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Characterizing pediatric emergency department visits during the COVID-19 pandemic

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Objective:
We determine how pediatric emergency department (ED) visits changed during the COVID-19 pandemic in a large sample of U.S. EDs.

Methods:
Using retrospective data from January–June 2020, compared to a similar 2019 period, we calculated weekly 2020–2019 ratios of Non-COVID-19 ED visits for adults and children (age 18 years or less) by age range. Outcomes were pediatric ED visit rates before and after the onset of pandemic, by age, disposition, and diagnosis.

Results:
We included data from 2,213,828 visits to 144 EDs and 4 urgent care centers in 18 U.S. states, including 7 EDs in children’s hospitals. During the pandemic period, adult non-COVID-19 visits declined to 60% of 2019 volumes and then partially recovered but remained below 2019 levels through June 2020. Pediatric visits declined even more sharply, with peak declines through the week of April 15 of 74% for children age < 10 years and 67% for 14–17 year. Visits recovered by June to 72% for children age 14–17, but to only 50% of 2019 levels for children < age 10 years. Declines were seen across all ED types and locations, and across all diagnoses, with an especially sharp decline in non-COVID-19 communicable diseases. During the pandemic period, there was 22% decline in common serious pediatric conditions, including appendicitis.

Conclusion:
Pediatric ED visits fell more sharply than adult ED visits during the COVID-19 pandemic, and remained depressed through June 2020, especially for younger children. Declines were also seen for serious conditions, suggesting that parents may have avoided necessary care for their children.

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1. Introduction

On March 13, 2020, the federal government declared a national emergency in response to escalating cases of coronavirus disease (COVID-19) which have since become a global pandemic. Early U.S. pandemic responses included closing schools and many businesses and restricting large gatherings, as well as promoting handwashing, social distancing and later, mask wearing to reduce viral spread. In mid-March, visits to U.S. emergency departments (ED) declined sharply, nadiring nationally at approximately 58% of 2019 volume in the second week of April [1]. Potential contributors to this steep fall included lower incidence of communicable disease and fewer injuries due to social distancing as well as reduced travel and activity, patients avoiding EDs due to fear of themselves contracting COVID-19 in the ED, and moves to telehealth as a substitute for face-to-face healthcare [2]. Since April, there has been a partial recovery in non-COVID ED visits but visit levels have remained substantially below 2019 levels.

ED visits for children in the U.S. and other countries also declined dramatically during the COVID-19 pandemic [1,3]. Studying pediatric ED visits in isolation is important because they occur for different reasons than adults, largely being driven by injury and communicable illness rather than underlying medical conditions [4]. Some children also have serious, time-sensitive emergencies such as appendicitis and sepsis that require immediate care that can only be delivered in hospitals. The detailed nature of the ED visit declines for children in the U.S. and potential health implications have not been previously been analyzed.

In this study, we analyze trends in pediatric visits of over the early months of the COVID-19 pandemic in a large sample of U.S. EDs. We
study variation in those trends based on child age, diagnosis, discharge status, and facility type.

2. Materials and methods

2.1. Study design, setting, and selection of participants

We conducted a retrospective observational study of pediatric ED visits during January–June 2020, relative to the same time period in 2019, using data from a national emergency medicine group. We included data from 144 EDs and 4 urgent care centers in 18 states. This dataset has been described in detail elsewhere [5]. Data elements are automatically extracted directly from electronic health records at each site. Analyses included data from general EDs (n = 110), pediatric EDs (n = 7), freestanding EDs (n = 26) and urgent care centers (n = 4) which were continuously staffed by the emergency medicine group between January 1, 2019 and June 30, 2020. This study was approved by the Institutional Review Board of Allegheny Health Network.

2.2. Methods of measurement and data analyses

Using data from January–June 2019 and January–June 2020, we calculated for each facility the ratio of 2020 visit counts to visits during the same period in 2019, stratified by patient age, facility type and location, principal diagnosis, discharge category, and the state where the ED was located. We used the comparable period in 2019 as the denominator for the ratio to control for seasonality. For the numerator (2020 visits) we located. We used the comparable period in 2019 as the denominator for principal diagnosis, discharge category, and the state where the ED was located. We used the comparable period in 2019 as the denominator for the ratio to control for seasonality. For the numerator (2020 visits) we

2.3. Results

In early 2020, the 2020/2019 ratio of non-COVID ED visits was somewhat above 1 in January but declined after that. (Fig. 1A) The ratio fell starting the week of March 11 and accelerated over the next several weeks, finally reaching tin April and then beginning to gradually rise. The overall drop through mid-April was to 42% of 2019 volume for adults, but substantially higher to 67% for ages 14–17 years, and 74% for children <10 years. There was a gradual visit rebound across all age groups that started in late-April, yet pediatric visit ratios remained below adult ratios, especially for children <10 years. By the final week in June, visits had returned to 84% of 2019 levels for adults, 74% for 14–17 years, 67% for 10–13 years, and 50% for <10 years.

Visit rates for the three most common diagnoses and serious conditions followed different patterns. (Fig. 1B) “Other upper respiratory tract infection visits” fell precipitously throughout March and April nadir at 7% of 2019 volume and by June had recovered only to 30%. By comparison, “Abdominal pain” and “Superficial injuries” visits followed similar patterns nadiring at 23% of 2019 volume and recovering to 61% by June. Visits for the five serious conditions included fell in April to 60% of 2019 volume, then increased to about 80% in May and June and returning to 100%, before falling again in late June. From March 13 to June 30, 2020, there were declines of 22% for the five common, serious conditions: appendicitis (−19%), septicemia (−49%), and intussusception (−42%), with no significant change for diabetic ketoacidosis and testicular torsion, compared to 2019 data from the same period. (Table 1)

For the most common diagnoses from March to June, especially large declines were seen in diagnoses for potentially communicable diseases: for example, for influenza (−84%), and other upper respiratory tract infections (−73%). Declines were smaller for arm fractures (−43%) and open head wounds (−31%), and for conditions commonly requiring antibiotics, including soft-tissue infections (−51%) and urinary tract infections (−47%). Declines were slightly smaller for small EDs (−52%) and

Fig. 1. Weekly Facility Ratios of ED Visits 2020/2019 in 147 Facilities by Age (A) and Selected Pediatric Conditions (B) During the COVID-19 Pandemic Note: Dotted vertical line separates pre-pandemic from pandemic period. Small vertical bars around each data point indicate 95% confidence interval, calculated using robust standard errors clustered at the facility-level. Trends in ages <3 were found to be nearly identical to trends in age 3–9 and were combined (<10 y). Serious pediatric conditions include appendicitis, sepsis, diabetic ketoacidosis, intussusception, and testicular torsion.
Table 1
Change in emergency department (ED) visits: 2020 (during pandemic; March 13–June 30) vs. same period in 2019.

| Facility characteristics | 2019 volume | 2020 volume | % change | 95% CI |
|---------------------------|-------------|-------------|----------|-------|
| All visits*               | 1,236,447   | 882,240     | −29%     | (−31%, −26%) |
| Adults ≥18 years          | 104,815     | 59,726      | −43%     | (−46%, −40%) |
| Pediatrics<18 years       | 271,269     | 111,764     | −59%     | (−62%, −56%) |
| Pediatric visit volume, by visit characteristics |          |             |          |       |
| Age                       |             |             |          |       |
| <10 y                     | 174,788     | 68,263      | −61%     | (−64%, −57%) |
| 10–13 y                   | 44,185      | 17,570      | −60%     | (−64%, −56%) |
| 14–17 y                   | 52,296      | 25,931      | −50%     | (−54%, −47%) |
| Gender                    |             |             |          |       |
| Male                      | 140,527     | 57,129      | −59%     | (−63%, −56%) |
| Female                    |             |             |          |       |
| Payer source              |             |             |          |       |
| Commercial                | 60,413      | 26,398      | −56%     | (−59%, −53%) |
| Medicaid                  | 172,599     | 64,251      | −63%     | (−66%, −59%) |
| Self-pay                  | 28,986      | 17,226      | −41%     | (−45%, −36%) |
| Other                     | 9252        | 3880        | −58%     | (−62%, −54%) |
| Disposition               |             |             |          |       |
| Admitted                  | 13,708      | 7795        | −43%     | (−46%, −40%) |
| Transfer                  | 4633        | 3019        | −35%     | (−40%, −30%) |
| Discharge                 | 243,935     | 98,004      | −60%     | (−63%, −57%) |
| LWT/AMA*                  | 7363        | 1584        | −78%     | (−87%, −70%) |
| ED Death/DOA             | 99          | 55          | −64%     | (−70%, −19%) |
| Other                     | 1528        | 1306        | −15%     | (−24%, −5%) |
| COVID-19                  |             |             |          |       |
| Confirmed diagnosis        | N/A         | 606         | −       |       |
| Serious conditions        |             |             |          |       |
| Appendicitis              | 1144        | 921         | −19%     | (−27%, −12%) |
| Septicemia                | 257         | 131         | −49%     | (−65%, −33%) |
| Diabetic ketoacidosis      | 229         | 214         | −7%      | (−25%, 12%) |
| Intussusception           | 69          | 40          | −42%     | (−72%, −12%) |
| Testicular torsion         | 89          | 96          | 8%       | (−24%, 39%) |
| All urgent conditions combined | 1788      | 1402        | −22%     | (−26%, −16%) |
| Most common visit diagnoses |             |             |          |       |
| Injuries                  |             |             |          |       |
| Superficial injury; contusion | 13,373   | 5892        | −56%     | (−60%, −52%) |
| Other unspecified injury   | 9842        | 3891        | −60%     | (−64%, −57%) |
| Sprains and strains        | 8138        | 2546        | −69%     | (−73%, −64%) |
| Open wounds of head and neck | 7858      | 5449        | −31%     | (−35%, −27%) |
| Fracture of the upper limb | 7382        | 4281        | −42%     | (−47%, −37%) |
| Open wounds to limbs       | 5610        | 4522        | −19%     | (−26%, −13%) |
| Conditions commonly caused by communicable diseases |          |             |          |       |
| Other specified upper respiratory infections* | 28,546     | 7829        | −73%     | (−80%, −65%) |
| Fever                     | 10,468      | 4512        | −57%     | (−61%, −53%) |
| Respiratory signs and symptoms | 6800     | 2894        | −57%     | (−64%, −51%) |
| Viral infection            | 6713        | 2523        | −62%     | (−69%, −56%) |
| Otitis media               | 10,781      | 2504        | −77%     | (−82%, −71%) |
| Nausea and vomiting        | 10,208      | 2336        | −77%     | (−82%, −73%) |
| Asthma                     | 5512        | 1329        | −76%     | (−83%, −68%) |
| Influenza                  | 5501        | 900         | −84%     | (−108%, −58%) |
| Acute bronchitis           | 4112        | 884         | −79%     | (−88%, −69%) |
| Symptoms & other system diseases |          |             |          |       |
| Abdominal pain             | 11,951      | 4495        | −62%     | (−66%, −58%) |
| Musculoskeletal pain, not low back pain | 4960     | 1839        | −63%     | (−68%, −58%) |
| Skin and subcutaneous tissue infections | 4602     | 2270        | −51%     | (−56%, −46%) |
| Urinary tract infections   | 4105        | 2186        | −47%     | (−51%, −42%) |
| Facility types             |             |             |          |       |
| General ED (N = 110)       | 166,016     | 65,294      | −61%     | (−64%, −58%) |
| Pediatric ED (N = 7)       | 84,254      | 37,467      | −56%     | (−59%, −52%) |
| Freestanding ED (N = 30)   | 20,999      | 9003        | −57%     | (−61%, −53%) |
| ED size*                   |             |             |          |       |
| Small (<30,000 visits) (N = 70) | 26,132   | 12,611      | −52%     | (−55%, −48%) |
| Medium (30,000–59,999 visits) (N = 58) | 97,941   | 37,474      | −62%     | (−65%, −59%) |
| Large (>60,000 visits) (N = 19) | 41,943  | 15,209      | −64%     | (−67%, −60%) |
| Location                   |             |             |          |       |
| Large central metro (N = 41) | 37,159    | 13,667      | −63%     | (−67%, −60%) |
| Large fringe metro (N = 51) | 50,122     | 19,259      | −62%     | (−65%, −58%) |
| Medium metro (N = 24)      | 42,074      | 16,062      | −62%     | (−65%, −59%) |
| Small metro and non-metro (N = 31) | 36,661  | 16,306      | −56%     | (−59%, −52%) |

* Visits to 147 EDs (110 general hospital EDs, 7 pediatric EDs, and 30 free standing EDs (includes 4 urgent care clinics). Facilities are located in Texas (30), Colorado (28), Ohio (19), Maryland (13), North Carolina (12), Pennsylvania (12), Florida (11), Oklahoma (5), plus 1–3 facilities in each of California, Connecticut, Hawaii, Illinois, Kansas, Kentucky, Michigan, New Hampshire, Nevada, New York, and Virginia.

AMA/LWT = left against medical advice or left without treatment.

* Other specified upper respiratory infections most commonly include acute upper respiratory infections, acute pharyngitis; streptococcal pharyngitis, acute obstructive laryngitis (croup), and acute nasopharyngitis (common cold).

* The majority of visits in this category are for patients that LWT/AMA includes ICD-10-cm code Z539 “procedure and treatment not carried out, unspecified reason.”

* ED size based on 2019 annual visit volumes. Location determined using the National Center for Health Statistics 2013 Urban-Rural Classification Scheme for Counties.

* 95% confidence interval does not cross zero. Confidence intervals are not corrected for multiple comparisons.
EDs in rural (−56%) areas. There were 606 specific COVID-19 diagnoses. The number of children who were dead on arrival or died in the ED fell (−44%).

4. Discussion

The COVID-19 pandemic led to sharply reduced pediatric ED visits, with especially large declines for younger children below the age of 10 years. Compared to adults, pediatric ED visits fell further and remain further below pre-pandemic levels. Certain visit types were more impacted. In particular, visits caused by communicable conditions, including influenza, other specified upper respiratory tract infections, otitis media, and symptoms of nausea and vomiting, had sharper and more persistent declines. There were also substantial reductions for injury, and for urgent infectious conditions requiring antibiotics. Approximately 1 in 2000 visits (relative to 2019 levels) involved a COVID-19 diagnosis, likely previously diagnosed because rapid testing was not yet available for definitive results in the ED.

Pediatric ED visits could be differentially affected relative to adult visits for a number of reasons. Social distancing, especially school closures, could have had a large impact on the causes of pediatric visits. Specifically, fewer face-to-face interactions likely reduced contagion and reduced school play reduced activity-related and motor vehicle crash injuries. Other studies have documented increased use of telemedicine but less office-based care during the pandemic [7]. Whether the lower pediatric ED visits observed in our study were a result of actual lower incidence of illness and injury, or whether care shifted to other settings or was avoided entirely is unknown [8]. However, an argument for a real reduction in incidence of disease and injury as the major contributor to our findings is supported by the very large percentage declines for infectious disease, as well as observed declines for fractures and open wounds, for which ED care would be hard to avoid.

Importantly, the visit rate for influenza in 2020 was less than one fifth of 2019 levels. These trends may portend a dramatically muted influenza season this fall and winter, mirroring the impact that has occurred in Australia [9]. The muted effect may be more prominent in regions which provide primarily distance-learning in the fall, and supports cautious optimism that COVID-19 pandemic may not be compounded by a typical yearly influenza epidemic to produce higher ED volumes.

As compared to adult visits, pediatric ED visits through June 2020 have remained dramatically depressed. Perhaps social distancing has had a larger effect on contagious disease for children than for adults, especially given that June is also summer break for children. Fear of ED-based contagion may also be more prominent when parents are considering bringing children for ED care. It is also possible that alternatives to ED care such as telemedicine by pediatric offices may also have been more readily available for children than for adults.

Perhaps the most concerning findings of our study are substantial drops in appendicitis, septicaemia, and intussusception visits. These conditions are true emergencies that require immediate treatment and are rarely treated outside of hospital settings. This raises the strong possibility that care may have been deferred or never occurred, with more serious outcomes (i.e., bowel perforations from untreated appendicitis or intussusception) or even death (i.e., untreated sepsis). However, it is also possible that because sepsis and intussusception can be preceded by viral illness, lower ED visits may reflect actual lower incidence of disease. To the extent that severe sepsis leads to delay in ED visits, rather than death at home, it is encouraging that visits with the child dead on arrival or died in the ED were rare and even fell during the pandemic period. This lower incidence of ED visits for severe conditions in children mirrors similar effects in adult patients with fewer visits for adults with acute myocardial infarction that occurred early in the pandemic [10].

Close examination of trends in pediatric ED visits during the COVID-19 pandemic, including study of outcomes after hospitalization should be a priority for both physicians and public health officials. Interventions may be required to ensure that children receive access to timely emergency care when necessary. The sharp decline in ED visits also severely affects the economics of sustaining an ED and, if sustained, may require subsidies for lower-volume EDs to avoid closure.

There are several study limitations. Our study EDs are geographically diverse (18 states) but represent only about 3% of U.S. EDs and may not generalize to other sites. In particular, our EDs were not in New York City or Seattle, which were early COVID-19 hotspots. However, our data include a variety of settings such as general EDs, children’s hospitals, freestanding EDs, and urgent care centers in multiple states.

Second, we solely examined ED and urgent care visit data and did not observe the outcomes of avoided or deferred care. We also cannot determine how often care was delivered in other settings, such as in pediatric offices or by telemedicine. Declines for specific conditions could reflect reduced incidence of disease (e.g. for limb fractures), or alternatively ED avoidance, or a combination of both. Further study will be required to assess the extent to which avoided or deferred care impacted children’s health and well-being. Finally, presumptive COVID-19 diagnoses based on exposure and symptoms would not have been coded as COVID-19 diagnoses. Therefore, we likely underestimated the actual COVID-19 prevalence in this study.

5. Conclusion

We found that pediatric ED visits fell more sharply than adult ED visits during the COVID-19 pandemic, and remained depressed through June 2020, especially for younger children. Declines were seen for serious conditions, suggesting in some case that parents may potentially have avoided necessary care for their children.

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