

Potential Opportunities for Prevention or Earlier Diagnosis of Child Physical Abuse in the Inpatient Setting

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ABSTRACT

OBJECTIVES: To compare rates of previous inpatient visits among children hospitalized with child physical abuse (CPA) with controls as well as between individual abuse types.

METHODS: In this study, we used the Pediatric Health Information System administrative database of 44 children's hospitals. Children <6 years of age hospitalized with CPA between January 1, 2011, and September 30, 2015, were identified by discharge codes and propensity matched to accidental injury controls. Rates for previous visit types were calculated per 10 000 months of life. χ^2 and Poisson regression were used to compare proportions and rates.

RESULTS: There were 5425 children hospitalized for CPA. Of abuse and accident cases, 13.1% and 13.2% had a previous inpatient visit, respectively. At previous visits, abused children had higher rates of fractures (rate ratio [RR] = 3.0 times; $P = .018$), head injuries (RR = 3.5 times; $P = .005$), symptoms concerning for occult abusive head trauma (AHT) (eg, isolated vomiting, seizures, brief resolved unexplained events) (RR = 1.4 times; $P = .054$), and perinatal conditions (eg, prematurity) (RR = 1.3 times; $P = .014$) compared with controls. Head injuries and symptoms concerning for occult AHT also more frequently preceded cases of AHT compared with other types of abuse (both $P < .001$).

CONCLUSIONS: Infants hospitalized with perinatal-related conditions, symptoms concerning for occult AHT, and injuries are inpatient populations who may benefit from abuse prevention efforts and/or risk assessments. Head injuries and symptoms concerning for occult AHT (eg, isolated vomiting, seizures, and brief resolved unexplained events) may represent missed opportunities to diagnose AHT in the inpatient setting; however, this requires further study.



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Child physical abuse (CPA) remains a prevalent problem with the rates of abuse-related hospitalizations, abusive head trauma (AHT), and fatalities remaining stable or increasing in recent years.^{1–4} Primary prevention is directed toward the general population and attempts to stop maltreatment from occurring.⁵ Hospital-based primary prevention efforts have principally targeted newborns during their birth hospitalizations. Unfortunately, these efforts have not clearly led to reductions in abuse.^{6,7}

Secondary prevention efforts are focused on subpopulations at higher risk for abuse.⁵ Children with psychosocial risk factors for abuse have been shown to have higher hospitalization rates.^{8,9} Additionally, hospitalization in early infancy has been associated with future maltreatment in general,¹⁰ as well as CPA, specifically.¹¹ These data suggest that some hospitalized children may be at higher risk for abuse and may also benefit from secondary prevention.

The early diagnosis of CPA can be difficult, and it is frequently missed at ambulatory or emergency department encounters^{12–16} in part because it accounts for a minority of clinical presentations.^{2,17–19} In addition to prevention opportunities, inpatient visits preceding abuse may also represent opportunities for earlier diagnosis of CPA. However, the incidence of hospitalizations and the various diagnoses preceding abuse, as well as how often abuse may be missed in the inpatient setting, remain largely unknown.

Our primary objective with this study was to compare children hospitalized for abuse with children hospitalized with accidental injuries (ie, matched controls) on their rates of having any previous inpatient visits as well as their specific previous visit type (eg, injuries, nonspecific symptoms concerning for occult abuse, and noninjuries). Our secondary objective was to compare the rates of previous visit types between types of abuse.

METHODS

Data Source

In this study, we used the Pediatric Health Information System (PHIS) administrative

database managed by the Children's Hospital Association (Lenexa, KS). The PHIS contains deidentified *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) discharge codes and administrative and financial data for all observation and inpatient visits at 44 children's hospitals in the United States. An encrypted patient identifier permits longitudinal tracking of patients between encounters within the same PHIS hospital.

Study Population

Our study population included children <6 years of age with a first-time CPA hospitalization at a PHIS hospital from January 1, 2011, to September 30, 2015. We used a previously published coding scheme using validated abuse codes to identify children hospitalized for CPA.^{2,20,21} In short, this scheme requires that 1 of the following 4 criteria be met: (1) ICD-9-CM codes for an injury (800–959) and abuse (995.50, 995.54, 995.55, 995.59, or E967), (2) ICD-9-CM codes for an injury and assault (E960, E966, E968), (3) ICD-9-CM codes for retinal hemorrhages (362.81) or anoxic brain injury (348.1) and abuse, or (4) any ICD-9-CM code for shaken infant syndrome (995.55). Exclusion criteria included late-onset injury effects, e-codes indicating that the injury occurred at a location not typical for abuse (eg, farms), or an abuse code at any previous encounter.² We classified abuse hospitalizations by injury type: fracture, AHT, abusive abdominal trauma, burns, skin, other (eg, lung contusion), and multiple.² AHT included but was not limited to isolated skull fractures, subdural hemorrhages, retinal hemorrhages, and/or anoxic brain injury. Patient characteristics included age, sex, race and/or ethnicity, payer, zip code–based median household income, ICU use, median ICU days, hospital length of stay, median total costs (based on standardized cost-to-charge ratios),²² and in-hospital mortality. Each child hospitalized with CPA was propensity matched by using a greedy algorithm with up to 2 children hospitalized with an accidental injury similar to previous work (E880–E888, E916–E921, E923–E928, and E810–E829) on the basis of age, race and/or ethnicity, sex, and insurance type.^{15,23–25}

Previous Inpatient Visits

We identified which children had any lifetime inpatient visit preceding their CPA or accidental injury hospitalizations. Normal birth hospitalizations were not counted as previous inpatient visits. Only visits closest to the abuse hospitalization and their primary discharge diagnoses were used to strengthen their conceptual association (ie, only 1 previous inpatient visit per case and control were investigated). All previous visits were categorized into 3 broad categories: (1) injuries, (2) nonspecific symptoms concerning for occult abuse, and (3) noninjuries.

First, we identified children diagnosed with an injury at a previous inpatient visit. We categorized previous injury visits as fractures, head injuries, and skin injuries with the same ICD-9-CM codes used to identify their respective abusive injury types. Next, we identified previous visits during which symptoms concerning for occult injury were diagnosed. Informed by previous literature describing misdiagnoses commonly made in cases of missed abuse,^{12–14,16} all authors (blinded to the frequencies of ICD-9-CM codes) reached consensus as to which noninjury ICD-9-CM codes from previous visits could conceptually represent occult AHT on a physiologic basis (Supplemental Table 3). These diagnoses were broken into 2 groups: (1) symptoms specifically concerning for occult AHT (ie, vomiting alone, gastroesophageal reflux [GERD], seizures, neurologic abnormalities, or abnormal breathing including apnea or brief resolved unexplained events [BRUEs; formerly apparent life-threatening events]) or (2) fussiness and/or feeding difficulties. Finally, all remaining diagnoses were designated as noninjury visits and organized by Clinical Classifications Software (CCS).²⁶ The CCS is a categorization scheme that groups the thousands of ICD-9-CM diagnoses into a smaller number of clinically meaningful categories. We included the 3 most common CCS categories, and all remaining noninjury encounters were collapsed into noninjury, other.

Statistical Analysis

We summarized patient characteristics with frequencies and percentages and used χ^2 tests to determine statistical differences

between abuse cases and the accidental injury controls as well as between individual abuse types. Because children varied in their exposure for having previous visits simply because of differences in age, the rates of different previous inpatient visit types were reported as per 10 000 months of life with 95% confidence intervals (CIs). The median number of days and interquartile range (IQR) between previous inpatient visits and the abuse hospitalizations quantified their temporal relationships. We used χ^2 and Poisson regression, controlling for hospital clustering with random intercepts for each hospital, to calculate associations of categorical and continuous variables with abuse type. All statistical analyses were performed by using SAS version 9.4 (SAS Institute, Inc, Cary, NC). P values $<.05$ were considered statistically significant. This study was deemed nonhuman subjects research by the Institutional Review Board at Children's Mercy Hospital.

RESULTS

Characteristics of Abuse Cases and Controls

There were 5425 children hospitalized with CPA. Abused children most often had multiple abusive injuries (39.3%) (Table 1). The most common combinations of multiple abusive injuries were AHT and skin, fracture and skin, and AHT and other injuries, which respectively accounted for 30.8%, 24.0%, and 5.1% of those with multiple abusive injuries. Figure 1 shows the distribution of abusive injuries.

Abused children were most commonly <6 months of age, boys, non-Hispanic white, with public insurance, and from the lowest quartile of median household income, but $\sim 14\%$ were from the highest income quartile. The overall median cost per hospitalization was $\sim \$11\,000$ and highest for AHT and abusive abdominal trauma, both of which cost over $\$22\,000$. The overall mortality rate was 6.2% and was highest for abusive abdominal trauma (10.8%) and AHT (10.4%).

There were 10 836 children hospitalized with accidental injuries who were matched to the CPA hospitalizations. There were no significant differences in demographics between CPA cases and accidental injury

controls, but CPA cases had longer lengths of stay, greater ICU use, more ICU days, and higher mortality (all $P < .001$) (Supplemental Table 4).

Frequencies of Previous Inpatient Visits

There were 711 (13.1%) abused and 1433 (13.2%) accidental injury children who had a previous inpatient visit at the same children's hospital where they were later hospitalized for physical abuse or accidental injuries. Children with abusive abdominal trauma, burns, and other abusive injuries occurred in small numbers and had such low (none in some cases) rates of previous inpatient visits that we excluded them from the analysis of previous visits. The frequencies of each previous visit type or diagnosis for abused children are shown in Fig 2.

Abuse Cases Compared With Controls

CPA cases (107.5 per 10 000 months of life [95% CI: 99.6–115.5]) were not significantly different from accidental injury controls (102.5 [95% CI: 97.2–107.8]) in their rates of having any lifetime previous inpatient visit ($P = .29$). However, CPA cases were more often diagnosed with injuries (rate ratio [RR] = 3.2 times; $P < .001$) and nonspecific symptoms concerning for occult abuse (RR = 1.4 times; $P = .03$) at previous inpatient visits compared with accidental injury controls (Table 2). Specifically, fractures (RR = 3 times; $P = .02$), head injuries (RR = 3.5 times; $P = .005$), and symptoms concerning for occult AHT (RR = 1.4 times; $P = .05$) more often preceded CPA compared with accidental injuries. Although CPA cases and controls had similar rates of previous noninjury inpatient visits overall, perinatal conditions (predominately diagnoses of prematurity or low birth weight) were diagnosed at a rate 1.3 times higher among CPA cases compared with controls ($P = .01$).

Comparisons Between Abuse Types

Previous Injury Inpatient Visits

Head injuries were the most frequent injury diagnosed at previous inpatient visits among abused children (2.1 [95% CI: 1.0–3.2]) (Supplemental Table 5) and preceded AHT at a rate 10.3 to 14.7 times higher than other types of abuse ($P < .001$;

Fig 3). The rates of previous fractures (1.8 [95% CI: 0.8–2.8]) and skin injuries (0.8 [95% CI: 0.1–1.4]) did not significantly differ between the individual types of abuse.

Previous Inpatient Visits for Nonspecific Symptoms Concerning for Occult Abuse

Nonspecific symptoms concerning for occult abuse were most often specifically concerning for occult AHT (10.4 [95% CI: 8.0–12.9]) and their rates were 2.4 to 4.2 times higher for children subsequently diagnosed with AHT compared with other abusive injuries ($P < .001$). They preceded AHT by the shortest time, a median of 52 days (IQR 16–90), which was significantly shorter than 67 days (IQR 32–230) for all abused children and 199 days (IQR 67–1201) for abusive skin injuries ($P = .04$). Fussiness and/or feeding difficulties were less common (2.3 [95% CI: 1.1–3.4]) and did not vary in their rates between types of abuse or median times between encounters.

Inpatient Visits Concerning for Missed Cases of AHT

Of all cases of AHT ($n = 2423$), both isolated and those with other concurrent abusive injuries, 2.2% had a previous inpatient visit during which either head injuries ($n = 11$) or symptoms concerning for occult AHT ($n = 42$) were diagnosed. However, by using only those children with AHT who had a previous inpatient visit as the denominator ($n = 271$), we found that 19.6% received 1 of these diagnoses concerning for possible missed AHT.

Previous Noninjury Inpatient Visits

Diseases of the respiratory system (21.8 [95% CI: 18.2–25.3]) was the most common category of noninjury diagnoses among abused children and were predominantly cases of bronchiolitis, asthma, or pneumonia. Second and third most common were conditions originating in the perinatal period (19.1 [95% CI: 15.7–22.4]) and congenital anomalies (10.3 [95% CI: 7.8–12.7]), which were most often diagnoses of prematurity or low birth weight and congenital heart disease, respectively. The median number of days between previous noninjury inpatient visits and abuse hospitalizations were 125.5 days (IQR 47–425.5) for respiratory

TABLE 1 Demographics of Children Hospitalized for Physical Abuse

Characteristic	Type of Abusive Injury						
	Overall	Fracture	AHT	Abdomen	Burn	Skin	Other
No. patients, <i>n</i> (%)	5425 (100)	959 (17.7)	1368 (25.2)	37 (0.7)	141 (2.6)	693 (12.8)	96 (1.8)
Age, <i>y</i> , <i>n</i> (%)							
<0.5	2717 (50.1)	606 (63.2)	899 (65.7)	4 (10.8)	17 (12.1)	215 (31)	39 (40.6)
0.5–1	998 (18.4)	205 (21.4)	283 (20.7)	3 (8.1)	25 (17.7)	99 (14.3)	16 (16.7)
1–3	1472 (27.1)	127 (13.2)	163 (11.9)	25 (67.6)	85 (60.3)	303 (43.7)	32 (33.3)
3–5	238 (4.4)	21 (2.2)	23 (1.7)	5 (13.5)	14 (9.9)	76 (11)	9 (9.4)
Sex ^a , <i>n</i> (%)							
Male	3174 (58.6)	551 (57.5)	829 (60.6)	25 (67.6)	85 (60.3)	406 (58.7)	49 (51.6)
Race and/or ethnicity, <i>n</i> (%)							
Non-Hispanic white	2642 (48.7)	446 (46.5)	655 (47.9)	9 (24.3)	39 (27.7)	366 (52.8)	45 (46.9)
Non-Hispanic African American	1290 (23.8)	253 (26.4)	276 (20.2)	15 (40.5)	83 (58.9)	157 (22.7)	30 (31.3)
Hispanic	851 (15.7)	152 (15.8)	236 (17.3)	4 (10.8)	7 (5)	101 (14.6)	15 (15.6)
Other	642 (11.8)	108 (11.3)	201 (14.7)	9 (24.3)	12 (8.5)	69 (10)	6 (6.3)
Payor, <i>n</i> (%)							
Public	4579 (84.4)	800 (83.4)	1109 (81.1)	35 (94.6)	126 (89.4)	592 (85.4)	79 (82.3)
Private	715 (13.2)	141 (14.7)	225 (16.4)	2 (5.4)	10 (7.1)	79 (11.4)	15 (15.6)
Other	131 (2.4)	18 (1.9)	34 (2.5)	0 (0.0)	5 (3.5)	22 (3.2)	2 (2.1)
Median household income quartile ^a , <i>n</i> (%)							
Lowest	1914 (36.2)	343 (36.7)	450 (33.8)	14 (37.8)	58 (41.4)	239 (35.2)	35 (36.8)
Less than average	1405 (26.6)	236 (25.2)	358 (26.9)	11 (29.7)	39 (27.9)	171 (25.2)	24 (25.3)
Greater than average	1208 (22.8)	215 (23)	321 (24.1)	8 (21.6)	26 (18.6)	155 (22.8)	23 (24.2)
Highest	763 (14.4)	141 (15.1)	203 (15.2)	4 (10.8)	17 (12.1)	114 (16.8)	13 (13.7)
ICU use, <i>n</i> (%)	2009 (37)	65 (6.8)	861 (62.9)	22 (59.5)	37 (26.2)	50 (7.2)	27 (28.1)
ICU length of stay, d, median (IQR)	4 (2–8)	2 (1–4)	4 (2–8)	3 (2–7)	5 (2–13)	2 (1–4)	5 (2–10)
Length of stay, d, median (IQR)	3 (2–8)	2 (1–3)	6 (3–14)	8 (4–21)	4 (2–10)	1 (1–3)	2 (1–7.5)
Total cost, dollars, median (IQR)	11 020 (53 149–29 003)	5891 (3748–9403)	22 700 (11 373–50 751)	25 816 (14 851–66 761)	8846 (3571–25 625)	4988 (3050–7812)	7477 (3441–22 310)
In-hospital mortality, <i>n</i> (%)	338 (6.2)	6 (0.6)	142 (10.4)	4 (10.8)	1 (0.7)	6 (0.9)	5 (5.2)

^a *P* values obtained from χ^2 tests. All *P* values $\leq .001$ except otherwise noted.

^a *P* values not significant.

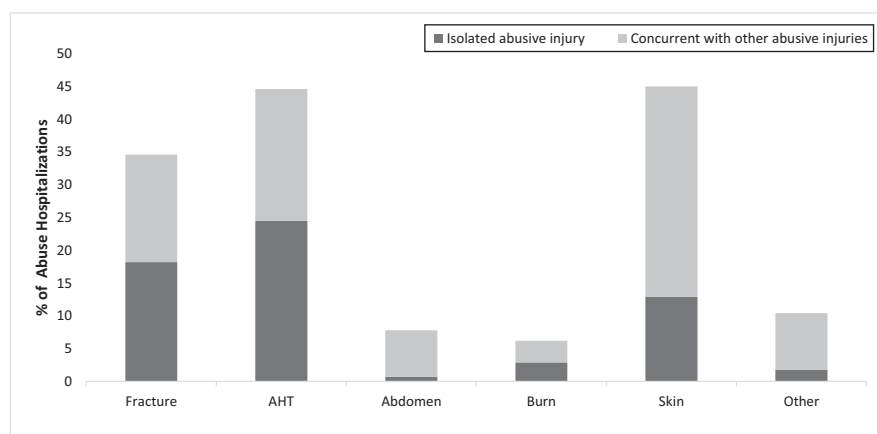


FIGURE 1 The distribution of abusive injury types. The 2131 (39.3%) children with multiple abusive injuries have been distributed to the mutually exclusive abusive injury categories (lighter bars).

diseases, 102.5 days (IQR 57–244) for perinatal-related discharges, and 237 days (IQR 60.5–704) for congenital-related discharges.

DISCUSSION

At previous inpatient visits, abused children had higher rates of injuries (fractures and head injuries), symptoms concerning for

occult AHT (eg, isolated vomiting, BRUEs), and prematurity-related conditions compared with controls. Given their commonality and higher rates among abused children, infants hospitalized with prematurity or low birth weight appear to be inpatient populations who may benefit from primary and/or secondary prevention efforts. We found that head injuries and symptoms concerning for occult AHT more frequently preceded abuse in general compared with controls as well as specifically AHT compared with other types of abusive injuries, suggesting that some of these previous visits may represent missed opportunities to diagnose AHT. Overall, these possible missed events appear to be rare, but of the AHT cases with a previous inpatient visit, ~1 in 5 had 1 of these diagnoses concerning for missed abuse. Despite these important differences, abused children did not significantly differ from matched accidental injury controls in their having any previous inpatient visit at the same children's hospital (each ~13%).

Abused children had higher rates of perinatal-related (eg, prematurity) diagnoses compared with controls, and perinatal-related conditions accounted for ~1 in 6 previous inpatient visits among abused children. Our results are in agreement with previous findings that prematurity and low birth weight are associated with increased risk for physical abuse^{10,27–30} but that congenital anomalies (eg, spina bifida) may not be.²⁸ Our results support NICUs as areas at children's hospitals that may particularly benefit from abuse prevention efforts. It is disappointing that primary abuse prevention efforts (The Period of PURPLE Crying and the Pennsylvania Shaken Baby Syndrome Prevention Program) employed during newborn hospitalizations have not clearly lead to reductions in AHT.^{6,7} How frequently these programs are used in NICUs or if they are more effective for this unique patient population, however, is unclear. Further study should better identify which abuse prevention strategies may be most efficacious for NICU populations.

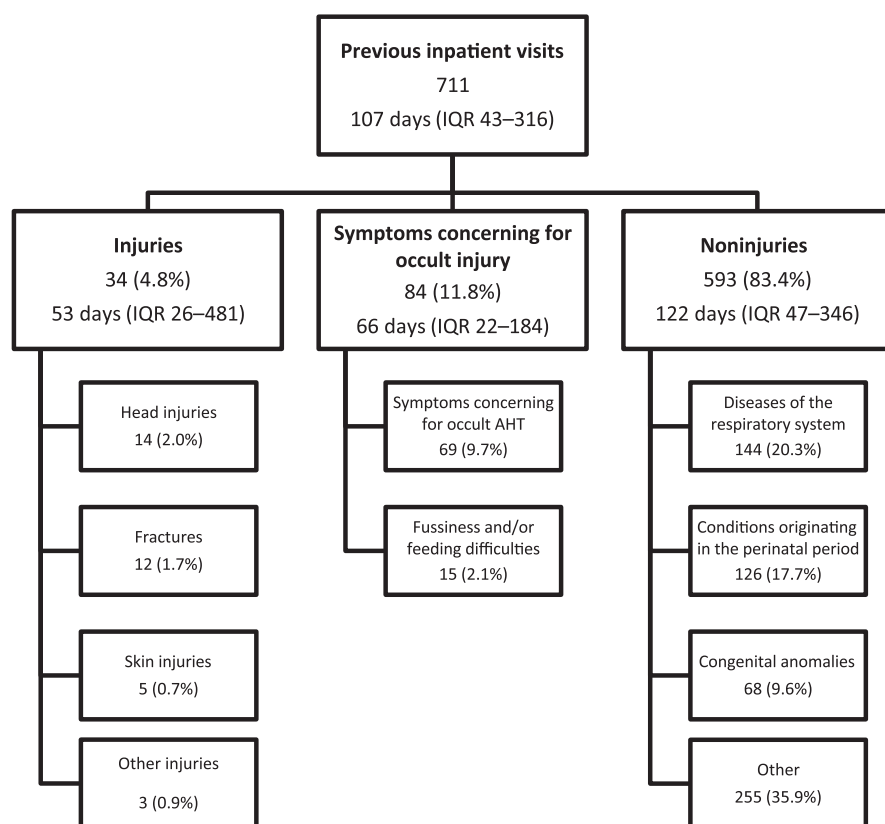


FIGURE 2 Frequencies of diagnoses (% of all previous inpatient visits) of inpatient visits before abuse hospitalizations. Median number of days (IQR) between hospitalizations are listed for all previous inpatient visits as well as the 3 broad categories of previous visit types (injuries, symptoms concerning for injuries, and noninjuries).

TABLE 2 Rates per 10 000 Months of Life (95% CIs) of Primary Discharge Diagnoses for Previous Inpatient Visits of Abused Children Compared With Accidental Injury Controls

	Overall	Abuse	Accident	<i>P</i> ^a
No. patients	16 261	5425	10 836	—
Exposure months	205 976	66 111	139 865	—
Inpatient visits	104.1 (99.7–108.5)	107.5 (99.6–115.5)	102.5 (97.2–107.8)	.29
Injury	2.7 (2–3.4)	5.1 (3.4–6.9)	1.6 (0.9–2.2)	<.001
Head injuries	1.1 (0.7–1.6)	2.1 (1–3.2)	0.6 (0.2–1.1)	.005
Fractures	1 (0.6–1.5)	1.8 (0.8–2.8)	0.6 (0.2–1.1)	.02
Skin injuries	0.4 (0.1–0.7)	0.8 (0.1–1.4)	0.2 (0–0.5)	.08
Symptoms concerning for occult injury ^b	10.4 (9–11.8)	12.7 (10–15.4)	9.4 (7.8–11)	.03
Symptoms concerning for occult AHT ^b	8.6 (7.3–9.9)	10.4 (8–12.9)	7.7 (6.3–9.2)	.05
Fussiness and/or feeding difficulties ^b	1.8 (1.3–2.4)	2.3 (1.1–3.4)	1.6 (1–2.3)	.34
Noninjury ^c	90.9 (86.8–95.1)	89.7 (82.5–96.9)	91.5 (86.5–96.5)	.69
Diseases of the respiratory system	22.7 (20.7–24.8)	21.8 (18.2–25.3)	23.2 (20.6–25.7)	.54
Certain conditions originating in the perinatal period	15.9 (14.2–17.6)	19.1 (15.7–22.4)	14.4 (12.4–16.4)	.01
Congenital anomalies	10.3 (8.9–11.7)	10.3 (7.8–12.7)	10.3 (8.6–12)	.99
Other	42 (39.2–44.8)	38.6 (33.8–43.3)	43.7 (40.2–47.1)	.09

—, not applicable.

^a *P* values obtained from Poisson regression comparing median times between previous visits and the abuse hospitalizations across abusive injury types.

^b Based on previous researchers' reporting of symptoms common among missed cases of abuse.^{12–14,16}

^c ICD-9-CM codes categorized by CCS level 1 groups.

We found that head injuries and symptoms concerning for occult AHT more frequently preceded abuse cases compared with controls as well as AHT compared with other abusive injuries and within a shorter median time. These results appear to validate previous case series' findings that isolated vomiting, GERD, seizures, neurologic abnormalities, apnea, and BRUEs are misdiagnoses commonly made in cases of missed AHT.^{12–16,31} Although our methods do not allow definite relationships to be made between encounters or allow for precise estimates of missed AHT, our findings raise concern that some of these previous visits represent missed opportunities to diagnose AHT and provide a base to improve occult injury detection in the inpatient setting.

Early identification of physical abuse remains critical given that it tends to be recurrent, often with increasing severity and mortality.^{15,32–34} Unfortunately, an estimated 20% to 36% of abused children

have emergency department or outpatient encounters during which their abuse was missed.^{12–16} Our findings suggest that inpatient encounters are a minimal contributor to the overall prevalence of missed AHT. However, they also suggest that an upper limit estimate of the proportion of children who may have their AHT missed by inpatient providers may be as high as that seen in outpatient and emergency department settings. Abused children were more likely to have previous injury-related hospitalizations compared with controls in our study, which supports previous findings that abuse is more likely to be substantiated with a greater number of past injuries.³⁵ These data support a heightened attention to medical histories in assessing children's risk for abuse, something that may have informed the ultimate abuse diagnoses in our study. A majority of the possible missed cases of AHT in this study, however, were in children for whom only concerning symptoms were diagnosed and

not discrete injuries. Among these concerning symptoms were BRUEs. An estimated 1% to 2% of children presenting for BRUEs have an abusive etiology,^{18,19} but only half may be appropriately identified on their first admission.¹⁹ BRUEs due to AHT more often have a 911 call before presentation, vomiting, or irritability.¹⁸ Similar factors to differentiate abused from nonabused children presenting with isolated vomiting or GERD are unknown, making the detection of abuse difficult given the high prevalence of these symptoms in inpatient settings.

Overall, our study identified a number of conditions (ie, prematurity, symptoms concerning for occult AHT, and injuries) in the inpatient setting that represent either precursors to abuse (ie, risk) or cases in which abuse may have already occurred but had gone undetected. Perhaps screening infants hospitalized with these conditions (or all infants given their risk for sustaining the most severe abusive injuries) for unmet social needs and adverse social determinants of health may improve the prevention and/or detection of abuse. There are screening tools effective at identifying and leading to referrals to address social needs.^{36,37} The impacts of these interventions in the inpatient setting on preventing abuse remain to be determined, but their preliminary success in the outpatient setting is encouraging.^{38,39}

This study has several limitations. First, identification of CPA with a hospitalized cohort at children's hospitals will underestimate abuse.^{40,41} Although identification of abuse with ICD-9-CM codes in the inpatient setting has high specificity (>90%), its sensitivity (73.5%) varies between institutions and can be limited by coding inaccuracies, reluctance to formally diagnose abuse, or some abuse diagnoses may have been assigned after discharge once further investigations were completed.^{20,21} Second, we likely underestimate the incidence of previous visits and chronic health conditions (eg, prematurity) because medical encounters occurring outside the hospital during which the abuse or accidental injury hospitalizations occurred would not have

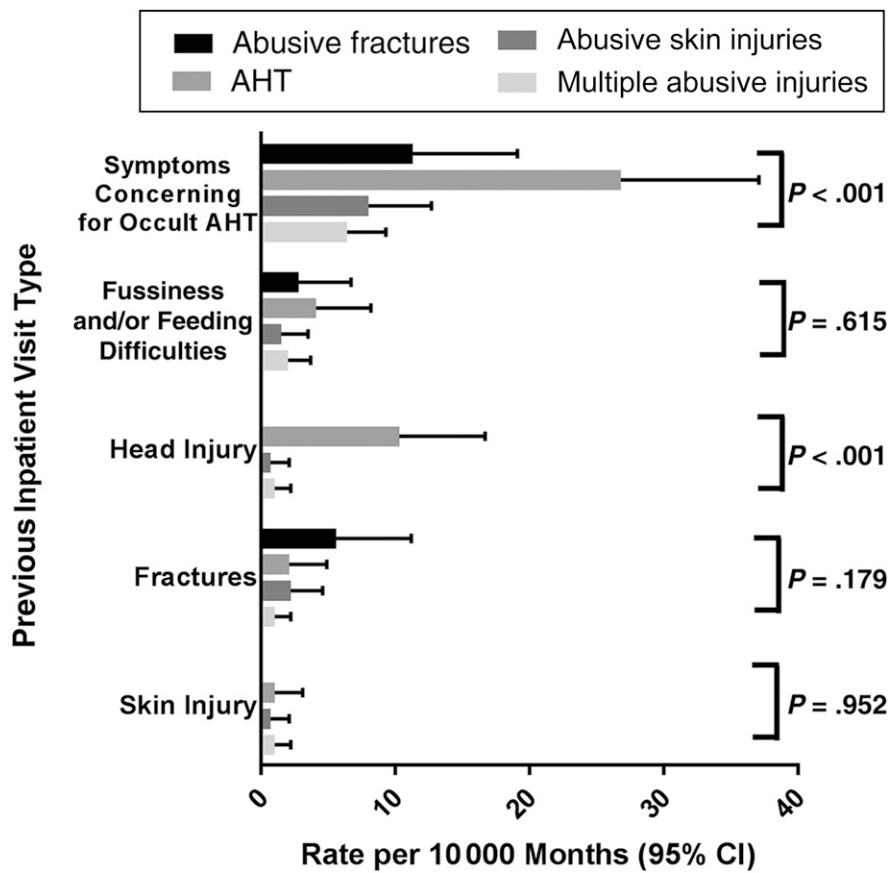


FIGURE 3 The age-adjusted rates of previous inpatient visits among each subsequent type of abusive injury in the 711 abused children who had a previous inpatient visit.

been captured, only primary discharge diagnoses were investigated, and only the visits most recent to the abuse were used. Third, rates of previous visits among the accidental injury controls may not reflect the total population of hospitalized children. However, use of nonabusive injury controls is common,^{15,23–25} and lower sensitivity for abuse coding would suggest that some of the controls were in fact cases of abuse, pushing our results toward the null. Lastly, owing to this study's design, definite relationships between previous inpatient visits and later abuse hospitalizations cannot be made. Some previous visits may have been identified as abuse but not coded as such, or some may have truly been unrelated to later abuse. Regardless, we provide an estimation and characterization of the possible missed opportunities to diagnose AHT as well as allowing for a clearer characterization of prevention opportunities within children's hospitals. In

addition, we identify key areas for future investigations and/or interventions that can improve the prevention or early detection of abuse.

CONCLUSIONS

Infants hospitalized with prematurity, low birth weight, symptoms concerning for occult AHT, and injuries are inpatient populations at children's hospitals who may benefit from abuse prevention and/or risk assessments. Diagnoses of head injuries, vomiting, GERD, seizures, neurologic abnormalities, apnea, and BRUEs were more likely to precede AHT specifically and may represent missed opportunities to diagnosis AHT in the inpatient setting. Although missed AHT in the inpatient setting appears rare overall, a similar proportion of AHT may be missed in the inpatient setting (1 in 5) compared with other clinical settings, but further study is needed to confirm these findings.

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