

Child Abuse Imaging and Findings in the Time of COVID-19

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Objective: To assess the impact of the COVID-19 pandemic on physical abuse in young children, we compared the following before and during the pandemic: (1) skeletal survey volume, (2) percent of skeletal surveys revealing clinically unsuspected (occult) fractures, and (3) clinical severity of presentation. We hypothesized that during the pandemic, children with minor abusive injuries would be less likely to present for care, but severely injured children would present at a comparable rate to prepandemic times. We expected that during the pandemic, the volume of skeletal surveys would decrease but the percentage revealing occult fractures would increase and that injury severity would increase.

Methods: We conducted a retrospective study of children younger than 2 years undergoing skeletal surveys because of concern for physical abuse at a tertiary children's hospital. Subjects were identified by querying a radiology database during the March 15, 2019–October 15, 2019 (pre-COVID-19) period and the March 15, 2020–October 15, 2020 (COVID-19) period, followed by chart review to refine our population and abstract clinical and imaging data.

Results: Pre-COVID-19, 160 skeletal surveys were performed meeting the inclusion criteria, compared with 125 during COVID-19, representing a 22% decrease. No change was observed in identification of occult fractures (6.9% pre-COVID vs 6.4% COVID, $P = 0.87$). Clinical severity of presentation did not change, and child protective services involvement/referral decreased during COVID.

Conclusions: Despite a >20% decrease in skeletal survey performance early in the pandemic, the percent of skeletal surveys revealing occult fractures did not increase. Our results suggest that decreases in medical evaluations for abuse did not stem from decreased presentation of less severely injured children.

Key Words: child abuse, COVID-19, diagnostic imaging, Fractures, bone
(*Pediatr Emer Care* 2022;38: 65–69)

Economic stress, caregiver mental health concerns, and natural disasters have all been associated with increased risk of child abuse, prompting concern that the severe acute respiratory syndrome coronavirus 2 pandemic (COVID-19) may have placed children at heightened risk of abuse.^{1–4} Here we describe the role

of imaging practices and findings as one metric by which to assess the impact of large-scale events on physical abuse in young children.

Similar to national trends, the volume of children presenting to our hospital emergency department (ED) decreased by more than 50% at the start of the pandemic and continued below normal for several months. The acuity of ED visits, including presentations for trauma, was higher during the early COVID-19 period compared with the pre-COVID-19 period, suggesting that decreased ED volume stemmed from decreased presentations of children with lower acuity injuries and illnesses.⁵ Our hospital's Department of Radiology similarly noticed decreases in the volume of skeletal surveys performed during the early COVID-19 period in 2020. Whether this decreased skeletal survey volume was due to decreases in presentations for medical care among children with less-severe (ie, lower acuity) abusive injuries or an overall decrease in presentations for abusive injuries of all severities is not known.

Because the American Academy of Pediatrics recommends skeletal surveys for all children younger than 2 years with concern for abuse,^{6,7} skeletal surveys can serve as an indicator for performance of medical evaluations for physical abuse in young children.

In this setting, we aimed to compare (1) skeletal survey volume, (2) percent of skeletal surveys revealing clinically occult (ie, unsuspected) fractures, and (3) clinical severity during the early months of the COVID-19 pandemic to the corresponding period 1 year prior in 2019. We hypothesized that severely injured children would be more likely than those less severely injured to present for medical care during the early COVID-19 pandemic and thus comprise a greater proportion of children undergoing skeletal surveys, manifesting as increased percentage of skeletal surveys identifying clinically occult fractures and increased clinical severity.

METHODS

We performed a retrospective, observational study of children younger than 2 years who underwent skeletal surveys because of concern for physical abuse in the ED or inpatient setting during the March 15, 2019–October 15, 2019 (pre-COVID-19) period versus the early pandemic March 15, 2020–October 15, 2020 (COVID-19) period at a large, tertiary free-standing children's hospital. Our hospital's institutional review board determined the study to be exempt.

Population

Nuance mPower Clinical Analytics (© 2021 Nuance Communications, Inc), a radiology report search engine used at our institution, was queried to identify children younger than 2 years who underwent an initial skeletal survey using an order specifying the indication was for trauma-related concerns during the study time periods. Medical records were then reviewed to exclude children outside the desired age range as well as children (1) whose skeletal survey was obtained outside the ED, inpatient, or intensive care unit (ICU) setting, which is the typical environment for initial skeletal survey evaluation in our institution, or (2) performed for medical indications (such as dysmorphic features) or during birth

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Disclosure: The Children's Hospital of Philadelphia has received payment for the expert testimony of Drs Henry, Wood, Bennett, and Chaiyachati when subpoenaed for cases of suspected abuse. Dr Otero and Ms Egbe declare no conflicts of interest.

Data Statement: The authors declare that they had full access to all of the data in this study, and the authors take complete responsibility for the integrity of the data and the accuracy of the data analysis.

Funding: No specific funding was obtained for this study. Salary support was provided by a National Institutes of Health/National Institute of Mental Health institutional training grant (T32 MH019112; to B.H.C.).

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ISSN: 0749-5161

hospitalization, or (3) whose follow-up skeletal survey with the initial skeletal survey fell outside the study periods or performed at another institution.

Skeletal Survey Volume Stability

To ensure that skeletal survey volume in the 2019 study time period pre-COVID was not an outlier, we assessed the stability of skeletal survey volume in both March 15, 2018–October 15, 2018 and March 15, 2019–October 15, 2019, compared with March 15, 2020–October 15, 2020, before performing detailed chart abstraction. After confirming stability in skeletal survey volume in the 2 preceding time periods from 2018 and 2019, we then focused on detailed chart abstraction from the study solely from 2019 and 2020.

Chart Abstraction

The medical record was reviewed for demographic information, clinical presentation, imaging performed, and injuries identified via imaging as reported in the clinical radiology reports.

Clinical and Care Outcomes

Our clinical and care-related outcomes were (1) child protective services (CPS) referral, (2) evaluation by the hospital's child protection team (CPT), and (3) clinical severity of presentations. Child protective services referral was defined as documentation of ongoing involvement or a new referral at the time of presentation. Clinically severe presentations were defined as those requiring intensive care, intubation, and documentation of abnormal mental status, or those resulting in death.

Imaging Outcomes

Our primary imaging outcome was identification of definite clinically occult fracture(s) on initial skeletal survey, defined as fractures not previously detected on imaging or suspected on physical examination in which diagnostic certainty was not in question on the radiology interpretation and report. Possible occult fractures in which there was some diagnostic uncertainty were documented separately. We recognize that there are multiple ways to determine yield of skeletal surveys, and we elected to apply this definition to allow for standardized comparisons with the information available at that point in time. We subsequently documented all fractures (clinically occult and nonoccult) over the course of the entire medical evaluation and whether these were ultimately considered possible or definite after further or follow-up imaging was obtained. We defined fractures specific for physical abuse as rib fractures^{8–10} and classic metaphyseal lesions (CMLs).^{11,12} Imaging was not systematically re-reviewed during this study. We relied on clinical interpretations and the medical record. When questions arose based on clinical documentation, for example, regarding type of fracture, a board-certified pediatric radiologist with 7 years of posttraining experience reviewed imaging to provide clarification.

Analysis

We report median age, and frequencies and proportions of demographic information, clinical presentations, imaging performed, imaging findings, and outcomes for the total population, as well as the pre-COVID-19 and COVID-19 time periods. Comparisons between pre-COVID-19 and COVID-19 time periods were made using the Wilcoxon rank sum test for comparisons of medians for nonnormally distributed variables (specifically, age). We tested for associations between COVID and our outcomes of interest

using Pearson χ^2 tests, unless a cell was size < N of 5, in which case we used a Fisher exact test.

RESULTS

Skeletal Survey Volume

We first assessed the stability of skeletal survey volume in March 15, 2018–October 15, 2018 and March 15, 2019–October 15, 2019, compared with March 15, 2020–October 15, 2020. During the pre-COVID time periods, 175 (2018) and 178 (2019) skeletal surveys were obtained, compared with 135 (2020). Having confirmed stability of skeletal survey volume over time pre-COVID, we then focused on performing detailed chart abstraction on data from 2019 and 2020.

Study Population

Of 313 (179 in 2019 and 135 in 2020) children identified in our query, 285 were eligible for inclusion (Fig. 1). By study period, 160 children were included in the pre-COVID-19 period compared with 125 during COVID-19, representing a 22% absolute decrease in skeletal survey volume. The pre-COVID-19 and COVID populations were comparable in age, race, payor, sex, and reason for presentation (Table 1).

Clinical Outcomes and Care

The proportion of children with severe presentations was similar in the pre-COVID-19 (28.1%) and COVID-19 (24.8%) time periods ($P = 0.53$). Our CPT was formally consulted less frequently during COVID-19, but this decrease did not reach statistical significance (Table 1). Child protective services involvement/referral decreased significantly during the pandemic (63.8% pre-COVID-19 vs 50.4% COVID-19, $P = 0.02$; Table 1).

Imaging and Findings

By definition, all children underwent skeletal surveys for inclusion in this study. Although follow-up skeletal surveys were less commonly performed during COVID-19 (Table 2), this did not reach statistical significance. No change in yield in identification of clinically occult definite fractures was seen across time periods (6.9% pre-COVID-19 vs 6.4% COVID-19, $P = 0.87$; Table 2). Similarly, there was no increase in abuse-specific fractures (ie, rib, CML) across time periods (8.1% pre-COVID-19 vs 6.4% COVID-19, $P = 0.58$; Table 2).

DISCUSSION

Total volume of skeletal surveys decreased by greater than 20% during the first 7 months of the COVID-19 pandemic. During this time, the percentage of skeletal surveys identifying clinically occult fractures and the percentage of children with abuse-specific fractures did not increase. No change was detected in the proportion of children with clinically severe presentations. We saw a trend in fewer formal CPT consultations and statistically significantly decreased CPS involvement/referrals during the pandemic. Taken together, our results suggest that decreases in the volume of medical evaluations for physical abuse did not stem from decreased presentations and/or identification of just less severely injured children.

Many have expressed concern that the COVID-19 pandemic would increase the risk of child abuse.¹³ Small sample sizes have limited interpretation of some single-center experiences,¹⁴ whereas multicenter administrative data suggest decreases in presentation for physical abuse and child maltreatment more generally.^{15–17} Surveillance data encompassing a broad definition of child maltreatment

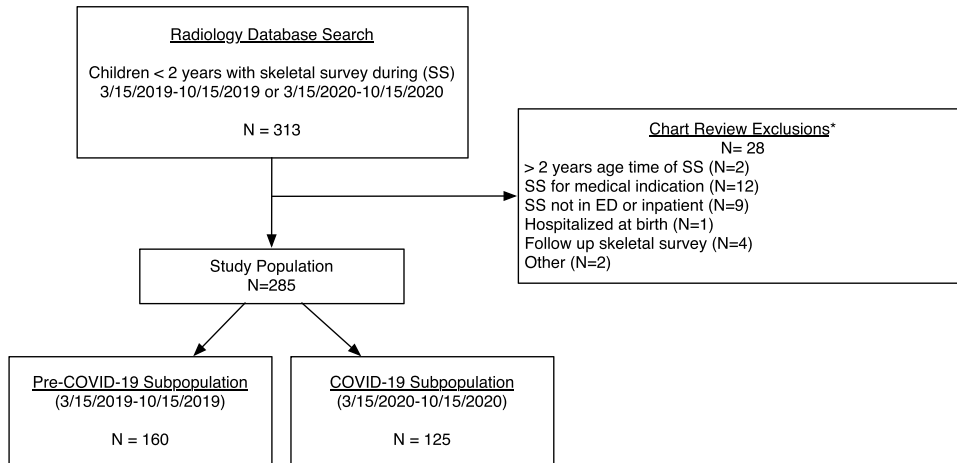


FIGURE 1. Population flow diagram. *Subjects may meet multiple exclusion criteria. SS, skeletal survey.

also including neglect and sexual abuse showed a decline in ED presentations for maltreatment during the early pandemic.¹⁶ Data limited to physical abuse have been similar. For example, among children presenting to children's hospitals with billing codes for physical abuse, number of injuries, mortality, and a hospital utilization metric

for severity of presentation were similar during and before COVID-19.¹⁵ Specific assessment of a severe form of child abuse, abusive head trauma, also demonstrated decreased presentations without significant increases in several markers of clinical severity (eg, ventilator use).¹⁷ Our results align with these administrative data.

TABLE 1. Demographics and Clinical Presentation and Care

	Combined (Total n = 285), n (%)	Pre-COVID-19* (Total n = 160), n (%)	COVID-19* (Total n = 125), n (%)	P [†]
Age, median (IQR), mo	5.1 (2.5–10.4)	5.1 (2.4–11.0)	5.0 (2.6–10.0)	0.85 [‡]
Race				0.62
Black	140 (49.1)	76 (47.5)	64 (51.2)	
White	85 (29.8)	47 (29.4)	38 (30.4)	
Other	60 (21.1)	37 (23.1)	23 (18.4)	
Payor				0.16 [§]
Public (Medicaid/CHIP)	208 (73.0)	117 (73.1)	91 (72.8)	
Private	63 (22.1)	32 (20.0)	31 (24.8)	
Other/unable to categorize	14 (4.9)	11 (6.9)	3 (2.4)	
Sex				0.42
Male	165 (57.9)	96 (60.0)	69 (55.2)	
Reason for presentation				0.88
Reported history of accidental trauma	92 (32.3)	51 (31.9)	41 (32.8)	
Abnormal signs or symptoms without history of trauma	132 (46.3)	73 (45.6)	59 (47.2)	
Other	61 (21.4)	36 (22.5)	25 (20.0)	
Severe clinical presentation				0.17
Admitted to ICU	61 (21.4)	39 (24.4)	22 (17.6)	0.69
Intubation due to clinical indication	23 (8.1)	12 (7.5)	11 (8.8)	0.35
Abnormal mental status	48 (16.8)	24 (15.0)	24 (19.2)	0.78
Death	15 (5.3)	9 (5.6)	6 (4.9)	0.53
Total severe presentations	76 (26.7)	45 (28.1)	31 (24.8)	
Consult and reporting				0.39
Evaluated by hospital CPT	145 (50.9)	85 (53.1)	60 (48.0)	0.02
CPS involvement/report	165 (57.9)	102 (63.8)	63 (50.4)	

*Pre-COVID-19 = March 15, 2019–October 15, 2019; COVID-19 = March 15, 2020–October 15, 2020.

[†]Pearson χ^2 unless otherwise specified.

[‡]Wilcoxon rank sum test.

[§]Fisher exact test.

IQR indicates interquartile range.

TABLE 2. Imaging Evaluation and Injuries Identified

	Total, n (%)	Pre-COVID-19, n (%)	COVID-19, n (%)	P*
Skeletal imaging [†]				
Initial SS	285 (100)	160 (100)	125 (100)	NA
FUSS	61 (21.4)	40 (25.0)	21 (16.8)	0.09
Clinically occult fracture [‡] on initial SS				
Definite	19 (6.7)	11 (6.9)	8 (6.4)	0.87
Possible	30 (10.5)	14 (8.8)	16 (12.8)	0.27
Possible or definite	42 (14.7)	22 (13.8)	20 (16.0)	0.60
Any fractures (occult or nonoccult) [§]				
Definite	104 (36.5)	54 (33.7)	50 (40.0)	0.28
Possible	13 (4.6)	7 (4.4)	6 (4.8)	0.87
Definite or possible	111 (39.0)	59 (36.9)	52 (41.6)	0.42
Child abuse–specific definite fractures				
Rib(s)	15 (5.3)	9 (5.6)	6 (4.8)	0.76
CML(s)	8 (2.8)	6 (3.8)	2 (1.6)	0.47 [¶]
Rib(s) or CML(s)	21 (7.4)	13 (8.1)	8 (6.4)	0.58
Abdominal imaging/findings				
CT with IV contrast	7 (2.5)	4 (2.5)	3 (2.4)	1.0 ^{¶¶}
Intra-abdominal injury	1 (14.3)	1 (25.0)	0 (0)	1.0 ^{¶¶}
Head imaging/findings				
CT or MRI	181 (63.5)	102 (63.8)	79 (63.2)	0.92
Intracranial hemorrhage [#]	66 (36.5)	42 (41.2)	24 (30.4)	0.13

*Pearson χ^2 unless otherwise stated.

[†]All underwent initial skeletal survey for inclusion.

[‡]As interpreted on initial skeletal survey regardless of what further imaging, if obtained, clarified.

[§]Fractures identified over course of entire evaluation, including those clarified on prior imaging.

^{||}Denominator is children who underwent abdominal imaging.

[¶]Fisher exact.

[#]Denominator is children who underwent head imaging (CT or MRI).

FUSS indicates follow-up skeletal survey; SS, skeletal survey.

Limitations

Our study has limitations. First, this is a retrospective, single-center study and may not be generalizable to all hospitals and care settings. In addition, these findings cannot be generalized beyond the study question of physical abuse of children younger than 2 years for whom the skeletal survey recommendation is clear. We recognize that the pandemic may have affected distinct types of child maltreatment, including neglect, in disparate ways. Second, our sample size, although reflecting the volumes of a large tertiary center, remains small regarding specific outcomes and lacks statistical power for subtle differences between time periods. Further research across centers is needed to fully understand the effect of the pandemic on child abuse and potentially identify small differences. Third, we used skeletal surveys as the sole proxy for evaluations for abuse with assumption of consistent, evidence-based utilization. If skeletal survey ordering practices changed during the pandemic, this could bias our results. Fourth, the effect of the pandemic may have changed over time, and we were only able to evaluate the early pandemic months in aggregate. Finally, this study is built upon the premise that skeletal survey yield in detection of clinically occult fractures is a valid proxy of overall severity of physical abuse. The agreement between skeletal survey findings and severity of presentation based on clinical markers suggests that our assumption is clinically relevant. Moreover, however imperfect, this approach allowed us to explore imaging utilization as an important metric that emergency medicine

physicians, pediatricians, radiologists, and health services researchers can consider when surveilling the effect of societal upheaval on physical abuse in young children.

Despite these limitations, we have shown that skeletal survey performance and yield is one lens through which to evaluate the effect of the pandemic on physical abuse. Future studies could consider leveraging trends in skeletal survey performance to assess for shifts in evaluations for physical abuse. Although our detailed chart abstraction carried the tradeoff of smaller sample sizes, this study's main strength is the ability to abstract clinical details from medical record review to assess for imaging yield and clinical markers of severity, which is not possible when studying larger administrative databases that lack this level of clinical granularity.

In conclusion, the effect of the pandemic on child physical abuse is complex and unlikely to be answered in a single study. Multicenter data with detailed clinical chart abstraction will be helpful to fully understand nuances of the impact of the pandemic on child physical abuse over time and to extrapolate lessons learned that health services researchers can leverage to study the effect of future national and global crises on child physical abuse.

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