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Firearm injuries in children: A missed opportunity for firearm safety education

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Abstract

Background: Surgeons frequently care for children who have sustained gunshot wounds (GSWs). However, firearm safety education is not a focus in general surgery training. We hypothesized that firearm safety discussions do not routinely take place when children present to a trauma center with a GSW.

Method: A retrospective review of patients <18 years presenting with GSWs to a level one pediatric trauma center from 2009–2019 was performed. The primary outcome was discussion of firearm safety with the patient or family. The secondary outcome was notification of child protective services (CPS).

Results: A total of 226 patients with GSWs were identified, 22% were unintentional, and 61% were assault. Firearm safety discussions took place in 10 cases (4.4%). Firearm safety discussions were more likely to occur after unintentional injuries compared to other mechanisms (16.0% vs. 1.1%, p<0.001). CPS was contacted in 29 cases (13%). CPS notification was more likely for unintentional injuries compared to other mechanisms (50% vs. 3.8%, p<0.001) and for younger patients (6.8 years vs 13.8 years, p<0.001).

Conclusion: At a pediatric trauma center, firearm safety discussions occurred in 4.4% of cases of children presenting with a GSW. There is a significant room for improvement in providing safety education interventions.

Keywords

firearm safety; resident education; pediatric trauma

INTRODUCTION

Firearm injuries are a leading cause of death and disability for children in the United States(1). A reported 50% of households in the United States have at least one firearm(2). Among firearm-owning households with children, 20% store firearms unsafely, or unlocked

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and loaded(3). Children living in a household with unsafely stored firearms are more likely to sustain a firearm injury than those living in households with safely stored firearms(4). Parents are often unaware that their child knows how to access firearms in their home. A reported 39% of parents who state that their child does not know where their firearm is stored are contradicted by their child(5). Twenty-seven states, including California where this study was conducted, have enacted child access prevention laws. These laws range from imposing criminal liability when a minor is likely to gain access to a firearm to prohibiting parents and guardians from directly providing a firearm to a minor. Strong state level child firearm access prevention laws are associated with lower pediatric hospitalization for firearm injuries(6, 7).

When children are treated after sustaining a gunshot wound (GSW), health care workers have an opportunity to initiate a conversation about firearm safety with the family. A firearm safety discussion can serve to educate the parents on the risks associated with storing a firearm in a house with children and steps they can take to decrease these risks. Seventy-five percent of all parents believe physicians should provide advice on safe firearm storage(8) and firearm-owning parents report willingness to discuss firearm safety with physicians (9). The extent to which firearm safety discussions occur when children present after GSWs is not known. The frequency with which Child Protective Services (CPS) is notified so further investigation into the child's access to a firearm can occur is also not known. We suspect one barrier to these firearm safety discussions is a lack of provider training. Education on firearm safety discussions has been incorporated into the education of pediatric residents and is associated with increased rates of firearm safety discussion(10). However, children who present after a GSW often do not see a pediatrician during their hospitalization, and may not receive regular care from a pediatrician.

Discussing firearm safety with families when a child presents with a GSW is an opportunity for pediatric trauma care providers to potentially decrease pediatric firearm injuries. Additionally, in the setting of child access prevention laws, this encounter is an opportunity to connect pediatric patients and families with CPS. Given that training on firearm safety discussions is not often provided during general surgery residency training, we hypothesized that in the majority of cases when a child presents with a GSW, a firearm safety discussion does not occur. The objectives of this study are (1) to determine the rate of firearm safety discussions and CPS notification when a child presents to a trauma center with a GSW, (2) to identify differences in patient populations who did and did not receive firearm safety discussions and (3) to identify differences in patient populations where CPS was and was not notified.

METHODS

Study Population

All pediatric patients under 18 years old with a GSW admitted to University of California Davis Hospital (UCDH) between July 2009 and July 2019 were evaluated. UCDH is a level 1 pediatric and adult trauma center serving Northern California, which admits over 800 pediatric trauma patients annually. Patients were included if they presented after a GSW

from a powder, non-powder or unknown type of firearm. Patients who were dead on arrival were excluded.

Study Design

The study was approved with a waiver for informed consent by the Institutional Review Board at UCDH (IRB #935667). This study is a retrospective cohort analysis of pediatric patients presenting to UCDH with a GSW. Patients were identified using ICD 9 and 10 codes through an existing trauma database at UCDH that captures all patients presenting with a trauma diagnosis. Electronic medical records were then reviewed to confirm eligibility and complete data collection.

We sought to identify differences in populations in which a firearm safety discussion occurred compared to those in which a firearm safety discussion did not occur. We also aimed to identify differences in populations where CPS was notified compared to those where CPS was not notified. For evaluation of mechanism of injury as a predictor of a firearm safety discussion we evaluated each mechanism compared to all others, for instance, unintentional vs. other mechanism. If there was insufficient information in the medical record to determine mechanism of injury, the case was not included in the respective analysis.

Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Data Collection

The institutional trauma database was used to collect patient age, gender, length of stay (LOS), intensive care unit (ICU) LOS and injury severity score (ISS). Electronic medical records were reviewed to determine race and ethnicity, location of injury, need for operative intervention, and mechanism of injury. Mechanism of injury was categorized as unintentional, assault, crossfire, suicide or unknown. Injury was classified as unintentional if there was documentation stating that the patient and/or family reported unintentional discharge (discharge without the intent to injure a human) of the firearm by the patient or another individual. Injury was classified as assault if the patient and/or family reported another individual discharging the firearm with intent to harm the patient, or if the GSW occurred during an altercation. Injury was classified as crossfire if the patient and/or family reported a bullet coming through a wall, window or into a car. Injury was classified as self-inflicted intentional if the patient and/or family reported suicidal ideation and discharge of the firearm with intent to harm or kill themselves. If there was not sufficient information to determine mechanism based on chart review, or if there were a variety of conflicting narratives of the event, it was classified as unknown.

The primary outcome was discussion of firearm safety with the patient or family. A firearm safety discussion was defined as any documentation of a conversation between social worker, child life specialist, physician or advanced care provider about firearm storage or methods to reduce risk of firearm injury. In addition to review of provider, social work and child life documentation throughout the hospitalization, discharge summaries and discharge

instructions were reviewed to evaluate for any firearm safety instructions provided to the family at discharge.

The secondary outcome was notification of child protective services (CPS). CPS notification was defined as any documentation by a social worker that CPS had been contacted in relation to the GSW.

Statistical Analysis

Demographic and clinical characteristics were summarized for the study population using counts and percentages for categorical variables, and medians and interquartile ranges or means and standard deviations for continuous variables. Continuous variables were compared using two-tailed t-test if data was normally distributed or Kruskal-Wallis test if the data was not normally distributed. Discrete variables were compared using chi-square test or Fisher's exact test. Significance was set as <0.05. All statistical analysis was performed with Minitab (Copyright 2020 Minitab, LLC).

RESULTS

During the 10-year study period from 2009 to 2019, a total of 226 patients under 18 years were admitted to UCDH after a GSW. Demographic data is presented in Table 1. The most common mechanisms of injury were assault, sustained by 63% of patients [n=143] and unintentional, sustained by 22.1% of patients [n=50]. Patients who sustained unintentional injuries were significantly younger, with a median age of 10 years, compared to a median age of 15 years for assault, 12 years for crossfire and 16 years for intentional injury by self ($p<0.001$). Unintentional injuries occurred in the child's home in 52% of cases, in the home of a family member or friend in 20% of cases and while hunting or at a shooting range in 8% of cases. In contrast intentional injuries inflicted by others most commonly occurred in the street or urban areas (48.3%).

Injury characteristics are displayed in Table 2. Children who sustained unintentional GSWs had higher rates of injuries to the face/head/neck and chest. Twenty-two patients died, giving a mortality rate of 9.7%. Patients who presented after intentional injury by self had the highest mortality rate at 50%.

A comparison of characteristics of patients in cases in which documentation of a firearm safety discussion occurred compared to cases in which a firearm safety discussion did not occur/was not documented is displayed in Table 3. A discussion of firearm safety occurred in only 10 cases [4.4%]. Social workers performed discussions in all 10 cases, with additional physician discussion in 2 cases. No families were provided with safe firearm storage instructions in their discharge instructions. In cases where firearm safety discussions occurred, patients were younger (12 years vs. 15 years, $p=0.018$). Patients were more likely to receive counseling if the injury was unintentional (occurred in 16% of unintentional injuries vs. 1.3% of other known mechanisms, OR 14.38, 95% CI 2.94, 70.29). There was no difference in ISS, LOS or ICU LOS between patients who did and did not have a firearm safety discussion.

A comparison of characteristics of patients in cases in which CPS was notified compared to cases when CPS was not notified is displayed in Table 4. CPS was notified in 29 [12.8%] cases. In cases where CPS was notified children were younger (7 years vs. 15 years, p<0.001). CPS was more likely to be notified for unintentional injuries compared to other mechanisms (40% vs. 3.9%, OR 16.33, 95% CI 6.05, 44.1). In cases where CPS was notified children had a longer LOS (7 vs. 3 days, p=0.003) and longer ICU LOS (1 vs. 0 days, p=0.030). There was no difference in sex or ISS between cases in which CPS was and was not notified.

A subset analysis of patients presenting after unintentional injuries was performed. Among patients who sustained unintentional injuries, there were no differences in demographics, ISS or duration of stay between patients who had firearm safety conversations compared to those who did not (Table 5). Among children who sustained unintentional injuries, the patients who had CPS notification were younger (7 years vs. 11 years, p=0.004), had longer LOS (3.5 days vs. 1 day, p=0.011) and had longer ICU LOS (0.5 days vs. 0 days, p=0.031) (Table 6).

DISCUSSION

We found that when a child presents after a GSW, firearm safety discussions are documented at the alarmingly low rate of 4.4%. In cases where children sustained an unintentional injury, firearm safety discussions were more likely to occur. However, even in unintentional injury cases, there was no documented discussion of safe firearm storage for the majority of children (84%).

No previous work has evaluated the rates of documented firearm safety conversations when a child presents to a hospital after a GSW(11). Evaluation of firearm safety counseling in this population is important as children who sustain GSWs have decreased access to healthcare (12, 13) and increased risk of future injury(14). Children who present to emergency departments after firearm injury have higher rates of public or no insurance and are more likely to live in areas with a higher neighborhood disadvantage index compared to children who present with non-firearm related diagnoses(12). Of adolescents admitted to a hospital with a traumatic injury, only 24% have been reported to follow up with a primary care provider within 6 months of injury(13). Furthermore, children who are victims of unintentional firearm injury are more likely to have future hospitalizations for violent injury and are more likely to be perpetrators of assault(14). All children who sustain GSWs are at risk for developing post-traumatic stress disorder and depression(15, 16), and adolescents who have been exposed to gun violence are more likely to start carrying a firearm (17). We identified that in children who have sustained GSWs, firearm safety discussions and notification of CPS occurred at a higher rate in children who sustained unintentional injuries, and in younger children. Our observed higher rates of counseling in children who sustained unintentional injuries is in line with the well demonstrated association between access to unlocked and loaded firearms in homes and unintentional injuries (4, 18). Higher rates of CPS notification for younger children are consistent with prior studies that suggest social workers and physicians perceive a younger child accessing an unsafely stored firearm to be more consistent with neglect than an older child accessing an unsafely stored firearm (19,

20). However, the limited access to healthcare and risk for future injury for all children who have sustained a GSW, suggest that all of these children could benefit from firearm safety counseling. Similarly, older children could also potentially benefit from CPS involvement given the risks of future firearm use for adolescents (17) and risks of suicide with access to firearms (18).

Previous surveys of pediatricians and family practice physicians demonstrate between 50–80% believe they should counsel on firearm safety, but only 5–40% actually do(21, 22). Primary care physicians report that the barriers to firearm safety conversations include discomfort with firearm counseling(23), a lack of time(21), and a lack of familiarity with firearm locks and storage devices(24). Our documented counseling rate of 4.6% is lower than reported in most studies of primary care providers. Differences in training and practice patterns between primary care providers and trauma providers may add barriers for trauma providers and account for the difference in counseling rates. Additionally, in the acute setting safe firearm storage conversations may not be appropriate in all circumstances, particularly when a child is acutely unstable or has died, and this may have discouraged providers in our study.

Counseling patients on safe firearm storage is not widely taught in medical school or in residency(25, 26). We did not identify any reports on firearm safety counseling education for surgery residents. Pediatric residents report receiving training on firearm safety counseling only 22% of the time(24). However, providing counseling and safety guidance of other topics, such as car seats, is a component of pediatricians' practice (27), and is not commonly performed by non-pediatricians (28). Trauma providers do report screening for alcohol use and drug use in adolescent patients, but otherwise view social workers as the individuals responsible for conducting screening for high risk behaviors in patients (29). These views are reflected in our study, with the vast majority of firearm safety conversations being conducted by social workers, and only 2 of 10 families receiving additional counseling from a physician. Unfortunately, relying on social workers to conduct firearm safety conversations may contribute to the low rates of firearm safety discussions, as only 25% report receive training on how to counsel about firearm safety (30).

Primary care providers and trauma providers may both be hesitant to discuss firearm safety due to concerns that families will be offended or will not change their storage practices. While firearm safety can be a challenging topic to broach, parents may be more willing than the general population to discuss firearm safety and open to change. In a recent study, Campbell et. al demonstrated that 63% of firearm-owning parents who did not keep their firearms stored locked and unloaded said that they would change the way they stored firearms in their home after watching a video on safe firearm storage(31). In addition, experiencing the injury of a child by a firearm may make families more open to changing their firearm storage practices. Individuals close to victims of firearm suicide have been demonstrated to be more willing to store firearms locked and unloaded (32). This may place trauma care providers in a better position to counsel families on safe storage.

Legal concerns may make physicians reticent to discuss firearms with patients. At a federal level, the Patient Protection and Affordable Care Act (ACA) prohibits required

collection of firearm ownership information by “health and wellness programs”. However, this does not apply to the vast majority of situations in which a pediatric trauma provider will be inquiring about firearm ownership and storage. At a state level, components of Florida’s Firearms Owners’ Privacy Acy law that limited provider discussions of firearms were overturned in 2017(33). Some states, including Montana, Missouri and Minnesota, have additional legislation limiting the universal acquisition of information on firearms by physicians and healthcare systems(34). Critically, none of these laws, at a federal or state level, block a physician from inquiring and counseling about firearm ownership and storage if the information is relevant to the patient’s health (34). Further, safe storage counseling is supported by the American College of Surgeons, the American Pediatric Surgical Association and the American College of Physicians(35–37).

Based on the results of this study we are now developing an educational curriculum for trauma providers covering how to have firearm safety discussions with patients and have developed discharge instructions on firearm safety. We will perform a review of rates of firearm safety conversations in pediatric GSW cases following this intervention. Ideally these conversations will occur prior to injury, and we will educate providers to consider safe storage counseling for any family with children presenting after a traumatic injury. Additionally, we support community safe firearm storage education efforts.

There are several limitations to our study. First, our study has the inherent limitations of being a single-center retrospective review. Second, it is possible that providers did have firearm safety discussions with families and did not document them. While it is possible that firearm safety counseling may have occurred at a slightly higher rate than documented, we suspect that the true discussion rate is within 10–15% of the documented rate (38, 39). While we have identified that these conversations do not occur, further work is required to investigate why trauma providers do not have these conversations with patients.

CONCLUSION

Firearm safety conversations after pediatric GSWs are rare. When a child presents after an unintentional injury, firearm safety education is more likely to occur though such discussions are still quite rare. Providing families with information on how to store firearms safely has the potential to decrease pediatric firearm injuries. Educating providers on how to carry out these discussions and evaluating the impact is critical.

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What is already known on this subject?

- Safe firearm storage is associated with decreased pediatric firearm injuries.
- Counseling parents on safe firearm storage is likely to change their storage habits.

What this study adds

- Pediatric trauma providers rarely counsel patient families on safe firearm storage when children present after a gunshot wound.
- Rates of counseling on safe storage are increased after unintentional injury, relative to other mechanisms, but only 16% of families received counseling after an unintentional injury.
- Child protective services is notified at a higher rate for younger children and for unintentional firearm injuries.

TABLE 1:

Patient demographics

	All patients n=226	Patients presenting after unintentional injury n=50	Patients presenting after intentional injury inflicted by others n=143	Patients presenting after injury due to crossfire n=6	Patients presenting after self-inflicted intentional injury n=4	p-value
Age, years [IQR]	15.0 [11.0,16.0]	10.0 [4.8, 12.0]	15.0 [13.0, 16.0]	12.0 [6.5, 16.0]	16.0 [16.0, 16.8]	<0.001
Male, n [%]	181 [80.1]	40 [80.0]	114 [79.7]	5 [83.3]	3 [75.0]	0.513
Race/ethnicity						0.096
AIAN, n [%]	1 [0.4]	0 [0]	1 [0.7]	0 [0]	0 [0]	
Asian, n [%]	9 [4.0]	5 [10.0]	4 [2.8]	0 [0]	0 [0]	
Black, n [%]	55 [24.3]	5 [10.0]	45 [31.5]	0 [0]	0 [0]	
Other – Hispanic, n [%]	81 [35.8]	15 [30.0]	52 [36.4]	4 [66.7]	2 [50.0]	
Other – non-Hispanic, n [%]	8 [3.5]	2 [4.0]	6 [4.2]	0 [0]	0 [0]	
White, n [%]	30 [13.3]	14 [28.0]	16 [11.2]	0 [0]	0 [0]	
Unknown, n [%]	38 [16.8]	9 [18.0]	18 [12.6]	2 [33.3]	2 [50.0]	
Location where event occurred, n [%]						0.015
Victim's home	57 [25.2]	27 [54.0]	27 [16.8]	3 [50.0]	3 [75.0]	
Home of friend/ family member	18 [8.0]	10 [20.0]	8 [5.6]	0 [0]	0 [0]	
Park	7 [3.1]	1 [2.0]	6 [3.5]	1 [16.7]	0 [0]	
Street or urban area	73 [32.3]	2 [4.0]	71 [48.2]	2 [33.3]	0 [0]	
Hunting or shooting range	4 [1.7]	4 [8.0]	0 [0]	0 [0]	0 [0]	
Other	10 [4.4]	0 [0]	10 [7.0]	0 [0]	0 [0]	
Unknown	34 [15.0]	6 [12.0]	27 [18.9]	0 [0]	1 [25.0]	

Abbreviations: AIAN, American Indian/Alaska Native

TABLE 2:

Injury characteristics

	All patients n=226	Patients presenting after unintentional injury n=50	Patients presenting after intentional injury inflicted by others n=143	Patients presenting after injury due to crossfire n=6	Patients presenting after self-inflicted intentional injury n=4	p-value
ISS, median [IQR]	9.0 [4.0, 16.3]	4.0 [1.0, 9.0]	9.0 [4.0, 16.0]	9.0 [7.8, 16.3]	20.5 [16.0, 25.0]	0.019
Operative intervention, n [%]	130 [57.5]	25 [50.0]	85 [59.4]	4 [66.7]	0 [0]	0.079
Body area injured						0.013
Face/head/neck, n [%]	61 [27.0]	22 [44.0]	29 [20.3]	0 [0]	2 [50.0]	
Chest, n [%]	36 [15.9]	12 [24.0]	17 [11.9]	1 [16.7]	2 [50.0]	
Abd/back/pelvis, n [%]	44 [19.5]	10 [20.0]	25 [17.5]	4 [66.7]	0 [0]	
Extremities, n [%]	51 [22.6]	4 [8.0]	43 [30.1]	1 [16.7]	0 [0]	
Multiple, n [%]	34 [15.0]	2 [4.0]	29 [20.3]	0 [0]	0 [0]	
LOS, days [IQR]	3.0 [1.0, 6.0]	2.0 [1.0, 4.3]	3.0 [1.0, 6.0]	4.0 [1.8, 5.3]	9.0 [1.3, 16.0]	0.349
ICU LOS, days [IQR]	0 [0, 1.0]	0 [0, 1.0]	0 [0, 1.0]	0 [0, 1.5]	0.5 [0, 1.0]	0.776
Died, n [%]	22 [9.7]	2 [4.0]	12 [8.4]	0 [0]	2 [50.0]	0.055

Abbreviations: ISS, Injury Severity Score; LOS, length of stay; ICU, intensive care unit

TABLE 3:

Comparison of demographics and patient characteristics for cases in which firearm safety education was delivered vs. cases in which firearm safety education was not delivered

	Firearm safety conversation occurred n=10	No firearm safety education occurred n=216	Odds ratio (95% CI)	p-value
Age, years [IQR]	12.0 [9.8, 12.3]	15.0 [11.0, 16.0]	N/A	0.018
Male, n [%]	8 [80.0]	173 [80.1]	0.99 (0.2, 4.85)	0.994
ISS, median [IQR]	9.0 [3.3, 13.8]	9.0 [4.0, 17.0]	N/A	0.768
Mechanism, n [%]				
Unintentional (n=50)	8 [80.0]	42 [19.4]	14.38 (2.94, 70.29)	<0.001
Assault (n=143)	2 [20.0]	141 [65.3]	0.09 (0.02, 0.45)	<0.001
Cross fire (n=6)	0 [0]	6 [2.8]	0	>0.999
Suicide (n=4)	0 [0]	4 [1.9]	0	>0.999
Unknown (n=23)	0 [0]	23 [10.6]	0	>0.999
LOS, days [IQR]	5.0 [1.0, 8.5]	3.0 [1.0, 6.0]	N/A	0.421
ICU LOS, days [IQR]	0.5 [0, 3.0]	0 [0, 1.0]	N/A	0.419

Abbreviations: ISS, Injury Severity Score; LOS, length of stay; ICU, intensive care unit

TABLE 4:

Comparison of demographics and patient characteristics for cases in which CPS was contacted vs. cases in which CPS was not contacted

	CPS notified n=29	CPS not notified n=197	Odds ratio (95% CI)	p-value
Age, years [IQR]	7.0 [2.0, 11.5]	15.0 [13.0, 16.0]	N/A	<0.001
Male, n [%]	22 [75.9]	159 [80.7]	0.75 (0.30, 1.89)	0.542
ISS, median [IQR]	9.0 [4.0, 13.5]	9 [4.0, 17.0]	N/A	0.827
Mechanism, n [%]				
Unintentional (n=50)	20 [69.0]	30 [15.2]	12.37 (5.14, 29.75)	<0.001
Assault (n=143)	6 [20.7]	137 [69.5]	0.11 (0.04, 0.29)	<0.001
Cross fire (n=6)	0 [0]	6 [3.0]	0	>0.999
Suicide (n=4)	0 [0]	4 [2.0]	0	>0.999
Unknown (n=23)	3 [10.3]	20 [10.2]	1.02 (0.28, 3.68)	>0.999
LOS, days [IQR]	7.0 [2.0, 10.0]	3.0 [1.0, 5.0]	N/A	0.003
ICU LOS, days [IQR]	1.0 [0, 2.5]	0 [0, 1.0]	N/A	0.030

Abbreviations: CPS, Child Protective Services; ISS, Injury Severity Score; LOS, length of stay; ICU, intensive care unit

TABLE 5:

Comparison of demographics and patient characteristics for unintentional injury cases in which firearm safety education was delivered vs. cases in which firearm safety education was not delivered

	Firearm safety conversation n=8	No firearm safety conversation n=42	p-value
Age, years [IQR]	11.5 [9.3, 12.0]	9.5 [3.8, 12.3]	0.525
Male, n [%]	7 [87.5]	33 [78.6]	0.563
ISS, median [IQR]	9.0 [4.3, 15.3]	4.0 [1.0, 9.0]	0.165
LOS, days [IQR]	5.5 [1.5, 9.5]	2.0 [1.0,3.3]	0.090
ICU LOS, days [IQR]	0.5 [0, 2.8]	0 [0,0.3]	0.223

Abbreviations: ISS, Injury Severity Score; LOS, length of stay; ICU, intensive care unit

TABLE 6:

Comparison of demographics and patient characteristics for unintentional injury cases in which CPS was contacted vs. cases in which CPS was not contacted

	CPS notified n=20	CPS not notified n=30	p value
Age (years), median [IQR]	7.0 [2.3, 10.0]	11.0 [8.0,13.0]	0.004
Male, n [%]	16 [80.0]	24 [80.0]	>0.999
ISS, median [IQR]	8.5 [1.3, 12.0]	4.0 [1.0, 9.0]	0.342
LOS (days), median [IQR]	3.5 [1.3, 9.8]	1.0 [1.0, 3.0]	0.011
ICU LOS (days), median [iQr]	0.5 [0, 1.8]	0 [0, 0]	0.031

Abbreviations: CPS, Child Protective Services; ISS, Injury Severity Score; LOS, length of stay; ICU, intensive care unit