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Boarding in US Academic Emergency Departments During the COVID-19 Pandemic

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Study objective: The first 2 years of the COVID-19 pandemic brought substantial and dynamic changes to emergency department volumes and throughput. The objective of this study was to describe changes in ED boarding among US academic EDs across the duration of the COVID-19 pandemic.

Methods: We conducted a retrospective analysis of monthly data collected from a convenience sample of academic departments of emergency medicine. The study period was from January 2019 to December 2021. The primary outcome was total boarding hours, and secondary outcomes included patient volume stratified by ED disposition. We used multivariable linear panel regression models with fixed effects for individual EDs to estimate adjusted means for 3-month quarters.

Results: Of the 73 academic departments of emergency medicine contacted, 34 (46.6%) participated, comprising 43 individual EDs in 25 states. The adjusted mean total boarding hours per month significantly decreased during the second quarter of 2020 (4,449 hours; 95% confidence interval [CI] 3,189 to 5,710) compared to the first quarter of 2019 (8,521 hours; 95% CI 7,845 to 9,197). Beginning in the second quarter of 2021, total boarding hours significantly increased beyond pre-pandemic levels, peaking during the fourth quarter of 2021 (12,127 hours; 95% CI 10,925 to 13,328).

Conclusions: A sustained and considerable increase in boarding observed in selected US academic EDs during later phases of the COVID-19 pandemic may reflect ongoing stresses to the health care system, with potential consequences for patient outcomes as well as clinician well-being. [Ann Emerg Med. 2022;■:1-8.]

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INTRODUCTION

Background

During the first wave of the COVID-19 pandemic, the number of patients seeking care in US emergency departments fell dramatically.¹ This decline coincided with stay-at-home orders and public health measures amidst considerable fear and uncertainty.² Whereas some patients sought alternative treatment settings, including telemedicine, others delayed seeking necessary care, leading to worse outcomes.^{3,4} ED boarding, or the time that admitted patients spend in the ED awaiting inpatient beds, also fell during the initial phase of the pandemic.⁵ However, early reports suggest that boarding has resurged, potentially beyond pre-pandemic levels.^{6,7}

Importance

Prolonged ED boarding is associated with worse patient outcomes and creates considerable challenges—if not crises—for clinicians and hospitals.⁸ Boarding and crowding

not only represent intractable problems for delivering high-quality emergency care but also serve as key indicators for the functioning of the health care system overall. Sustained increases in boarding during the later phase of the COVID-19 pandemic may reflect ongoing stresses, and potentially lasting structural changes, to the health care system that merit immediate attention by policymakers and leaders.

Goals of this Investigation

In this study, we describe trends in ED boarding over the course of the COVID-19 pandemic among US academic EDs. We also determined whether changes in ED volume have persisted throughout the pandemic, including a comparison of patients requiring hospitalization to those who were discharged.

METHODS

Study design and setting

This study was a retrospective cross-sectional analysis of data collected from a convenience sample of US academic

Editor's Capsule Summary*What is already known on this topic*

Emergency department (ED) boarding is associated with poor patient and health systems outcomes.

What question this study addressed

How did boarding change during the COVID-19 pandemic in select US academic EDs?

What this study adds to our knowledge

In this retrospective study, tracking operational data from a convenience sample of 34 academic EDs between Jan 2019 to Dec 2021, mean total boarding hours per month increased from a low of 4449 hours (Q2 2020) to 12127 hours (Q4 2021), well beyond pre-pandemic levels.

How this is relevant to clinical practice

At these sites, the strain imposed on ED acute care changed and grew as the COVID-19 pandemic evolved. Policymakers must address structural changes to mitigate the harm that can arise from crowded EDs.

EDs to investigate changes in ED boarding and volume from January 2019 and December 2021. The Academy of Administrators in Academic Emergency Medicine (AAAEM) and Association of Academic Chairs of Emergency Medicine (AACEM) conduct an annual benchmarking survey of academic EDs. A detailed description of the annual survey, eligibility criteria, and administration methods has been previously reported.⁹ To monitor changes in ED clinical operations during the COVID-19 pandemic, the AAAEM/AACEM Benchmark Committee collected supplemental monthly data, which were used for this study. We followed the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for cross-sectional observational studies (Supplement, available at <http://www.annemergmed.com>.)¹⁰ The institutional review board at the University of Pennsylvania determined that this study was exempt from review.

Selection of Participants

In August 2020, we approached 73 academic EDs who participate in the annual survey to voluntarily submit monthly operations data. Departments were asked to report selected operations metrics using standard internal processes utilizing electronic health record systems. The

metrics were chosen by the study team to represent key aspects of ED operations, including total boarding hours and patient volumes. The data collection instrument is provided in the Supplement. Previously designated administrators at all eligible departments were contacted twice through an existing email listserv. Sites that did not submit data within one month were considered nonresponders and not contacted again, given the burden of managing ED operations during the early COVID-19 pandemic.

As the pandemic continued, updated data were requested through direct emails to designated administrators from participating sites. Three additional updates occurred in February 2021, July 2021, and January 2022. Participants reported metrics for one or more affiliated EDs, which could include the primary academic hospital as well as affiliated hospitals within the same academic department. We excluded dedicated pediatric EDs. Data were electronically transferred between participants and the survey administrator (CAH) responsible for managing the data. The administrator reviewed individual data points for each hospital and month to check for reporting errors or outliers and compared data to historical levels to ensure consistency within sites.

Outcomes and Measurements

The primary outcome was the total boarding hours per month. Boarding time was defined as the interval between the time of an inpatient admission or observation order and the time when the patient left the ED for an inpatient unit. Given variation between sites, the data collection instrument specified that the first documented time for any of the following might be used as long as the measure remained consistent for each individual facility: 1) admission or inpatient observation order by the emergency clinician, 2) bed request order, or 3) time of acceptance by an admitting clinician.

Secondary outcomes included the total number of ED encounters per month, defined as all patients who registered to receive ED care. The total ED encounters were further stratified by disposition: 1) hospitalization (admission or observation), 2) discharge, and 3) left without being seen (LWBS) or screened and left, which, together, include patients who registered but did not receive full evaluation by a clinician. Finally, we examined the total number of patient arrivals by emergency medical services per month. For all outcomes, we standardized monthly count data to account for variations in the number of days per month.

We obtained baseline characteristics for participating and nonparticipating EDs from the 2020 AAAEM/

AACEM annual survey.⁹ To adjust for differences in the impact of COVID-19 case volumes between participating sites over the study period, we obtained publicly available data from the Centers for Disease Control and Prevention on the number of new cases of COVID-19 for each month and the state in which the ED was located.¹¹ We then determined per capita COVID-19 incidence using the estimated state population for April 2020, available from the US Census Bureau.¹²

Analysis

We first plotted monthly median values for primary and secondary outcomes using standard box-and-whisker plots. We then aggregated monthly data into quarters (3-month intervals). To compare outcomes across quarters, we estimated adjusted means for primary and secondary outcomes. To do so, we used multivariable linear panel regression models, with fixed effects for individual EDs. This approach allowed us to estimate within-ED changes across the study period, comparing subsequent quarters with the first quarter of 2019 as the pre-pandemic reference period. This approach does not require further adjustment for baseline hospital or ED characteristics, with each ED serving as its own control for any observed or unobserved characteristics. Models were adjusted for per capita COVID-19 cases for each month and the state in which EDs were located. We used cluster-robust standard errors to account for correlated observations within each ED, with standard error estimates, therefore, robust to heteroscedastic and autocorrelated disturbances in the model. Finally, we reviewed any missing data for hospitals by month, although panel regression can incorporate missing outcomes values for individual hospitals.¹³ For ease of interpretation, we used predictive margins to report adjusted means. As a secondary analysis, we performed interrupted time-series analyses to characterize trends for outcomes over 6-month intervals during the study period.¹⁴ Analyses were performed using Stata, version 16.1 (StataCorp LP).

RESULTS

Of the 73 academic EDs approached, 34 (46.6%) participated in the study, comprising 43 individual EDs. These facilities were located in 25 states. Thirty-eight individual EDs provided data for the entire study period, ending in December 2021; 3 provided data through August 2020, 1 provided data through February 2021, and 1 provided data through June 2021. The 39 departments that did not respond to the survey included 64 individual EDs. Characteristics of participating and nonparticipating EDs are shown in [Table 1](#).

Median total boarding hours by quarter are shown in [Table 2](#). The [Figure](#) shows box-and-whisker plots for total boarding hours by month, presented against the monthly incidence of COVID-19 cases.

In the adjusted analysis, mean total boarding hours per month were significantly decreased during the second quarter of 2020 (4,449 hours; 95% confidence interval [CI] 3,189 to 5,710) compared to the first quarter of 2019 (8,521 hours; 95% CI 7,845 to 9,197). However, mean total boarding hours returned to pre-pandemic levels in the next quarter ([Table 2](#)). Beginning in the second quarter of 2021, total boarding hours were significantly increased compared to the pre-pandemic period, peaking during the fourth quarter of 2021 (12,127 hours; 95% CI 10,925 to 13,328).

A similar pattern was observed for the total number of LWBS or screened-and-left encounters per month, with significant decreases that began during the second quarter of 2020 and persisted until the second quarter of 2021, after which LWBS or screened-and-left encounters exceeded pre-pandemic levels ([Table 2](#)).

The mean total number of ED encounters were significantly decreased in the second quarter of 2020 (3,733 encounters; 95% CI 3,521 to 3,946) compared to the first quarter of 2019 (5,449 encounters; 95% CI 5,345 to 5,554) and remained significantly lower until the third quarter of 2021. However, mean total ED hospitalizations were only reduced for the second quarter of 2020 compared to the pre-pandemic reference period, with no significant changes for any subsequent quarters ([Table 2](#)). Mean total ED discharges remained significantly lower than pre-pandemic levels from the second quarter of 2020 through the end of the study period ([Supplement](#)).

In the interrupted time-series analyses, the primary outcome demonstrated a rising trend from July 2020 through the end of the study period ([Supplement](#)). Mean total boarding hours rose by 447 hours per month from July 2020 to December 2020 (95% CI, 212 to 681), 367 hours per month from January 2021 to June 2021 (95% CI, 134 to 601), and 220 hours per month (95% CI, 21 to 461) from July 2021 to December 2021. Trends for secondary outcomes are described in the [Supplement](#).

LIMITATIONS

This brief report has many limitations. First, EDs included in this study are located in academic medical centers and affiliated hospitals, limiting generalizability. It is possible that changes in boarding and volume were greater in these hospitals, given that many are safety net institutions located in urban centers and care for more

Table 1. Characteristics of participating and nonparticipating hospitals.

Hospital Characteristics	Participating Hospitals (N=43)	Nonparticipating Hospitals (N=64)
US Region, n (%)		
Northeast	20 (46.5)	25 (39.1)
South	7 (16.3)	17 (26.6)
Midwest	12 (27.9)	9 (14.1)
West	4 (9.3)	13 (20.3)
Hospital type,* n (%)		
Primary academic	33 (76.7)	39 (60.9)
Academic affiliate	10 (23.2)	25 (39.1)
Licensed hospital beds, no., median (IQR)	664 (404-895)	519 (224-717)
ED treatment spaces, no., median (IQR)	57 (43-82)	56 (34-73)
Overflow treatment spaces, no., median (IQR)	10 (6-20)	8 (4-15)
Annual ED volume, no., median (IQR)		
Total arrivals	58,562 (46,921-67,048)	57,747 (35,160-74,730)
ED admissions	14,555 (9,348-18,838)	11,873 (6,941-15,339)
ED discharges	37,292 (29,072-42,338)	38,931 (24,290-50,091)
EMS arrivals, %, median (IQR)	25.9 (20.2-32.9)	22.2 (17.6-31.5)
Pediatric visits,** %, median (IQR)	1.1 (0.1-10.1)	2.8 (0.6-13.7)
LWBS or SAL, %, median (IQR)	2.8 (1.5-5.3)	3.1 (1.6-5.4)
ED encounters by billing level, %, median (IQR)		
99281 and 99282	2.5 (1.3-5.4)	4.2 (1.3-8.2)
99283	15.3 (7.2-21.2)	16.3 (6.7-21.6)
99284	35.0 (29.3-40.8)	39.9 (28.7-52.6)
99285 and 99291	44.6 (35.7-56.3)	35.9 (26.3-47.2)
ED total length of stay, hours, median (IQR)		
All encounters	6.4 (4.6-8.7)	5.6 (4.0-7.3)
Hospitalizations	9.2 (6.9-11.1)	8.8 (6.4-12.4)
Discharges	4.9 (3.9-5.7)	4.3 (3.4-5.4)
ED boarding time,*** hours, median (IQR)	5.2 (3.3-7.2)	4.1 (2.0-5.8)
Payer, %, median (IQR)		
Commercial	28.5 (23.5-32.6)	24.2 (20.0-32.5)
Medicare	30.1 (26.5-33.2)	27.2 (23.0-32.3)
Medicaid	25.3 (17.7-32.6)	27.1 (19.8-40)
Other	11.1 (6.7-16.3)	13.3 (9.5-17.7)

IQR, interquartile range; EMS, emergency medical services; LWBS, left without being seen; SAL, screened- and left.

*Primary academic hospitals are defined as the main teaching hospital within the academic department of emergency medicine; academically affiliated hospitals are other hospitals included, managed, and staffed by the academic department.

**Pediatric visits are defined as any visit by patients younger than 18 years of age.

***ED boarding time is defined as the interval between the time of an inpatient admission or observation order and when the patient left the ED for an inpatient unit.

complex or severely ill patients. Second, participants comprise a convenience sample of hospitals that responded to requests to report monthly data during the COVID-19 pandemic, introducing possible nonresponse bias. Third, this study does not include patient-level data, including patient characteristics that may influence patterns in utilization or boarding. A related limitation is that we did not account for transient system or practice changes during the pandemic, such as thresholds for hospitalization.

Finally, some participants did not report outcomes data for the entire study period; however, our analyses accounted for missing outcomes data by using panel regression with hospital fixed effects.¹³

DISCUSSION

In this study, we found that boarding transiently decreased in selected academic EDs during the initial phase

Table 2. Medians and adjusted means for primary and select secondary outcomes by quarter.

Outcome	2019 Q1* Jan-Mar (reference)	2020 Q1 Jan-Mar	2020 Q2 Apr-Jun	2020 Q3 Jul-Sep	2020 Q4 Oct-Dec	2021 Q1 Jan-Mar	2021 Q2 Apr-Jun	2021 Q3 Jul-Sep	2021 Q4 Oct-Dec
Total boarding hours per month									
Median (IQR)	7,204 (2,968-11,286)	5,643 (3,042-10,309)	2,965 (1,824-5,232)	6,713 (2,660-10,462)	7,920 (3,280-11,247)	7,134 (2,995-11,179)	8,928 (3,730-13,265)	10,040 (5,635-13,879)	11,480 (6,370-13,796)
Adjusted Mean (95% CI)	8,521 (7,845-9,197)	8,033 (7,191-8,875)	4,449 (3,189-5,710)	7,844 (7,096-8,592)	8,812 (8,109-9,514)	8,827 (8,275-9,379)	10,383 (9,677-11,088)	11,838 (10,806-12870)	12,127 (10,925-13,328)
Total LWBS or SAL per month									
Median (IQR)	201 (77-339)	159 (78-308)	57 (21-107)	133 (55-237)	101 (41-213)	98 (34-160)	189 (84-395)	348 (115-510)	262 (66-443)
Adjusted Mean (95% CI)	253 (228-277)	227 (195-258)	88 (50-125)	173 (153-193)	141 (120-162)	133 (115-152)	269 (242-297)	379 (328-430)	313 (278-350)
Total ED encounters per month									
Median (IQR)	5,236 (4,127-6,494)	5,032 (4,150-6,311)	3,672 (2,965-4,762)	4,548 (3,738-5,819)	4,439 (3,603-5,602)	4,534 (3,597-5,495)	5,117 (4,215-6,127)	5,275 (4,262-6,354)	4,983 (3,957-6,022)
Adjusted Mean (95% CI)	5,449 (5,345-5,554)	5,254 (5,157-5,351)	3,733 (3,521-3,946)	4,744 (4,657-4,831)	4,726 (4,625-4,828)	4,675 (4,605-4,745)	5,283 (5,218-5,348)	5,493 (5,394-5,592)	5,300 (5,186-5,415)
Total ED hospitalizations per month									
Median (IQR)	1,506 (1,043-1,936)	1,439 (1,061-1,799)	1,237 (904-1,528)	1,462 (1,041-1,683)	1,424 (1,047-1,739)	1,427 (1,035-1,834)	1,543 (1,104-1,984)	1,501 (1,059-1,871)	1,437 (1,034-1,806)
Adjusted Mean (95% CI)	1,508 (1,447-1,569)	1,447 (1,400-1,494)	1,262 (1,226-1,297)	1,431 (1,406-1,456)	1,429 (1,392-1,466)	1,436 (1,404-1,469)	1,518 (1,489-1,546)	1,495 (1,442-1,548)	1,438 (1,392-1,484)

*Additional quarters (2019 Q2, Q3, Q4) were omitted from this table for ease of interpretation; no significant differences from the baseline period were observed for these quarters in the adjusted model.

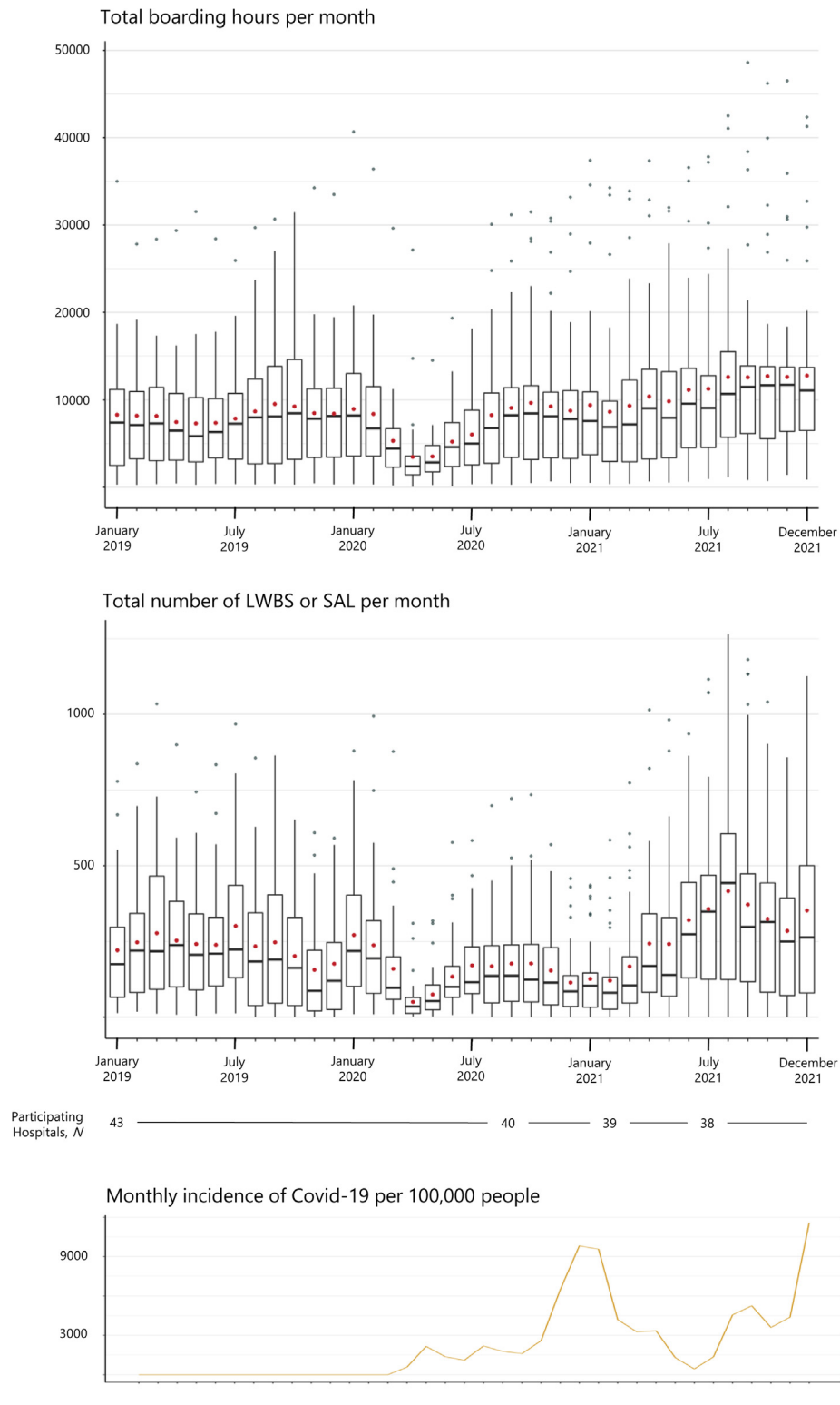


Figure. Total boarding hours and LWBS or SAL per month, with monthly incidence of COVID-19 per 100,000 people. Box-and-whisker plots show, for each month, median (horizontal bar), IQR (box), 1.5*IQR (whisker), and outliers (points). Red points indicate unadjusted monthly mean. The number of participating EDs/hospitals varies over time; 43 EDs are included from January 2019 to August 2020, 40 EDs are included from September 2020 to February 2021, 39 EDs are included from March 2021 to June 2021, and 38 EDs are included from July 2021 to December 2021.

of the COVID-19 pandemic but subsequently surged beyond 40% of pre-pandemic levels by the end of 2021. We also found that the total number of patients seeking emergency care in this sample of academic EDs returned to baseline levels. Although the number of patients who required hospitalization rapidly recovered after the initial shock of the pandemic, EDs still discharged fewer patients at the end of 2021 compared to before the pandemic. Together, these trends suggest deepening challenges for ED and hospital capacities as the COVID-19 pandemic has evolved.

These findings are consistent with emerging evidence, as well as media reports, that ED boarding has increased over the later phase of the pandemic.^{6,7} This study did not examine potential explanations for the increased boarding. However, previous literature suggests that increased surgical volume, hospital closures, increased hospital length of stay, and decreased hospital staffing all may contribute to worsening ED boarding.⁸ All of these factors are likely consequences of the COVID-19 pandemic or responses to financial challenges for hospitals during this time. Another potential cause may have been operational changes to inpatient hospital units, with the need to cohort patients with COVID-19 for infection control purposes creating inefficient bed management practices, as well as the need to obtain COVID-19 testing prior to admission. Regardless of the likely multifactorial etiologies for this surge in boarding, the consequences for not only patient experience but also patient outcomes are severe. Furthermore, emergency clinicians may struggle under the burden of increased boarding, exacerbating an ongoing staffing and well-being crisis.¹⁵

In summary, the total number of patients seeking emergency care in selected academic medical centers has returned to pre-pandemic levels, although these EDs still discharge fewer patients than before the pandemic. However, patients awaiting hospital admission are boarded in academic EDs for considerably more time than before the pandemic. As the pandemic—and US health care system—continues to evolve, it will be essential to not only monitor these trends but consider structural approaches to alleviating the boarding crisis.

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