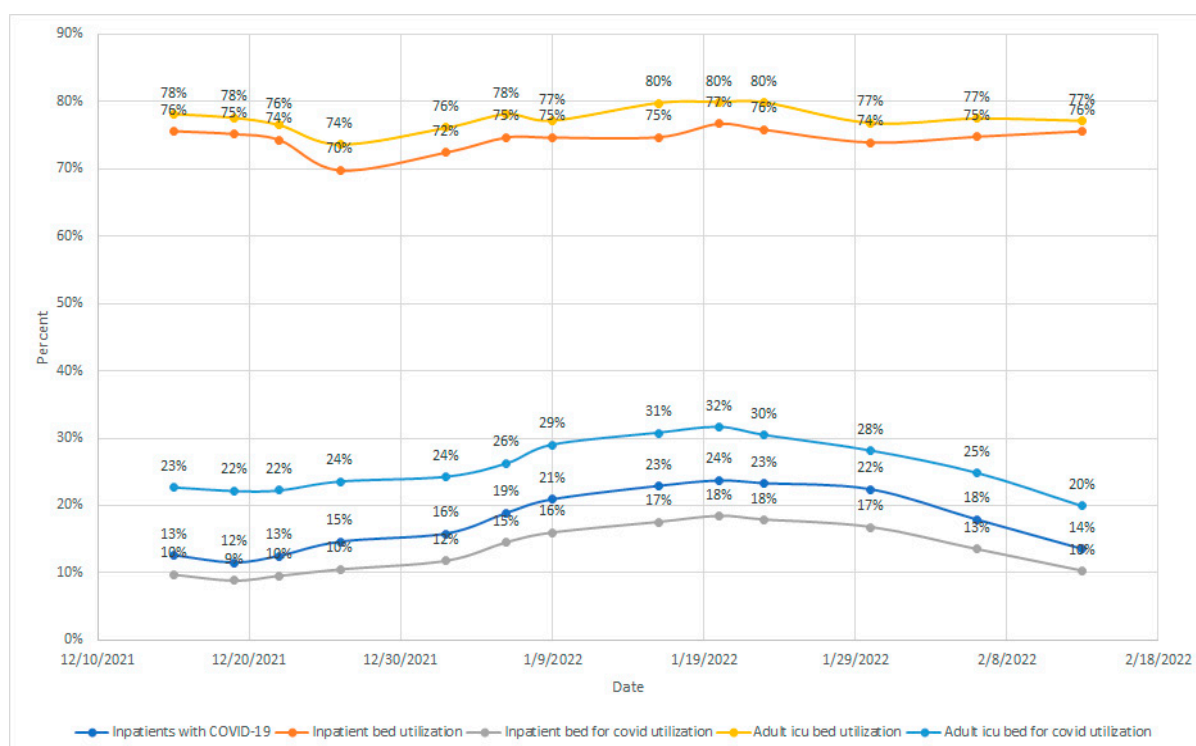


Figure 1. Percentage of inpatients with COVID-19 versus the percentages of inpatients beds utilization across time during the emergence of Omicron variant in the United States.

Across all states and territories of the US, Maryland, Ohio, and Indiana had the highest percentage of inpatients with COVID-19, at 25.2%, 23.8%, and 23.4% daily, respectively (Figure 2). Texas had the highest number of COVID-19 deaths with an average of 101 per day, followed by Pennsylvania at 80 per day, and Arizona at 74 per day, during the emergence of the Omicron variant (Figure 3). California, Louisiana, and Wisconsin had the largest average number of critical staffing shortages at 97, 48, and 45 daily, respectively (Figure 3). In general, as the number of hospitals with critical staffing shortages went up, the total number of COVID-19 death cases went up ($r = 0.494$, $p < 0.001$).

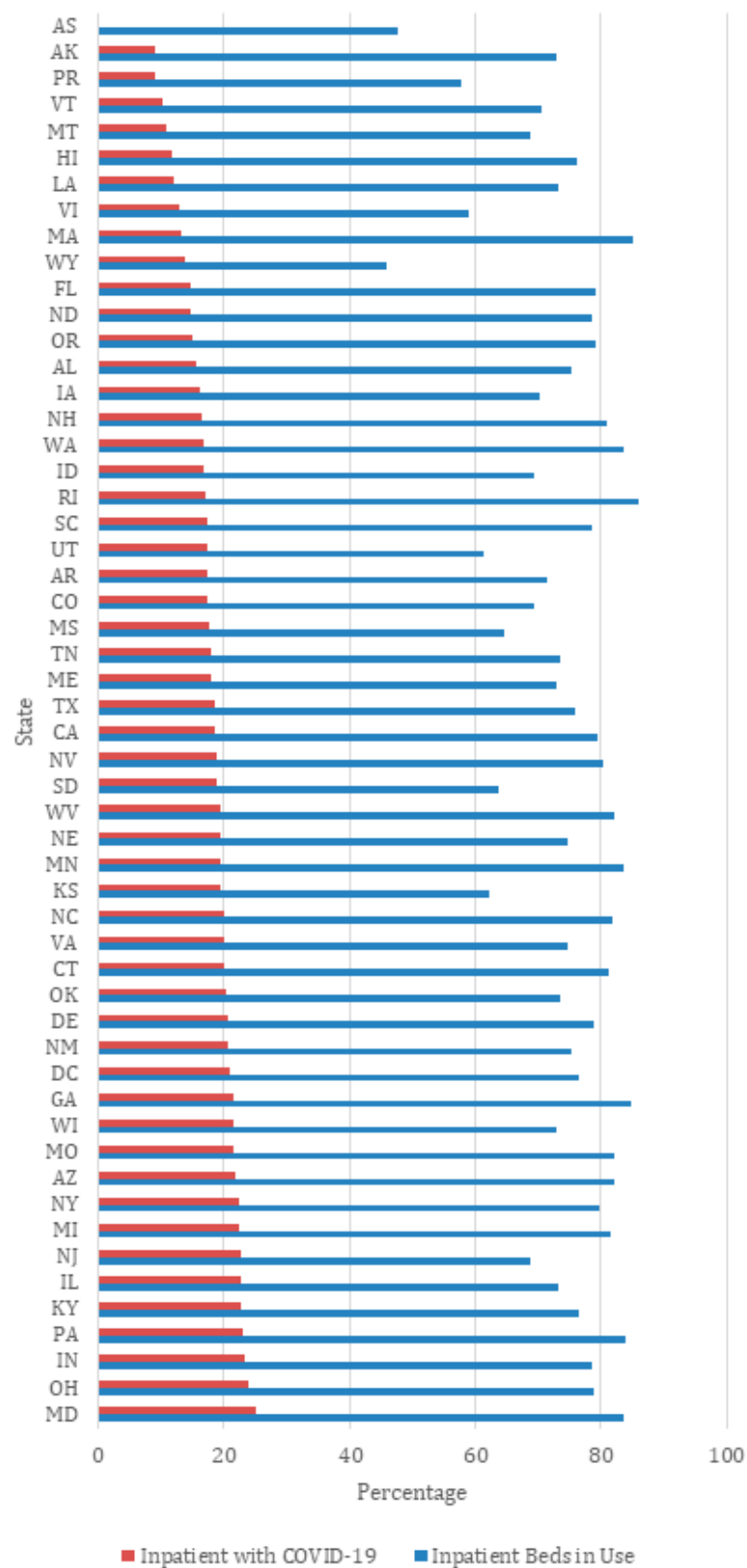


Figure 2. Percent of inpatients with COVID-19 versus the percent of inpatients beds in each state in the United States during the emergence of the Omicron variant.

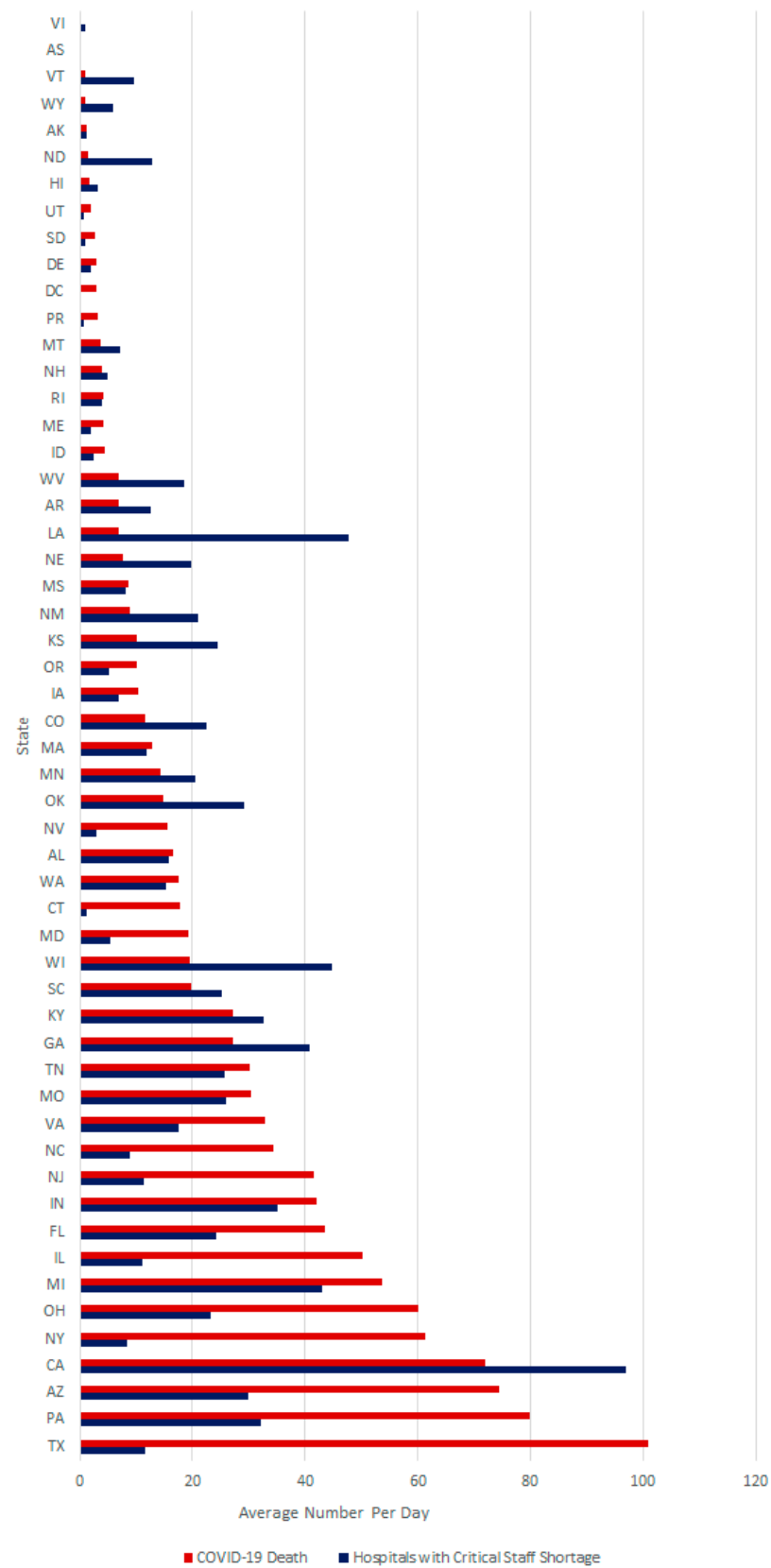


Figure 3. Average number of COVID-19 deaths per hospital versus the average number of critical staffing shortages per hospital in each state in the United States during the emergence of the Omicron variant.

4. Discussion

The HHS reported that 24% of hospitals faced critical staffing shortages during the peak of Omicron [9]. Our study provides evidence that across the US, hospital bed use was at about 75% capacity on average, and approximately one-third of the US hospital's adult ICU beds were used for COVID-19 patients at the peak of the Omicron variant emergence. When compared to the pre-COVID-19 level, this is about 10% higher, confirming findings reported by the Centers for Disease Control and Prevention (CDC) in early 2022 [10]. Although the disease severity was lower with the Omicron variant, according to data reported by the CDC [10], the volume of hospitalizations and associated staff shortages was a significant challenge to local health care systems.

As the Omicron variant swiftly spread across the country in late 2021, more hospitalizations occurred, which took a toll on the healthcare system, leading to staffing shortages. Our results indicated that states that had relatively high percentage of inpatient bed utilization are mostly located along the east coast region of the US. This may be related to the population density in the areas or the average age of the population within these states. East coast states are the most densely populated in the US, holding all 10 of the top 10 rankings [11]. Of the states that rank in the top 10 for highest median age, 9 of them are located along the east coast [12]. This underscores the necessity for greater efforts to address hospital surge capacity and improve staffing of local healthcare systems, especially in the east coast region.

With the rise in inpatients, the severity of COVID-19 and staffing shortages, COVID-19 has had a substantial impact on the US healthcare system. Our findings confirm studies that have found that more than any other COVID-19 variant, Omicron has taxed the country's healthcare system with more cases and hospitalizations [13]. Although deaths due to COVID-19 increased with more critical staffing shortage and this relationship was statistically significant, there was exception. For example, Texas has the largest number of COVID-19 deaths, but its critical staffing shortage was minimal relative to other states. On the other hand, Louisiana had many critical staffing shortages, yet its total COVID-19 death cases was relatively small. During this study, the adult bed utilization fluctuated at around 78%, yet the adult ICU bed for COVID utilization was at 32% at the peak of the Omicron emergence. The need for additional resource management is necessary in order to prepare for future waves of the pandemic. Due to the nature of the SARS-CoV-2 virus's mutation rate, another variant is expected, and hospital surge capacity needs to be accounted for [14].

The results of this study must be considered in light of its limitations. One limitation of this study is that it only captured data points throughout a two-month period. It may be helpful to look at data over a large span of time. Nonetheless, this two-month period captured the trend of hospital capacities during the emergence of the first wave of the Omicron variant. Further research needs to be conducted on understanding why certain states' critical staffing shortages were proportional to inpatient COVID-19 deaths but not in other states. With the given individual statewide data from the Department of Health and Human Services, it would be beneficial to compare those numbers to the current vaccination rates of the states in question.

5. Conclusions

Comparing hospital capacity data from different states allowed us to better understand the link between hospitalization rates and staffing shortages. If another variant more severe in hospitalizations were to arise, then the healthcare system may be in trouble. The results of this study can inform hospital administrators and public health policymakers on how to modify the use of existing hospital and human resources as the continually evolving pandemic taxes hospital capacity. Individual state data, when compared to others, could educate local governments on what factors to adjust in preparation for the inevitable forthcoming variant. They can also be used to identify states that are falling behind and are in need of federal government funds and resources. Future studies need to be conducted

to determine the long-term trend in hospital capacity and how the COVID-19 pandemic continues to change hospitalizations rapidly.

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Conflicts of Interest: The authors declare no financial conflict of interest for this work.

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