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Original Contributions

The Effect of COVID-19 Stay-At-Home Orders on the Rate of Pediatric Foreign Body Ingestions ☆

Jeffrey T. Neal, MD, Michael C. Monuteaux, SCD, John J. Porter, MBA, and Joel D. Hudgins, MD

Division of Emergency Medicine, Boston Children's Hospital, Boston, Massachusetts
Reprint Address: Jeffrey T. Neal, MD, Division of Emergency Medicine, Boston Children's Hospital, 300 Longwood Avenue, Boston, MA 02115.

□ **Abstract—Background: Foreign body ingestions are a common presentation in the emergency department (ED), particularly in young children. Objective: We sought to determine whether the COVID-19 pandemic lockdowns had an effect on the proportion of foreign body ingestions. Methods: We performed a retrospective review of the Pediatric Health Information System for patients younger than 19 years who were identified by International Classification of Diseases, Tenth Revision codes for foreign body ingestion. We analyzed patients in the following three groups: young children (younger than 5 years), school-aged children (5–12 years), and adolescents (13 years and older), using an interrupted time series analysis. Our primary outcome was the difference in proportion of foreign body ingestions. We compared 1 year after the declaration of the COVID-19 pandemic (March 13, 2020 to March 31, 2021) with the previous 3 years (March 1, 2017 to March 12, 2020). Results: Total pediatric ED encounters decreased in the post period ($p < 0.01$); 4902 patients per year presented for foreign body ingestion pre–COVID-19 shutdown vs. 5235 patients per year post–COVID-19 shutdown. In all three age groups (young children, school-age children, and adolescents), there was a higher proportion of foreign body ingestions post–COVID-19 shutdown ($p < 0.01$, $p < 0.01$, and $p = 0.028$, respectively), driven primarily by the decrease in total ED encounters. In the youngest age group (younger than 5 years), there was also a significant increase in slope for foreign body ingestions post–COVID-19 ($p = 0.010$). Conclusions: The proportion of foreign body ingestions increased after the declaration of the COVID-19 pandemic, primarily driven by an overall decrease in total ED volume. © 2022 Elsevier Inc. All rights reserved.**

□ **Keywords—Foreign body; COVID-19; Ingestion; Emergency department**

Introduction

Foreign body ingestions are common in pediatric emergency departments (EDs) (1). Certain presentations, such as those associated with button batteries, can be life-threatening due to corrosive damage to the esophagus requiring emergent intervention (2,3). A recent study demonstrated that the annual rate of foreign body ingestions per 10,000 children increased by 91.5% during a 20-year period (4). Coins are the most commonly ingested object; other objects include toys, button batteries, magnets, marbles, and sharp objects (such as screws or safety pins) (1). Certain measures, such as the Consumer Product Safety Improvement Act (CPSIA) in 2008—which requires batteries for use in toys intended for children younger than 3 years to be secured in compartments—have attempted to reduce pediatric foreign body ingestions (5). Nevertheless, despite an initial decrease until

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2011, the overall trend of foreign body ingestions has continued to increase year after year (4).

On March 11, 2020, the World Health Organization declared the COVID-19 outbreak a pandemic (6). Shortly after this declaration, governors throughout the United States issued statewide lockdowns through stay-at-home mandates and shuttered schools, after which students transitioned to remote learning modalities. At the peak of school closures, it is estimated that at least 55.1 million students in approximately 124,000 schools were affected (7). Approximately 66% of parents and caregivers who primarily worked from home during this time stated that they had at least some childcare responsibilities while working from home (8).

In this investigation, we attempted to determine the impact of the COVID-19 lockdowns on the proportion of pediatric foreign body ingestions presenting to EDs throughout the United States. We hypothesized that the proportion of foreign body ingestions would increase due to children being at home for longer periods of time than expected, with less supervision due to parental work responsibilities and other distractions. These findings could help raise parental and governmental awareness of the need for additional public health measures to protect children during this particularly vulnerable time, as coronavirus variants continue to surge throughout the United States, potentially leading to additional school closures.

Materials and Methods

Study Design and Setting

We performed a retrospective review of pediatric patients younger than 19 years who presented to the ED for foreign body ingestion. We obtained data for this study from the Pediatric Health Information System (PHIS), an administrative database that contains inpatient, ED, ambulatory surgery, and observation encounter-level data from more than 50 not-for-profit, tertiary care pediatric hospitals in the United States. These hospitals are affiliated with the Children's Hospital Association (Lenexa, KS). Data quality and reliability are assured through a joint effort between the Children's Hospital Association and participating hospitals. For the purposes of external benchmarking, participating hospitals providedischarge or encounter data, including demographic characteristics, diagnoses, and procedures. Nearly all of these hospitals also submit resource utilization data (e.g., pharmaceuticals, imaging, and laboratory) to PHIS. Data are deidentified at the time of data submission and are subjected to several reliability and validity checks before being included in the database. The PHIS Review Board and the Institutional Review Board of our institution approved this study.

To understand the effect of the COVID-19 lockdowns, we defined two study periods as "pre–COVID-19 lockdown" and "post–COVID-19 lockdown." Given the varying school closure dates as the pandemic grew, we defined the study periods according to the U.S. declaration of a national emergency on March 13, 2020 (9). We compared the visits for the 3 years prior to this date (pre–COVID-19 lockdown: March 1, 2017 to March 12, 2020) with the visits after this date (post–COVID-19 lockdown: March 13, 2020 to March 31, 2021). Although statewide lockdowns and school closures happened at different times, we thought that the date of the declaration of a national emergency would reflect an appropriate division between the pre-lockdown and post-lockdown periods. The end of the post–COVID-19 lockdown period was driven by the most recently available data provided by PHIS.

Selection of Participants

We included patients younger than 19 years who presented to the ED with a primary discharge diagnosis of foreign body ingestion. We collected data from PHIS hospitals with complete administrative and billing data during the entire study period from March 1, 2017 through March 31, 2021. We defined foreign body ingestion using International Classification of Diseases, Tenth Revision (ICD-10) codes T18.8XXA / T18.9XXA ("foreign body in other parts of alimentary tract, initial encounter") as a principal diagnosis (10). Exclusion criteria included visits by patients with complex chronic conditions (11–15). We stratified patients *a priori* into three separate age groups (young children [younger than 5 years], school-aged children [5–12 years], and adolescents [13–18 years old]) based on previous literature showing different rates of foreign body ingestion according to age (16,17).

Measurements

We abstracted the following data elements electronically from the database: demographic information including age, gender, race, ethnicity, and payer information (private, public, or other), as well as visit information, including check-in time of day (day, evening, or overnight), weekend visit (yes or no), and ED disposition (discharged, admitted, transferred, left against medical advice, or operating room). We also collected clinical information, including imaging (radiography, computed tomography, or fluoroscopy), procedures (identified by ICD-10 procedure codes listed in the Appendix, mean hospital charges, mean lengths of stay, and return visits within 7 days.

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Outcomes

Our primary outcome was the proportion of pediatric foreign body ingestions within each age group; the denominator included total ED encounters. Secondary outcomes included the absolute count of pediatric foreign body presentations, rates of imaging, mean hospital charges, mean length of stay, and rates of return visits within 7 days of initial ED presentation.

Analysis

We used descriptive statistics to characterize the demographic and clinical features of the study population. We performed interrupted time series analyses using logistic regression separately for each age group to assess for changes in the proportion of foreign body ingestions before and after the declaration of the national emergency. We estimated a logistic regression model with the proportion of patients presenting for foreign body ingestions as the dependent variable. The independent variables included time (modeled monthly), intervention period (pre vs. post declaration of the COVID-19 national emergency), and time-by-intervention interaction term. The time variable provides an estimate of the pre-period slope. The intervention variable compares the pre- vs. post-intervention intercepts (i.e., the level change), and the interaction term tests whether the change over time in the pre–COVID-19 lockdown period differed compared with the change over time in the post–COVID-19 lockdown period (i.e., comparison of the pre- vs. post-lockdown slopes or slope change).

All regression models used robust SEs clustered on hospital to account for intrahospital correlation. We performed statistical analyses using STATA (version 16.0; StataCorp) and IBM SPSS (version 23; IBM SPSS) software. All statistical tests were two-tailed and α was set at 0.05.

Results

Characteristics of Study Subjects

Of all eligible PHIS hospitals, 40 had complete administrative and billing data during the entire study period and were included in this study. During the pre-pandemic and post-pandemic periods, there were 8,156,272 and 1,513,493 ED encounters, respectively. Of these visits, there were 14,705 encounters (4902 encounters per year) that had a primary diagnosis of foreign body ingestion during the 3-year period prior to the COVID-19 lockdown (March 1, 2017 to March 12, 2020) compared with 5235 encounters in the 1-year period after the COVID-19 lockdown (March 13, 2020 to March 31, 2021). There was no significant difference between these two populations based on age or gender. In both populations, the patients were more likely to be male than female (56% vs. 44%) and more likely to be younger than 5 years (66%). There was a statistically significant difference regarding race and payer type between the two groups. A higher proportion of White and private payer patients presented to the ED post lockdown. Most ED presentations occurred in the evening (51%). The summary statistics of this population are presented in Table 1.

Main Results

Among the encounters with patients younger than 5 years, there was both a significant level change (odds ratio [OR] 1.72; 95% CI 1.51–1.97) and slope change (OR 1.02; 95% CI 1.00–1.03) in the positive direction, indicating an increase in the proportion of foreign body visits after the onset of the shutdown ($p < 0.01$ and $p = 0.029$, respectively). Among the encounters with patients aged 5–12 years, there was a significant level change (OR 1.97; 95% CI 1.73–2.30) in the positive direction ($p < 0.01$), with no slope change (OR 1.01; 95% CI 0.99–1.02]). Among the encounters with patients aged 13–18 years, there was a significant level change (OR 1.81; 95% CI 1.07–3.06) in the positive direction ($p = 0.028$), with no slope change (OR 0.97; 95% CI 0.92–1.02) (Figure 1).

The absolute number of pediatric ED visits per month decreased dramatically ($z = -8.63$; $p < 0.01$), but the absolute number of monthly visits for foreign body ingestions remained relatively steady ($z = 0.82$; $p = 0.41$) after the declaration of the national emergency (Figure 2). The annual number of visits for foreign body ingestions during the study period were as follows: 2017, n = 4156; 2018, n = 4592; 2019, n = 4983; 2020, n = 4876; and 2021, n = 1333 (first quarter only).

The clinical and management characteristics are presented in Table 2. Most encounters for suspected foreign body ingestions ended in discharge from the ED in both the pre– and post–COVID-19 shutdown periods (94.5% and 93.7%, respectively). Mean hospital charges and mean lengths of stay were not statistically different between the two study periods. There was a statistically significant difference in ED disposition, rates of imaging, procedures, and return visits within 7 days. A higher proportion of patients had imaging and were admitted post lockdown, but fewer procedures and fewer return visits were seen post lockdown.

Discussion

Our study investigated the impact of the COVID-19 lockdowns on the proportion of pediatric foreign body

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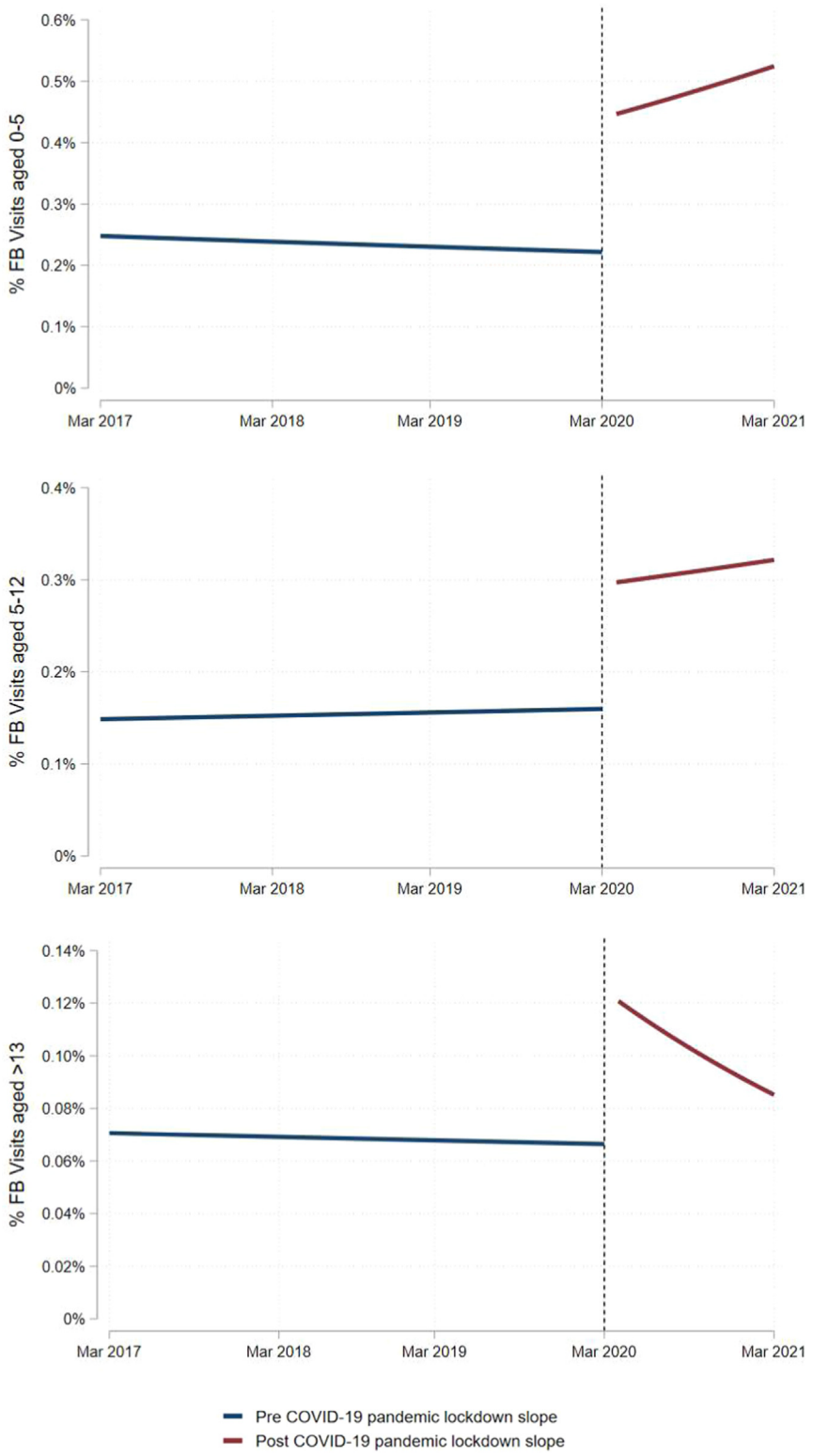

Figure 1. Interrupted time series regression. FB = foreign body.

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Table 1. Patient Characteristics of Pediatric Foreign Body Ingestions Treated at Pediatric Health Information System Emergency Departments.

Characteristic	Pre–COVID-19 Shutdown (3/1/2017–3/12/2020) (n = 14,705)		Post–COVID-19 Shutdown (3/13/2020–3/31/2021) (n = 5235)		*p* Value*
	n	%	n	%	
Age					0.957
< 5 y	9668	65.8	3444	65.8	
≥ 5–12 y	4105	27.9	1454	27.8	
13–18 y	932	6.3	337	6.4	
Gender					0.345
Male	8173	55.6	2949	56.3	
Female	6527	44.4	2284	43.7	
Race					0.002
White	8727	59.4	3307	63.2	
African American	2371	16.1	822	15.7	
Asian	424	2.9	175	3.3	
Other	2311	15.7	750	14.3	
Unknown	872	5.9	181	3.5	
Ethnicity					0.054
Hispanic	3590	24.4	1246	23.8	
Non-Hispanic	10,196	69.3	3807	72.7	
Unknown	919	6.3	182	3.5	
Payer					0.045
Private	5766	39.2	2185	41.7	
Public	7842	53.3	2734	52.2	
Other	767	5.2	274	5.2	
Unknown	330	2.2	42	0.8	
Time of day					0.162
Day (8 am to 4 pm)	5830	39.6	2140	40.9	
Evening (4 pm to 12 am)	7588	51.6	2671	51	
Overnight (12 am to 8 am)	1287	8.8	4245	8.1	
Weekend visit	4042	27.5	1368	26.1	0.058
Total ED volume	8,156,272	—	1,513,493	—	—
≤ 5 y	4,575,813	56.1	780,950	51.6	
>5–12 y	2,220,189	27.2	401,019	26.5	
>12 y	1,360,270	16.7	331,524	21.9	

ED = emergency department.

* Comparison of the pre- to post-COVID shutdown groups, testing the null hypothesis of no difference across all subgroups for each bolded patient characteristic.

ingestions treated at EDs throughout the United States. Although this study did not show a significant increase in the absolute number of foreign body ingestions after the declaration of a national emergency and shutdown of schools, it did demonstrate that the proportion of ED visits related to foreign body ingestions increased. This proportional increase was driven largely by the overall decrease in ED visits, but demonstrates that pediatric foreign body ingestions remained a common presentation even throughout a pandemic. Pediatric ED visits to

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Figure 2. Absolute number of foreign body presentations compared to total emergency department (ED) volume.

children's hospitals decreased nationwide throughout the COVID-19 pandemic across a broad range of conditions (18).

In this study population, a higher proportion of patients in the post-lockdown group had imaging performed and were admitted to the hospital, with fewer procedures performed. Although there was no difference in the absolute number of foreign body ingestions between the study groups, potential explanations for these findings could include reluctance to perform certain procedures, such as endoscopy, due to concern for COVID-19 infection and more reliance on admission for observation of passage of the foreign body. Additional study is needed to see whether these changes have persisted over the course of the pandemic.

The COVID-19 lockdowns led to an unprecedented number of school closures throughout the United States, leaving millions of children at home with adult guardians, some of whom were required to manage childcare and virtual work at the same time. Social distancing and stay-at-home orders also led to extended periods of time in homes, where children (unsupervised or not) may have had the opportunity to ingest foreign bodies. A recent study found that most foreign body ingestions during the pandemic occurred while at home (19). Although our study did not show an increase in the absolute number of foreign body presentations, other studies performed in Italy, Britain, and Japan have reported an increase throughout the COVID-19 pandemic, primarily with magnet and button battery ingestions, as well as with overall

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Table 2. Clinical Characteristics of Pediatric Foreign Body Ingestions Treated at Pediatric Health Information System Emergency Departments.

Characteristic	Pre-COVID Shutdown (3/1/2017–3/12/2020) (n = 14,705)	Post-COVID Shutdown (3/13/2020–3/31/2021) (n = 5235)	*p* Value
ED disposition, n (%)			0.006
Discharge	13,888 (94.5)	4903 (93.7)	
Admission	724 (4.9)	302 (5.8)	
Transfer	49 (0.3)	24 (0.4)	
Against medical advice	44 (0.3)	6 (0.1)	
Operating room*	316 (2.2)	127 (2.4)	
Imaging, n (%)			
X-ray study	12,204 (83.0)	4551 (86.9)	< 0.00
Computed tomography	53 (0.4)	42 (0.8)	< 0.00
Fluoroscopy	421 (2.9)	97 (1.9)	< 0.00
Other	16 (0.1)	5 (0.1)	0.799
Procedures, n (%)	180 (1.2)	43 (0.8)	0.017
Hospital charges (US$),† mean	682	750	0.601
Length of stay (d) mean	1.03	1.03	0.478
Return visit within 7 d, n (%)	512 (3.5)	150 (2.9)	0.03

ED = emergency department.
* Included in admission number.
† Adjusted for inflation.

hospitalizations (19–21). Furthermore, our study demonstrated that foreign body ingestions remain a common presentation even throughout a pandemic and EDs should be equipped to manage them.

With the possibility of future variants, such as the recent highly transmissible Omicron variant, there is a possibility that additional school or community lockdowns will be enacted. At the beginning of the 2021-2022 academic school year, many school districts throughout states with low vaccination rates, including Alabama, Florida, and Texas, were forced to close down for portions of the school year due to surging COVID-19 cases (22–24). It is also possible that younger children will continue to be kept at home until widespread vaccination has been obtained among our most vulnerable age groups. Previous researchers have reported that public health measures, such as advertisements and medical education programs, can lead to a reduction in foreign body ingestions (25,26). Therefore, it remains important to continue to educate parents and primary care practitioners on guidance for the safe storage of dangerous objects, such as button batteries or other objects that may pose a threat to young children.

Several measures put forth by the Consumer Safety Production Commission, such as the CPSIA in 2008—which requires batteries for use in toys intended for children younger than 3 years to be secured in compartments—have attempted to improve safety surrounding the ingestion of foreign bodies (5). Additional measures, such as a federal safety standard with regard to high-powered magnets, initially led to a decrease in magnet ingestions, but ultimately was overturned in 2016, leading to a rebound in presentations for magnet ingestions (27). As we have shown, foreign body ingestions remain a frequent problem requiring ED utilization throughout a pandemic, and continued research should focus on legislation regarding this important issue.

Limitations

Our study has limitations to consider. First, this is a retrospective study in an administrative database. Therefore, we are limited to data collected from the ED encounter, which do not include clinical information from the visit, type of foreign body ingested, or risk factors for ingestion.

Second, the data were limited to the hospitals included within the PHIS database, which are all academic children's hospitals. Therefore, the results of this study may not be generalizable to other hospitals throughout the United States, such as community hospitals, where a large proportion of children are treated annually.

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Conclusions

The proportion of foreign body ingestions increased after the declaration of the COVID-19 pandemic, driven primarily by an overall decrease in the total pediatric ED volume.

Appendix. List of Internationl Classification of Diseases, Tenth Revision Procedure Codes Included

0DB98ZZ 0DB98ZX 0DB58ZX 0DBA8ZX 0DB38ZX
0DB28ZZ 0DB28ZX 0DB88ZX 0DB68ZZ 0DB68ZX
0DB78ZZ 0DB78ZX 0DB18ZX 0DCQ7ZZ 0DCK8ZZ
0DCH8ZZ 0DC98ZZ 0CCR8ZZ 0DC48ZZ 0DC58ZZ
0DCB8ZZ 0DC38ZZ 0DC28ZZ 0WC3XZZ 0CCM8ZZ
0CCM7ZZ 0DCP7ZZ 0DC68ZZ 0DC78ZZ 0DC18ZZ
0DD98ZX 0DD58ZX 0DD68ZX BD14ZZZ BD11ZZZ
BD15ZZZ BD16ZZZ 0WJP8ZZ 0DJD8ZZ 0DJD7ZZ
0CJY8ZZ 0WJ3XZZ 0DJ68ZZ 0DJ08ZZ

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ARTICLE SUMMARY

1. Why is this topic important?

Foreign body ingestions are a very common presentation in emergency departments (EDs). It is important to know the burden of these presentations so that EDs, particularly community-based EDs, have appropriate pediatric readiness.

2. What does this study attempt to show?

This study attempts to show the effect of national lockdowns during the COVID-19 pandemic on the rate of pediatric foreign body ingestions at selected Pediatric Health Information System hospitals.

3. What are the key findings?

The rate of foreign body ingestions as a proportion of ED volume increased after the declaration of the worldwide COVID-19 pandemic, primarily driven by an overall decrease in the total pediatric ED volume.

4. How is patient care impacted?

Pediatric foreign body ingestions remain a common presentation, even during global pandemics, and EDs should be prepared with resources in place to provide effective care for pediatric patients.

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