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Functional status impairment at six-month follow-up is independently associated with child physical abuse mechanism☆,☆☆

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Abstract

Background: Children with abusive injuries have worse mortality, length-of-stay, complications, and healthcare costs compared to those sustaining an accidental injury. Long-term functional

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☆☆This work has not previously been presented.

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Declaration of competing interest

None of the authors has any personal or financial conflicts of interest to disclose.

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Literature Search: Jensen, Evans, Burd

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Appendix A. Supplementary data

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impairment is common in children with abusive head trauma but has not been examined in a cohort with heterogeneous body region injuries.

Objective: To assess for an independent association between child physical abuse and functional impairment at discharge and six-month follow-up.

Participants and setting: Seriously injured children (<15 years) treated at seven pediatric trauma centers.

Methods: Functional status was compared between child physical abuse and accidental injury groups at discharge and six-month follow-up. Functional impairment was defined at discharge ("new domain morbidity") as a change from pre-injury ≥2 points in any of the six domains of the Functional Status Scale (FSS), and impairment at six-month follow-up as an abnormal total FSS score.

Results: Children with abusive injuries accounted for 10.5% (n = 45) of the cohort. New domain morbidity was present in 17.8% (n = 8) of child physical abuse patients at discharge, with 10% (n = 3) of children having an abnormal FSS at six-months. There were no differences in new domain morbidity at hospital discharge between children injured by abuse and or accidental injury. However, children injured by physical abuse were 4.09 (2.15, 7.78) times more likely to have functional impairment at six months.

Conclusions: Child physical abuse is an independent risk factor for functional impairment at six-month follow-up. Functional status measurement for this high-risk group of children should be routinely measured and incorporated into trauma center quality assessments.

Keywords

Pediatrics; Injuries and wounds; Child abuse; Physical abuse; Outcomes assessment

1. Introduction

Child physical abuse is a major contributing factor to mortality in young children, accounting for 43% of injury-related mortality among those less than one year old and 31% under five years old (Rosenfeld, Johnson, Wesson, et al., 2020). Children injured from abuse have higher mortality rates, greater need for operative management, longer intensive care unit length of stay, increased incidence of complications, and higher healthcare costs than those injured by accidental mechanisms (Burke, Lim, et al., 2019; Deans, Minneci, Lowell, & Groner, 2013; Estroff, Foglia, & Fuchs, 2015; Livingston, Grigorian, Kuza, et al., 2019; Nair, Cohen, & Flori, 2020; Roaten, Partrick, Nydam, et al., 2006; Shahi, Phillips, Meier, et al., 2020). Poor outcomes in child physical abuse patients have been associated with delays in presentation and more frequent injuries to multiple body regions (Estroff et al., 2015; Pontarelli, Jensen, Komlofske, & Bliss, 2014; Vadivelu, Esernio-Jenssen, Rekate, et al., 2015). Higher mortality after child physical abuse occurs despite the presence of lower-grade injuries measured using injury severity metrics such as the Abbreviated Injury Scale (AIS) or its derived Injury Severity Score (ISS) (Deans, Minneci, et al., 2013), suggesting that abuse has an independent association with outcome (Brown, Gestring, Leeper, et al., 2018; Deans, Minneci, et al., 2013).

Although mortality associated with child physical abuse is high, most patients survive the initial hospitalization. About 10% of survivors are discharged to a long-term care facility or rehabilitation, showing that substantial functional impairment is likely in this population (Rosenfeld et al., 2020). The number of child physical abuse cases is underestimated. With intensive screening, up to 25% of infants sustaining head trauma can be attributed to this mechanism (Kim, McCagg, Dundon, et al., 2017). Children surviving abusive head injuries have higher functional impairment rates, although not all functional impairment is apparent at discharge (Bonnier, Nassogne, & Evrard, 1995; Deans, Thackeray, Askegard-Giesmann, et al., 2013). Functional impairment after abusive head trauma increases over time and can persist, with up to 90% of patients having residual impairment six years after injury (Rhine, Wade, Makoroff, et al., 2012). Impairment may not be recognized for years, only manifesting when developmental milestones are unmet. Delayed recognition of impairment mainly occurs in the domains of attention, memory, and behavior (Barlow, Thomson, Johnson, & Minns, 2005). Although functional impairments associated with abusive head trauma are known, outcomes for a cohort of child physical abuse patients with heterogeneous body region injuries have not been examined.

The need for including functional outcomes as a quality assessment after injury has increasingly received attention (Ahmed, Holubkov, Dean, et al., 2019; Bennett, Dixon, Kartchner, et al., 2016; Gabbe, Simpson, Sutherland, et al., 2011). Routine measurement of functional impairment is limited by the resources needed to collect outcomes data, particularly after discharge (Wilcox & Ely, 2019). Identifying groups of patients at the highest risk for functional impairment facilitates targeting these limited resources at groups expected to have the highest frequency of impairment. Severe traumatic brain injury (TBI), extremity injuries, and multiple injured body regions have been shown to have the highest level of impairment at discharge, and these discharge impairments are associated with long-term impairment at six months (Burd et al., in press; Burd et al., 2021). Given the associations between child physical abuse and mortality, the same relationship was expected with functional impairment in this group. The effect of child abuse on six-month functional impairment was expected to be independent of discharge functional status, consistent with observed declines over time and delayed recognition of impairment after abusive head trauma (Barlow et al., 2005; Bonnier et al., 1995; Rhine et al., 2012).

The purpose of this study was to evaluate functional impairment associated with child physical abuse in a sample of patients with heterogeneous body region injuries. The primary hypothesis was that children injured by physical abuse would have higher functional impairment at discharge than children injured by an accidental mechanism. The secondary hypothesis was that children injured by physical abuse would have higher rates of impairment at six months, independent of the level of discharge functional impairment.

2. Methods

2.1. Participating centers and patient selection

This report is a planned secondary analysis of the “Assessment of Health-Related Quality of Life and Functional Outcomes after Pediatric Trauma” multicenter prospective observational cohort study conducted between March 2018 and September 2020. IRB approval was obtained from the coordinating site using a central mechanism. Written consent was obtained from the primary caregiver as well as assent from the minor when appropriate. All seven study sites are designated as pediatric trauma centers and participated in the Collaborative Pediatric Critical Care Research Network (CPCCRN). Children up to 15 years old were recruited to the primary study if admitted to one of seven participating hospitals after sustaining an Abbreviated Injury Scale (AIS) ‘serious’ (AIS severity score 3) or greater injury and expected to survive to discharge. Patient enrollment was stratified to ensure adequate inclusion of patients with uncommon injuries and injuries in multiple body regions. Children with burns were excluded from the study due to unique relationships between thermal injury and functional outcomes (Polinder, Essink-Bot, et al., 2011). Patients were also excluded if the primary caregiver’s language was not English or Spanish to ensure valid implementation of survey instruments. Families were incentivized with gift cards to complete surveys at enrollment ($25 USD) and follow-up ($50 USD).

2.2. Outcome measures

The Functional Status Scale (FSS) was used to assess pre-injury, discharge, and six-month functional status. The FSS has been validated in large cohorts of general pediatric patients and critical care patients (Pollack, Holubkov, Glass, et al., 2009). The FSS measures functional impairment in six domains (mental status, sensory, communication, motor, feeding, and respiratory), with each domain scored from 1 (normal) to 5 (very severe dysfunction). This study’s primary outcome was “new domain morbidity” at discharge, defined as an increase ≥2 from baseline pre-injury status in any single domain (Pollack, Holubkov, Funai, et al., 2015). A composite FSS score ranges from 6 to 30 and is categorized as normal (FSS 6–7), mildly abnormal (FSS 8–9), moderately abnormal (FSS 10–15), severely to very severely abnormal (FSS >15) (Pollack, Holubkov, Funai, et al., 2014). The secondary outcome for this study was abnormal total FSS (>7) six months after discharge.

2.3. Main exposure variable

Child physical abuse as the mechanism of injury was defined by research coordinators based on chart review if provider notes indicated that child abuse was ‘more likely than not’ to be the primary mechanism of injury. Due to known problems with defining and documenting child abuse (Durand, McLaughlin, Imagawa, et al., 2019), we performed sensitivity analyses for concordance between the research coordinator definitions and trauma registry coding for child abuse using International Classification of Diseases 10th edition (ICD-10) diagnosis codes and mechanism using ICD-10 external cause codes. Trauma registrar abstracting of ICD-10 diagnostic and mechanism codes was performed independent of the research team.

2.4. Baseline patient and injury characteristics

Self-reported race, ethnicity, preferred language, insurance coverage, annual household income, and primary caregiver level of education were obtained from the child’s primary caregiver using surveys at enrollment. Pre-injury comorbidities were abstracted using chart review by research coordinators at participating sites using a pre-specified categorized list of chronic respiratory (asthma), cardiovascular (arrhythmia/congenital heart disease), neurologic (seizures/other), or other conditions. Mechanism of injury, body region injury characteristics, and baseline physiological variables (initial systolic blood pressure, heart rate, and Glasgow Coma Scale [GCS]) were obtained from the trauma registries at participating sites. GCS motor was classified as abnormal if <5. Patients with missing GCS were classified as abnormal due to known associations between missing GCS and poor outcomes, including mortality (O'Reilly, Cameron, & Jolley, 2012). Systolic blood pressure and heart rate were categorized into normal or abnormal for age using age-normalized z-scores (Bonafide, Brady, Keren, et al., 2013; Fayers & Shinebourne, 1980; Rabbia, Grosso, Cat Genova, et al., 2002).

2.5. Statistical analyses

Univariate comparisons of baseline patient, injury, and physiological characteristics were performed using Chi-squared, Fisher's exact, Cochran-Armitage trend, and Wilcoxon rank-sum tests as appropriate. Multivariable logistic regression was used to assess the association between new domain morbidity at discharge with child physical abuse mechanism, controlling for predefined covariates: age category, race, ethnicity, insurance type, annual household income, primary caregiver education level, abnormal initial physiological variables, and body regions injured. A second multivariable model assessed the association between functional impairment at six-month follow-up and child physical abuse, adjusting for discharge functional status, age category, abnormal GCS motor score, and body region injuries. Socioeconomic factors were not included in the secondary outcome model because of the large proportion of patients injured by a child abuse mechanism expected to be discharged to alternative caregivers.

Missing baseline data was addressed using multiple imputation. To address oversampling of patients with uncommon injuries and multiply injured body regions, inverse probability weighting was used based on all registry patients from participating institutions. Ten datasets were imputed using chained regressions under the assumption of missingness at random pattern (Raghunathan, Van Hoewyk, & Solenberger, 2001; Rubin, 1987). All analyses were performed using SAS v9.4 (Cary, NC). Statistical significance was defined as $p < 0.05$.

3. Results

3.1. Study sample characteristics

The analysis cohort from the parent study included 427 patients, 11% (n = 45) who were identified as being injured by child physical abuse. Child physical abuse mechanism as identified by research coordinators was concordant with independent trauma registrar abstraction of both ICD-10 diagnosis codes in 96% (n = 408) of cases and ICD-10 external cause codes in 93% (n = 397) (Supplemental Table 1). Cases coded as child abuse in the registry but classified as accidental injury by research coordinators were all coded as 'child physical abuse, suspected' diagnostic codes in the trauma registry. None were coded as 'child abuse, confirmed' by diagnosis code or as child physical abuse with a known perpetrator by external cause code.

Child physical abuse patients were younger than those admitted after accidental injury, with most (80%, n = 36) less than one year old (Table 1). Patients in this group were more frequently black, covered by public health insurance, and from homes with an annual income under $50,000. Most (58%, n = 26) primary caregivers of these children did not attend college and had a lower education level than primary caregivers in the accidental injury group. Pre-existing chronic medical conditions were uncommon overall (15%, n = 66) and had a similar frequency in both groups (Table 2). Penetrating injuries occurred only in the accidental injury group (Table 2). Head injuries were more common in the child physical abuse (64%, n = 29) than the accidental trauma group (30%, n = 115). Intensive care unit admission was used in 42% (n = 174) of the overall cohort, and was not statistically different between the abusive (37%, n = 15 with ICU admission) and accidental (42%, n = 159 with ICU admission) groups (p = 0.51).

3.2. Association between functional impairment at discharge and child physical abuse mechanism

Complete FSS data was available for all 427 patients at discharge. New domain morbidity at discharge was observed in 17% (n = 74) of patients in this cohort. In unadjusted analyses, no differences were observed in the frequency of impairment between those injured by child physical abuse (18%, n = 8) or by an accidental mechanism (17%, n = 66) (Table 3). On multivariable analysis, child physical abuse mechanism was not independently associated with a new domain morbidity at discharge after adjusting for age, initial physiology, race, ethnicity, insurance type, household income, caregiver education level, and body regions injured (Table 4). Additional factors associated with the development of new domain morbidity at discharge on multivariable analysis included young age (<1 year or 1–4 years old), abnormal GCS motor score, non-white race, non-Hispanic ethnicity, private/commercial insurance, and injuries to any of the five body regions.

3.3. Association between functional impairment at six-month follow-up and child physical abuse

Complete six-month follow-up FSS data was available for 75.6% (n = 323) of patients, including 66.7% (n = 30) patients injured by child physical abuse and 76.7% (n = 293) injured by an accidental mechanism. Children with a primary caregiver who had a lower education level were more often lost to follow-up (Supplemental Table 2). Among patients with complete follow-up data, an abnormal FSS at six months after discharge was seen in 10.2% (n = 33) patients. In an unadjusted analysis, the frequency of abnormal FSS at six months was not different between the child physical abuse (10%, n = 3) and accidental injury (10.2%, n = 30) groups. However, after adjusting for abnormal FSS at discharge, age, abnormal GCS motor score, and body regions injured, child physical abuse was associated with a higher risk of functional impairment at six months (Table 5). Additional factors associated with abnormal functional status at six-month follow-up included moderate to severe functional impairment (FSS >10) at hospital discharge, abnormal GCS motor score, older age (10–14 years old), and spine injury. The presence of an abdominal injury was independently associated with a lower risk of functional impairment at follow-up. Analysis of domain-specific morbidity among the three child physical abuse patients with six-month impairment showed mild communication impairment in all three, and mild motor impairment and feeding impairment in two. Mild impairment was also seen in the mental status, sensory, and respiratory domains for one patient each.

4. Discussion

In this analysis of children admitted with serious injuries, an association was observed between a child physical abuse mechanism and functional impairment at six-month follow-up, but not at hospital discharge. The association between child physical abuse and impairment at follow-up was significant after adjusting for discharge functional status, suggesting child abuse is a factor associated with additional long-term functional impairment. These findings are based on a low event rate for long-term functional impairment in the child physical abuse. The effect size is substantial, with victims of child physical abuse having a four-fold greater adjusted risk of long-term impairment. One-third of child abuse patients had unmeasured six-month outcomes, with primary caregiver level of education the only significant predictor of retention.

Although the level of functional impairment was not different between the child physical abuse and accidental injury groups at discharge, several factors may contribute to this finding. Overall mortality is reported to be higher among children injured by abuse (9–10%) compared to those injured by an accidental mechanism (1–2%) (Estroff et al., 2015; Livingston et al., 2019; Roaten et al., 2006). In this non-mortality population, functional impairment in the child abuse may be relatively lower than in accidental injury patients due to the censoring by mortality before study enrollment. Patient selection criteria for this study cohort included the presence of a serious injury with an AIS of 3 or greater. Higher mortality among children injured by an abusive mechanism is associated with a higher ISS (median 10 to 18) than for accidentally injured children (median 5 to 9) (2–4). The threshold cutoff of AIS 3 may have had a greater impact on increasing the level of observed impairment in accidentally injured children, as these cases with lower ISS injuries were not analyzed in this cohort. Infants with abusive injury, however, do have a higher head AIS-matched mortality when compared to those injured by an accidental mechanism, suggesting that the increased risk for mortality is not adequately captured by injury severity scoring systems (Brown et al., 2018; Deans, Thackeray, et al., 2013). A more likely explanation is undetected impairment at discharge in young infants. These young infants have undeveloped sensory, communication, mental status, and motor function at baseline, and impairment may be difficult to recognize prior to development of these functions. The FSS may therefore not adequately capture functional morbidity in very young children at discharge leading to under-reporting of the true morbidity in abuse patients.

Several factors that confound the association between child abuse and mortality have been studied. The multivariable analyses used in this study showed an association between functional impairment at discharge and factors that are commonly associated with child physical abuse injury mechanism, including very young age, severe GCS impairment, non-white race, and injuries in all body regions. The model used in this study may have adjusted for factors that are associated with functional impairment. Children injured by physical abuse were mostly infants and had more head injuries. Abusive injury occurs more frequently in children under one year of age and is independently associated with mortality in infants (Rosenfeld et al., 2020). In contrast, accidental injuries in infants are rarely fatal given the lack of participation in activities with higher blunt force (e.g., bicycle riding and fall from height) and more frequent use of protective measures such as car seats (Heerman, Perrin, Yin, et al., 2014; Zagory, McLaughlin, Mallicote, et al., 2018). Black race and lower household income are associated with a higher incidence of child abuse and with higher mortality after child physical abuse (Jones, Babb, Gee, & Beres, 2019; Rangel, Burd, & Falcone, 2010; Rosenfeld et al., 2020). Possible differences in chronic health conditions between the abuse and accidental injury groups were accounted for, as these conditions have been identified as risk factors for an abusive injury (Puls, Anderst, Bettenhausen, et al., 2018).

A higher risk of functional impairment was observed at follow-up among those injured by child physical abuse after adjusting for discharge impairment. This finding is consistent with previous studies showing increasing levels of impairment over time after abusive head trauma. Hemiparesis, quadraparesis, cortical blindness, or other visual impairment may occur during the acute hospitalization after abusive head trauma. Other symptoms such as behavioral problems, psychomotor impairment, or mental retardation, however, may not be apparent for months or years (Bonnier et al., 1995). A long-term follow-up study of abusive head trauma using the Glasgow Outcome Score showed an increasing frequency of functional morbidity, with 63% of children impaired at first follow-up (mean 6 months) and 89% of children at late follow-up (mean 81 months) (Rhine et al., 2012). Some level of long-term impairment after inflicted brain injury is almost always observed when psychological, neurological (epilepsy), motor, and ophthalmological morbidities are assessed (Talvik, Männamaa, Jüri, et al., 2007). Impairments may not be apparent in infancy but become apparent later as children fail to meet developmental milestones. Although half of the children with abusive head trauma developed behavioral problems, this impairment is not evident until up to three years old (Barlow et al., 2005). Cognitive development, fine motor function, and expressive language skills may decline over the first three years after an abusive injury, with developmental delay and learning disorders occurring in over 40% at 5-years (Eismann, Theuerling, Cassedy, et al., 2020; Nuño, Ugiliweneza, Zepeda, et al., 2018). Injuries to the frontal region of the brain may lead to cognitive impairment that may not be evident until adolescence (Stipanicic, Nolin, Fortin, & Gobeil, 2008). Adverse childhood events and stress that results from child maltreatment are associated with impaired brain and body system development and lead to long-term chronic health conditions, including asthma, developmental delay, sleep disruption, and chronic pain (Oh, Jerman, Silvério Marques, et al., 2018). These findings support tracking functional outcomes after abusive injury, particularly those with head injuries.

This study has several limitations. Reasons that eligible patients were not enrolled in the study were not tracked. It is possible that children injured by abuse were enrolled at a lower rate due to. One potential factor contributing to lower enrollment is the reticence of primary caregivers to consent when child physical abuse is the mechanism. Despite complete outcome data for the primary outcome at discharge, 33% of those injured by child physical abuse did not complete follow-up, potentially leading to an underestimate of morbidity at six months. A high loss to follow-up has been shown after injury by child abuse mechanism (Millar MM et al., 2021). To address this source of bias, differences in baseline characteristics of abuse patients that were or were not lost to follow-up were analyzed. Caregiver education level was the only significant factor identified to be associated with retention. As lower caregiver education level is associated with greater functional impairment, this difference would be expected to lead to under-recognition of impairment. In future studies, improved follow-up could be achieved by engaging other specialists with family contact, including social workers, court advocates, child protection case workers, therapists, and patient navigators. The degree of physiological impairment may also have been under-recognized, as this study was limited to variables available in the trauma registry data. A final limitation is the use of FSS to measure functional outcomes. FSS was developed to be applicable to hospitalized pediatric patients across a wide spectrum of ages and inpatient environments. Because FSS identifies the most impactful functional limitations, most hospitalized injured children had normal values. Other measures may detect functional impairment not observed using FSS. FSS may have underestimated overall morbidity, as long-term mental health morbidity related to social and behavioral function is not measured by FSS.

5. Conclusions

Child physical abuse is associated with more frequent functional impairment at six-month follow-up after adjusting for discharge impairment. These findings suggest that children that survive after severe abusive injuries are at high risk for long-term functional morbidity. Long-term functional outcomes should be routinely measured in this high-risk group.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data statement

The dataset for this study will be made available upon publication through the Collaborative Pediatric Critical Care Research Network (CPCCRN) website https://www.cpccrn.org/study-datasets/.

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Table 1

Demographic information for exposure groups.

	Suspected child abuse		
	No (N = 382)	Yes (N = 45)	P-value
Age category			<0.01[a]
<1 year	28 (7.3)	36 (80.0)	
1–4 years	95 (24.9)	7 (15.6)	
5–9 years	109 (28.5)	2 (4.4)	
10–14 years	150 (39.3)	0 (0.0)	
Male sex	245 (64.1)	26 (57.8)	0.40[b]
Race			<0.01[c]
White	256 (67.0)	21 (46.7)	
Black	75 (19.6)	20 (44.4)	
Other	50 (13.1)	4 (8.9)	
Hispanic or Latino ethnicity	41 (10.7)	8 (17.8)	0.17[b]
Insurance			0.02[c]
Private/commercial	198 (51.8)	15 (33.3)	
Medicaid/medicare	168 (44.0)	30 (66.7)	
Self-pay/no insurance	12 (3.1)	0 (0.0)	
Preferred language			0.66[c]
English	369 (96.6)	43 (95.6)	
Spanish	13 (3.4)	2 (4.4)	
Total household income in the last calendar year			<0.01[a]
Less than $15,000	56 (14.7)	11 (24.4)	
$15,000–$19,999	17 (4.5)	4 (8.9)	
$20,000–$29,999	33 (8.6)	5 (11.1)	
$30,000–$39,999	29 (7.6)	5 (11.1)	
$40,000–$49,999	33 (8.6)	5 (11.1)	
$50,000–$74,999	49 (12.8)	4 (8.9)	
≥$75,000	137 (35.9)	7 (15.6)	
Highest level of education obtained by the child's primary caregiver			<0.01[a]
Did not finish high school/high school diploma/GED	127 (33.2)	26 (57.8)	
Associates degree (2-year degree)/vocational degree/some college	103 (27.0)	11 (24.4)	
Bachelor's degree (4-year degree)	79 (20.7)	3 (6.7)	
Graduate degree (Masters, PhD, JD, MD, etc.)	58 (15.2)	3 (6.7)	
Pre-existing chronic diagnoses, yes	63 (16.5)	3 (6.7)	0.12[c]

Missing data for race (n = 1), ethnicity (n = 2), insurance type (n = 4), household income (n = 32), caregiver education level (n = 17) not included in p-value calculations.

[a] Cochran-Armitage trend test.

[b]Chi-squared test.

[c]Fisher's exact test (Monte Carlo approximation for tables larger than 2 × 2).

Table 2

Child injury and hospital information by exposure group.

	Suspected child abuse		
	No (N = 382)	Yes (N = 45)	P-value
Patient transferred from another acute care facility	241 (63.1)	22 (48.9)	0.18[a]
Initial physiology			
GCS motor score < 5	67 (17.5)	11 (24.4)	0.31[b]
Heart rate – abnormal[d]	99 (25.9)	33 (73.3)	<0.001[b]
Systolic blood pressure – abnormal[d]	12 (3.1)	3 (6.7)	0.15[b]
Prehospital cardiac arrest	3 (0.8)	0 (0.0)	>0.99[b]
Injury type			0.62[b]
Blunt	351 (91.9)	29 (64.4)	
Penetrating	17 (4.5)	0 (0.0)	
Missing[e]	14 (3.7)	16 (35.6)	
Body region with severe injury[f]			
Head injury	115 (30.1)	29 (64.4)	<0.001[a]
Thorax injury	74 (19.4)	7 (15.6)	0.69[b]
Abdomen injury	118 (30.9)	5 (11.1)	0.005[b]
Extremity injury	139 (36.4)	13 (28.9)	0.32[a]
Spine injury	31 (8.1)	1 (2.2)	0.23[b]
Number of body regions with a serious injury			0.88[c]
1	317 (83.0)	37 (82.2)	
2	40 (10.5)	6 (13.3)	
3 or more	25 (6.5)	2 (4.4)	

[a] Chi-squared test.

[b] Fisher's exact test.

[c] Cochran-Armitage trend test.

[d] Abnormal is defined as an age-normalized z-score < −1.96 or >1.96.

[e] Not included in p-value calculation.

[f] Body region injuries are not mutually exclusive.

Table 3

Primary and secondary outcomes by exposure group.

	Suspected child abuse		
	No (N = 382)	**Yes (N = 45)**	**P-value[a]**
FSS new domain morbidity at discharge	66 (17.3)	8 (17.8)	0.93
Follow-up FSS complete	293 (76.7)	30 (66.7)	0.14
FSS status normal at follow-up	263 (68.8)	27 (60.0)	0.97

FSS: Functional Status Scale. New domain morbidity defined as change ≥2 from baseline in any single domain. Normal FSS defined as FSS total score < 8.

[a]Chi-squared test.

Table 4

New domain-related morbidity at discharge determined by multivariable logistic regression, children with accidental mechanism of injury as reference.

	Odds ratio (95% CI)	P-value
Suspected child abuse		
No	Reference	
Yes	0.83 (0.52, 1.31)	0.42
Age category		
<1 year	3.90 (2.28, 6.69)	<0.01
1–4 years	2.88 (1.99, 4.15)	<0.01
5–9 years	0.77 (0.53, 1.12)	0.17
10–14 years	Reference	
Race		
White	Reference	
Black	1.61 (1.15, 2.23)	<0.01
Other	1.47 (1.00, 2.17)	0.05
Ethnicity		
Hispanic or Latino	0.46 (0.27, 0.76)	<0.01
Not Hispanic or Latino	Reference	
Insurance		
Private/commercial	Reference	
Medicaid/medicare	0.63 (0.43, 0.93)	0.02
Self-pay/no insurance	0.59 (0.22, 1.56)	0.29
Household income		
<$50,000	1.08 (0.71, 1.66)	0.71
$50,000+	Reference	
Caregiver education		
Did not complete high school	1.16 (0.84, 1.60)	0.37
Completed high school	Reference	
Initial physiology		
GCS motor score – abnormal[a]	6.23 (4.66, 8.32)	<0.01
Heart rate – abnormal[a]	0.72 (0.50, 1.05)	0.09
Systolic blood pressure – abnormal[a]	0.53 (0.08, 3.51)	0.48
Body region with severe injury[b]		
Head	3.41 (2.14, 5.43)	<0.01
Thorax	7.39 (4.78, 11.44)	<0.01
Abdomen	1.69 (1.01, 2.82)	0.05
Spine	33.12 (16.40, 66.91)	<0.01
Extremity	12.19 (7.69, 19.34)	<0.01

Body region injuries are referenced against no injury in stated body region. Fit statistics from one imputation: C-statistic = 0.85 (0.80, 0.90), Hosmer-Lemeshow p-value = 0.32. Number of records: 427.

[a] Abnormal is defined as a z-score < −1.96 or >1.96.

[b] Body region injuries are not mutually exclusive.

Table 5

FSS status at follow-up determined by multivariable logistic regression, children with accidental mechanism of injury as reference.

	Odds ratio (95% CI)	P-value
Suspected child abuse		
No	Reference	
Yes	4.09 (2.15, 7.78)	<0.001
FSS total at discharge category		
6–7 (good)	Reference	
8–9 (mildly abnormal)	0.67 (0.44, 1.01)	0.06
≥10 (moderately to very severely abnormal)	4.44 (2.95, 6.67)	<0.001
Age		
<1 years	0.18 (0.08, 0.37)	<0.001
1–4 years	1.01 (0.72, 1.41)	0.96
5–9 years	0.52 (0.36, 0.77)	<0.001
10–14 years	Reference	
GCS motor score – abnormal[a]		
No	Reference	
Yes	2.08 (1.45, 2.97)	<0.001
Body region with severe injury[b]		
Head	1.01 (0.64, 1.60)	0.97
Thorax	1.20 (0.76, 1.90)	0.42
Abdomen	0.32 (0.18, 0.60)	<0.001
Spine	3.77 (2.19, 6.49)	<0.001
Extremity	1.16 (0.76, 1.77)	0.50

Multivariable model C-statistic = 0.76 (0.67, 0.85), Hosmer-Lemeshow p-value = 0.21.

Number of records: 323.

[a]Abnormal is defined as a z-score < −1.96 or >1.96.

[b]Body region injuries are not mutually exclusive. Body region injuries are referenced against no injury in stated body region.