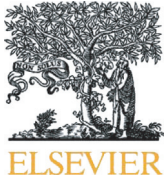




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## Pediatric emergency department volumes and throughput during the COVID-19 pandemic



Patient volumes in our pediatric emergency department (PED) decreased significantly after the initiation of public health interventions during the Covid-19 pandemic. Chaiyachati et al. demonstrated decreased volumes in a US PED [1], and recent studies in other countries support this observation [2–6]. An understanding of patient and visit characteristics during pandemics can ensure PED preparedness during high-volume surges or atypical low-volumes. The aim of this study was to describe PED visit characteristics, with an emphasis on throughput, during the COVID-19 pandemic compared with a historical period.

We performed a review of all patients presenting to an academic PED from March 16 to April 30, 2020 (from initiation of local public health interventions to gradual re-openings) and compared visit characteristics with those during the same period in 2018 and 2019. All patients presenting to the PED were included. Patient level variables we examined included age, gender, race, ethnicity, preferred language, arrival time and method, referral status, Emergency Severity Index (ESI), disposition, and revisit and left without being seen (LWBS) rates. PED volume and flow characteristics included daily volumes, time to room, provider, and disposition, and length of stay (LOS). Our Institutional Review Board approved this study.

Categorical variables were described using counts and percentages and compared with the  $\chi^2$  test. We used the Kruskal-Wallis test to compare non-parametric continuous variables. Significance was set at a *p*-value of 0.05 *a priori*. Analyses were performed using the R statistical software (version 3.5.0).

19,722 patients presented to the PED: 3688 patients during the pandemic period and 16,084 patients during the comparison period. The characteristics of patients presenting to the PED in both periods are presented in Table 1. During the pandemic period, the proportions of patients >18-years-old, referred to the PED, arriving by ambulance, and admitted were higher, and the LWBS rate was significantly lower. Characteristics of the PED volume and throughput for the study periods are presented in Table 2. Daily volumes were significantly lower during the pandemic period. All flow parameters were significantly shorter during the pandemic period.

In this study, we describe differences in patient and department characteristics during the COVID-19 pandemic compared to prior years. We noted a decrease in the absolute number of patients in the pandemic period, consistent with other published work [1–6]. We demonstrated higher acuity and admission rates. We hypothesize that early public health interventions and risk assessment regarding healthcare-related exposure to COVID-19 and increased use of telehealth contributed to reduced PED attendance for low-acuity complaints [4,7–13].

A larger proportion of referrals and ambulance arrivals occurred during the pandemic period, which may reflect higher acuity or changes in referral patterns for local primary care offices, as many were limiting visits for patients with infectious symptoms during the pandemic.

A novel finding in our study is the description of throughput during the pandemic period. Because of lower daily volumes, all time-based parameters were shorter during the pandemic period, along with a lower LWBS rate. This association between PED volumes, throughput variables, and LWBS rate has been previously described, but not in the setting of a pandemic [14–16].

Understanding pandemic volume and acuity variation allows PED leadership to plan resource allocation. In our PED, residents see approximately 80% of patients and continued in this role during the pandemic. The only change made to staffing was the elimination of an “intake” physician, who conducts a brief initial assessment and places preliminary orders to expedite throughput. While prior studies on PED preparedness during a pandemic have focused on volume surges, our study shows that pandemic preparedness must also address resource allocation for reduced patient volumes. [17,18] Decreasing PED staffing during a pandemic reduces potential healthcare worker exposure to disease carriers and conserves personal protective equipment. Low volume contingency plans could decrease scheduled shifts for providers and utilize a back-up system for additional providers as needed, while maintaining adequate trainee learning opportunities.

Our study was based at a single center and may not be generalizable to other settings. Local epidemiologic data suggests that the prevalence of COVID-19 was low during our study period, and our results may not be reproducible in areas of high viral transmission [19]. The data was collected retrospectively and is subject to biases associated with this methodology. Additionally, while our date range selection aligns with the start of Ohio’s local public health interventions, it is difficult to assess how much this contributed to our results.

This study offers insight into PED preparedness and planning for a pandemic. Hesitation to seek care for low-acuity illnesses during the COVID-19 pandemic may have contributed to fewer PED presentations. Patients experienced timelier PED throughput, were less likely to leave without being seen, and were more often admitted. PED pandemic preparedness must not only address volume surges, but also anticipate decreased volumes to conserve resources.

### Presentations

This work has not been previously presented formally at any scientific meeting.

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### Author contributions

Conceptualization: LE and AAV; Data curation: AAV; Formal analysis: MJL; Investigation: LE, AAV, MJL, PMW, PD, BTK; Writing - original

**Table 1**  
Characteristics of patients presenting to and dispositioned from a pediatric emergency department between March 16 to April 30.

Characteristic, n (%)	Overall (19,722)	2018 and 2019 (16,084)	2020 (3688)	P	P#
Age				0.001	
0 – <1 m	357 (1.8)	278 (1.7)	79 (2.1)		0.714
1 m – <1 y	2306 (11.7)	1862 (11.6)	444 (12.0)		1.0
1 y – <2	1950 (9.9)	1596 (9.9)	354 (9.6)		1.0
2 y – <5 y	3111 (15.7)	2559 (15.9)	552 (15.0)		1.0
5 y – <12 y	5092 (25.8)	4197 (26.1)	895 (24.3)		0.161
12 y – <18 y	5381 (27.2)	4371 (27.2)	1010 (27.4)		1.0
>18 y	1575 (8.0)	1221 (7.6)	354 (9.6)		0.007
Male sex	9904 (50.1)	8079 (50.2)	1825 (49.5)	0.43	
Race				0.034	
White	12,245 (61.9)	9895 (61.5)	2350 (63.7)		0.042
Black/African American	6849 (34.6)	5639 (35.1)	1210 (32.8)		0.03
Other	678 (3.4)	550 (3.4)	128 (3.5)		1.0
Ethnicity				0.71	
Non-Hispanic	18,775 (95.0)	15,278 (95.0)	3497 (94.8)		
Preferred language				0.71	
English	19,020 (96.2)	15,469 (96.2)	3551 (96.3)		
Spanish	488 (2.5)	403 (2.5)	85 (2.3)		
Other	264 (1.3)	212 (1.3)	52 (1.4)		
Referral to PED	3724 (18.8)	2778 (17.3)	946 (25.7)	<0.001	
Arrival method				<0.001	
Walk-in	17,141 (86.7)	14,037 (87.3)	3104 (84.2)		<0.001
Ambulance	2589 (13.1)	2012 (12.5)	577 (15.6)		<0.001
Air	42 (0.2)	35 (0.2)	7 (0.2)		1.0
Presenting shift				<0.001	
0000–0800	3263 (16.5)	2587 (16.1)	676 (18.3)		<0.001
0800–1600	7342 (37.1)	6120 (38.1)	1222 (33.1)		0.012
1600–0000	9167 (46.4)	7377 (45.9)	1790 (48.5)		<0.001
ESI at triage*				<0.001	
1	66 (0.3)	50 (0.3)	16 (0.4)		1.0
2	6430 (33.0)	5193 (32.8)	1237 (33.7)		1.0
3	8053 (41.3)	6460 (40.8)	1593 (43.4)		0.02
4	4263 (21.9)	3540 (22.4)	723 (19.7)		<0.001
5	672 (3.4)	574 (3.6)	98 (2.7)		0.005
LWBS	624 (3.2)	608 (3.8)	16 (0.4)	<0.001	
Patient disposition				<0.001	
Discharged	14,412 (72.9)	11,755 (73.1)	2657 (72.0)		1.0
Admitted to general ward	4058 (20.6)	3228 (20.1)	880 (23.9)		<0.001
Admitted to ICU	427 (2.2)	337 (2.1)	90 (2.4)		0.22
Transferred	133 (0.7)	104 (0.6)	29 (0.8)		1.0
Eloped	59 (0.3)	46 (0.3)	13 (0.4)		1.0
Expired	9 (0.0)	6 (0.0)	3 (0.1)		1.0
Patient revisits	795 (4.0)	670 (4.2)	125 (3.4)	0.034	

PED, pediatric emergency department; OSH, outside hospital; ICU, intensive care unit; ESI, emergency severity index; LWBS, left without being seen; ICU, intensive care unit, patient revisit, the daily number and percent of patients who were evaluated in the pediatric emergency department within the last 72 h.

# Adjusted for multiple comparisons.

\* 1.2% of overall patient volume had no ESI level recorded.

**Table 2**  
Characteristics of the pediatric emergency department volume and flow from March 16 to April 30.

Characteristic, median [IQR]	Overall	2018 and 2019	2020	P
Daily visits	155.5 [89.0, 186.5]	177.5 [155.8, 192.0]	74.5 [67.3, 88.0]	<0.001
Patient room time*, min	15.0 [10.0, 29.0]	18.0 [11.0, 36.0]	12.0 [9.0, 17.0]	<0.001
Time to Provider#, min	56.0 [31.0, 102.0]	63.0 [33.0, 114.0]	40.0 [22.0, 61.0]	<0.001
Time to disposition, min	154.0 [99.0, 226.0]	161.0 [105.0, 234.0]	124.0 [79.0, 190.0]	<0.001
PED LOS, min	204.0 [137.8, 292.0]	210.0 [144.0, 299.0]	179.0 [119.0, 261.0]	<0.001

STS, shock trauma suite; presenting shift, shift during which patient presented; rooming, time from patient arrival to placement in an examination room; provider time, time from patient arrival to first provider evaluation; disposition time, time from arrival to patient disposition; PED, pediatric emergency department; LOS, length of stay.

\* 2.8% of overall data missing.

# 3.4% of overall data missing.

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PMW reports no conflict of interest.

PD reports no conflict of interest.

AAV reports no conflict of interest.

**Declaration of Competing Interest**

LE reports no conflict of interest.  
MJL reports no conflict of interest.

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