

CASE STUDY

Difference in impact on emergency department visits following four major peaks of COVID-19 cases

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ABSTRACT

Objective: Several variants of SARS-CoV-2 have emerged since its first appearance in 2019, greatly impacting healthcare systems across the globe. Previous literature indicated a substantial decline in emergency department (ED) visits in hospitals since the start of the COVID-19 pandemic. However, little research has been done to compare different variants' (Ancestral, Alpha, Delta, Omicron, etc.) impact on patients presenting to the ED. Thus, the purpose of this retrospective observational study is to compare the changes in total ED volume following four major peaks of SARS-CoV-2 infection within a multi-hospital health system.

Methods: Utilizing electronic healthcare record (EHR) data, total ED visits (484,268) and COVID-19 case counts (24,358) were collected and analyzed to compare ED census and COVID-19 trends across four years and four variant peak periods, from January 2019 to June 2022.

Results: Results showed that ED visits declined after the first two major peaks (Ancestral and Alpha) in COVID-19 cases, which was consistent with national trends and prevailing literature. In contrast, ED visits increased following the fourth major peak (Omicron) in COVID-19 cases.

Conclusions: The increase in ED visits following the fourth major peak was inconsistent with previous literature and trends. This may be attributed to the severity differences between variants, increased vaccination uptake, newly adopted public countermeasures, and evolving perceptions of safety and fear regarding COVID-19. These results underscore the critical importance for health administrators and policy planners to be cognizant of new strategies that alleviate barriers to receiving emergency care, especially during times of crisis.

Key Words: COVID-19, Emergency department, Census trends, SARS-CoV-2 variants

1. INTRODUCTION

Emergency departments (EDs) play a crucial role in our healthcare system. In addition to providing emergency medical care for trauma or acute injuries and illnesses, they serve

as an emergency safety net for when needed care becomes inaccessible from other health care providers. Thus, their existence and survival are foundational to a robust health-care system, and delays or hesitancy to receive treatment and

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care can have detrimental effects on quality health outcomes. Amid the coronavirus 2019 (COVID-19) pandemic, hospital EDs have been at the forefront of the health care delivery response and the net impact on ED visits has been drastically affected across the spectrum of health systems.^[1,2] After the declaration of a national emergency in the United States on March 13, 2020, it was estimated that average weekly hospital ED visits sharply declined by 42% (March 29–April 25, 2020) until July of the same year before increasing again, resulting in a net ED visit decline of 25% in 2020 versus the same months in the pre-pandemic year of 2019, according to the CDC's National Syndromic Surveillance Program.^[1,3,4] Subsequent ED visit declines occurred following the Alpha peak at the end of 2020, to which studies seemed to also indicate a correlation between case surges and ED visits.^[5] However, it remained unclear if different variants of SARS-CoV-2 had differing effects on ED visits following the Delta and Omicron peaks in COVID-19 cases in August 2021 and January 2022, respectively. In this retrospective observational analysis, total ED visits following four major COVID-19 peaks were examined to determine if differences in variant severity, transmissibility, or other individual- and contextual-level factors (e.g. environmental, social), may have contributed to this pattern change for patients presenting to the ED for needed care.

2. METHODS

2.1 Study setting and population

AHMC Health System (AHMC) is a healthcare organization of ten community hospitals with a capacity of approximately 1,400 hospital beds and 3,000 partnered physicians, primarily serving Southern and Northern California. A cross-sectional, retrospective study was conducted using electronic health-care record (EHR) data from six of the ten hospitals within our health system. The four excluded hospitals had been recently acquired and were still using an EHR system incompatible with the throughput measurement portal used by our IT department. The study population included both adults and children to capture a comprehensive snapshot of the total impact on ED volume following different case surges of COVID-19 infection.

2.2 Study design, variables, and statistical analysis

ED volume data from EHR records, which included both positive COVID-19 case counts and total ED visits (COVID and non-COVID) from January 2019 to January 2022, were collected through AHMC's centralized IT department. To protect private patient information, anonymized and confidential secondary data was produced before being disseminated for analytical use by the authors of this study.

Descriptive statistics were used to compare temporal changes in ED volume across four years and four major variants of SARS-CoV-2 using an equivalent baseline period for comparison. Within those years, lab-confirmed COVID-19 case counts and ED visits were tallied daily for each hospital. ED visits were defined as visits to the ED by patients who were discharged within one day. Patients that were admitted on the same day that admission was requested were also included in the ED visit count. In order to maintain data consistency and reliability across all hospitals, patients who "left without being seen" were not counted. SARS-CoV-2 peak periods were distributed evenly (7 months per period) across the full spectrum of the 28-month timeframe ranging from the early pandemic period of March 2020 to the later pandemic period of June 2022. Variant identification for peak periods was defined as such using CDC's "Variants and Genomic Surveillance for SARS-CoV-2" tracking tools. The peak 1 (Ancestral) wave was defined as the period between March 2020 to September 2020. The peak 2 (Alpha) wave was defined as the period between October 2020 to April 2021. The peak 3 (Delta) wave was defined as the period between May 2021 to November 2021. The peak 4 (Omicron) wave was defined as the period between December 2021 to June 2022. To gauge the net impact on ED visits following the emergence of the COVID-19 pandemic and SARS-CoV-2 variants that followed thereafter, the collective health system data were aggregated to calculate a monthly baseline pre-pandemic period mean, from January 2019 to December 2019 for the pandemic year comparison, as well as from August 2019 to February 2020 for the pre-pandemic SARS-CoV-2 peak period baseline. Further speculative analysis in the subsequent discussion was done in the context of the broader pandemic trends and prevailing literature that observed a compelling correlation between COVID-19 case surges and overall declines in ED volume.

For COVID-19 case counts and ED visit volume, a stacked area chart was constructed to display the daily positive case counts starting from the early Ancestral pandemic period of March 2020 to the end of the initial Omicron period in June 2022. For ED volume, the stacked area shows the total ED census from the pre-pandemic period of January 2019 to the end of the Omicron period in June 2022. Two tables were also constructed to present the ED data numerically and to show the mean difference in ED visit volume when comparing the baseline pre-pandemic period to the subsequent pandemic years and SARS-CoV-2 peak periods. For both tables, one-way ANOVA tests were completed to find statistical significance between our ED census variables and the different pandemic years and SARS-CoV-2 peak periods. For Table 1, the pandemic years of 2020-2022 were com-

pared to the 2019 pre-pandemic baseline. For Table 2, the SARS-CoV-2 peak periods were compared to an equivalent period (7 months) during the pre-pandemic. The data was collected and analyzed using SAS version 9.4.

2.3 Ethics statement

No ethics approval was required as this study uses anonymized and confidential secondary data.

2.4 Patient and public involvement statement

No patients were involved in this study.

3. RESULTS

The ED census volume breakdown by years and SARS-CoV-2 peaks can be seen in Table 1 and Table 2, respectively. For the pre-pandemic period of 2019, we calculated a total of 170,167 ED visits across six hospitals within our community health system, resulting in a 12-month mean of 14,181 visits. For the pre-pandemic peak comparison period, we calculated a total of 100,967 ED visits for a 7-month mean of 14,424 visits. In total (see Table 2), there were 69,501 ED visits (period monthly mean = 9,929) during the “Ancestral” peak 1 period, resulting in a net ED visit decline of -31.16% when compared to the equivalent pre-pandemic period. For the “Alpha” peak 2 period, there were 62,538 ED visits (period monthly mean = 8,934), resulting in a net ED visit decline of

-38.06%. For the “Delta” peak 3 period, there were 73,377 ED visits (period monthly mean = 10,482), resulting in a net ED visit decline of -27.33%. Finally, for the “Omicron” peak 4 period, there were 80,058 ED visits (period monthly mean = 11,437), resulting in a net ED visit decline of -20.71%.

A similar trend was found when comparing subsequent pandemic years to the pre-pandemic period (see Table 2). For 2020, there were a total of 128,547 ED visits (12-month mean = 10,712), resulting in a net ED visit decline of -24.26%. For 2021, there were a total of 116,149 ED visits (12-month mean = 9,679), resulting in an ED decline of -31.75%. At the time of writing, our data and analysis for 2022 are complete up to June 30, 2022. In this 6-month period, there were a total of 69,405 ED visits (6-month mean = 11,568), resulting in an ED decline of -18.43%.

Notably, we observed the most significant discrepancy in net ED decline (versus the pre-pandemic period) when comparing the peak 2 “Alpha” period to the peak 4 “Omicron” period. For the peak 2 “Alpha” period, there was a significant relative decrease in ED visits as COVID-19 case counts increased. In contrast, for the peak 4 “Omicron” period, there was a significant relative increase in ED visits when compared to the peak 2 period as COVID-19 case counts increased. These results and their potential significance are outlined in Table 1 and Table 2.

Table 1. Total ED visits, average ED visits per month, ED visits total percentage change (versus 2019 pre-pandemic baseline; January 2019 to December 2019), segregated by years across six hospitals within AHMC Health System (January 1, 2019 to June 30, 2022)

ED Visits 2019-2022	Total ED Visits Sample (n)	Average ED Visits per Month (Mean)	ED Visits Change in Percentage (%)
2019	170,167	14,181	N/A
2020	128,547	10,712	-24.46% ***
2021	116,149	9,679	-31.75% ***
2022	69,405	11,568	-18.43% **

Note. ** *p* < .01, *** *p* < .001

Table 2. Total ED visits, average ED visits per month, and ED visits total change in percentage (versus 7-month pre-pandemic baseline; August 2019 to February 2020), segregated by SARS-CoV-2 peak periods (7-month intervals) across six hospitals within AHMC Health System (January 1, 2019 to June 30, 2022)

SARS-CoV-2 Peaks	Total ED Visits Sample (n)	Average ED Visits per Month (Mean)	ED Visits Change in Percentage (%)
Pre-Pandemic	100,967	14,424	N/A
Peak 1 (Ancestral)	69,501	9,929	-31.16% ***
Peak 2 (Alpha)	62,538	8,934	-38.06% ***
Peak 3 (Delta)	73,377	10,482	-27.33% ***
Peak 4 (Omicron)	80,058	11,437	-20.71% ***

Note. *** *p* < .001

For visualization purposes, we constructed a stacked area chart to showcase the changes and overlap between COVID-19 cases and total ED volume – from the pre-pandemic period of January 1, 2019 to the later Omicron period of June 30, 2022 – all of which can be seen in Figure 1. For COVID-19

case counts specifically, the peak counts for each period are as follows: peak 1 “Ancestral” (2,511 cases in July 2020), peak 2 “Alpha” (4,132 cases in December 2020), peak 3 “Delta” (938 cases in August 2021), and peak 4 “Omicron” (3,882 cases in January 2022).

AHMC Monthly ED Census and COVID-19 Cases, January 2019-June 2022

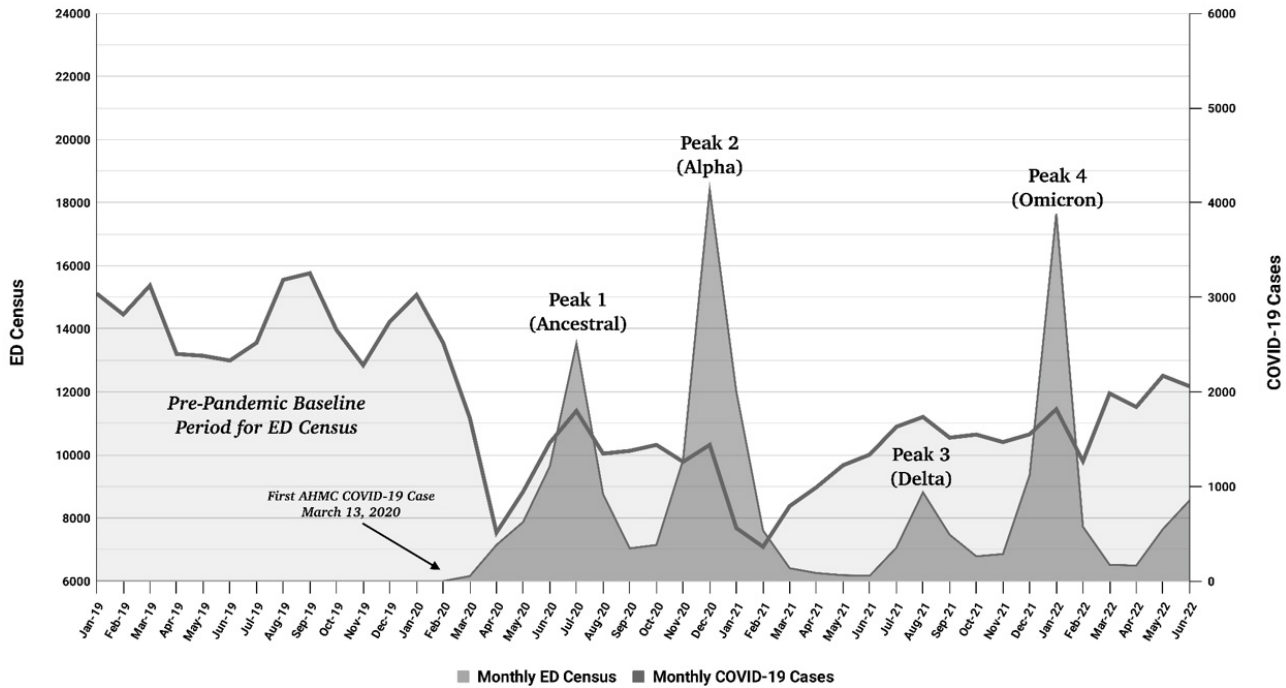


Figure 1. Total ED visits, average ED visits per month, ED visits total percentage change (versus 2019 pre-pandemic baseline; January 2019 to December 2019), segregated by years across six hospitals within AHMC Health System (January 1, 2019 to June 30, 2022)

4. DISCUSSION

To date, multiple studies have already shown a decrease in ED visits during the COVID-19 pandemic. For example, from January 1, 2019 to May 30, 2020, ED visits in the United States declined by an estimated 42%.^[1] Additionally, a health system in Massachusetts saw ED visits decline by 30.9% in 2020 compared to 2019.^[2] In another study, five health care systems in Colorado, Connecticut, Massachusetts, New York, and North Carolina were observed, and it was found that ED visits declined when COVID-19 cases increased.^[5] While the results from our study were consistent with the previous literature and indicated a decline in ED visits when COVID-19 cases increased in July 2020 and December 2020, it was also revealed that ED visits continued to increase despite the peak in COVID-19 cases in January 2022.

There are numerous possible explanations for our inconsistency with the literature and why there was an increase in

ED visits after a rise in COVID-19 cases in January 2022 during the Omicron peak, one factor may be attributed to fear. Pandemic diseases like COVID-19 that have a high transmission rate with no or limited availability of effective treatments have been shown to elicit fear among people.^[6] Furthermore, in a recent study on ED patients during the COVID-19 pandemic, it was reported that most ED patients had a fear of contracting COVID-19.^[7] As a result of this fear-related impact on behavior, the CDC advises health care systems to address public health concerns about exposure to counteract the decline in seeking help in ED visits during the pandemic.^[1]

First, the dominant COVID-19 variants during December 2020 and January 2022 were notably different. In December 2020, the dominant variant was Alpha (B.1.1.7), and in January 2022, the dominant variant was Omicron (B.1.1.529).^[8,9] The Omicron variant is reportedly less severe and is associated with lower hospitalization and death rates when compared to the Alpha variant.^[8] Consequently,

people may have felt less afraid of going to EDs during January 2022 than they did in December 2020, leading to increased ED visits in January 2022 as shown in the results. Another possible factor is vaccines, which had just been authorized for emergency use on December 11, 2020, and it was not until August 23, 2021 that the FDA fully approved the first COVID-19 vaccine.^[9] As a result, nearly 68.8% of the California population was fully vaccinated by January 2022.^[10] The protection from COVID-19 that vaccinations offered, as well as the cross-protection conferred from prior infections, could have alleviated risk concerns of contracting COVID-19 from hospitals and encouraged people to seek care when needed. Hence, the difference in the number of individuals protected from COVID-19 between December 2020 and January 2022 could explain why ED visits in January 2022 during the Omicron period increased despite the major increase in COVID-19 cases reminiscent of the infection wave during the December 2020 Alpha period.

Lastly, it was not until January 20, 2020 that the first laboratory-confirmed case of COVID-19 was identified in the United States,^[11] as well as the declaration of national emergency on March 13, 2020. The many unknowns surrounding this virus and the need to adopt new precautionary behaviors may have contributed to the fear people had about it.^[12] Furthermore, between December 2020 and January 2022, extensive research had been conducted on COVID-19, allowing health organizations to inform people on how to effectively protect and care for themselves and others.^[13] This period of time also allotted a year for individuals to adjust to these new precautionary behaviors. Thus, these contributing factors could have relieved people's fear of presenting to hospital EDs, and are plausible reasons for why ED visits saw a relative increase even though COVID-19 cases grew in January 2022 compared to ED visits in December 2020.

Despite the results showcased within our health system, there are several limitations to our results and their overall generalizability. Being that AHMC is a health system in California, our results may not be reflective of other populations in different regions with varying public health and safety governance protocols. Also, due to a lack of comparable data from each hospital pertaining to our COVID-19 patients and their admission severity, a thorough analysis of ED admission trends could not be included. Regardless, we hope our data is useful as a comparator for other similar studies and we recognize that further research must be done to develop strategies for hospitals to utilize when events similar to the COVID-19 pandemic occur – specifically, strategies that address people's concerns about safety and ease their fear of visiting hospitals in order to avoid the direct and indirect consequences of

delayed care.

5. CONCLUSIONS

The COVID-19 pandemic has affected healthcare systems globally. While numerous studies reported a decline in ED visits during the COVID-19 pandemic, it remained unclear how ED visits had been impacted when different variants of COVID-19 predominated. By analyzing the data from six hospitals within the AHMC Health System, it was found that ED visits declined following the increase in COVID-19 cases in July 2020 when the Ancestral variant predominated, and in December 2020 when the Alpha variant predominated, which was consistent with previous studies and literature. In contrast, ED visits continued to increase despite a similar increase in COVID-19 cases in January 2022 when the Omicron variant predominated (and to a lesser extent when the Delta variant predominated in August 2021). This pattern change in patients presenting to the ED was also reflected in broader national trends according to the CDC's National Syndromic Surveillance Program. While this study demonstrates notable variation for ED visits following four comparable and major COVID-19 peaks of the pandemic, the precise causes accounting for this difference remain inconclusive. Our results in context of our subsequent discussion suggest numerous possible contributing factors, including differences in variant severity, transmissibility, the public availability of vaccines and their increased uptake over time, an adherence to new precautionary behaviors and public measures, and evolving perceptions of safety, fear, and fatigue regarding COVID-19 in general. All of these elements may or may not have directly contributed to this disparity in ED volume following the Ancestral, Alpha, Delta, and Omicron peaks. Further research is warranted and in-depth studies are necessary to provide a better understanding of how these individual- and contextual-level factors may have impacted ED utilization throughout the pandemic. Regardless, these findings further underscore the critical need for healthcare systems, health administrators, and policy planners to create and adopt new strategies to improve access to emergency care, especially in times of crisis.

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CONFLICTS OF INTEREST DISCLOSURE

The authors declare they have no conflicts of interest.

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