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Original Research

Assault in children admitted to trauma centers: Injury patterns and outcomes from a 5-year review of the national trauma data bank☆

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HIGHLIGHTS

- Injury patterns of assaulted children admitted to trauma centers is unknown.
- Up to 10% of children admitted to trauma centers are victims of assaults.
- Traumatic brain injuries are predominant among infants.
- Adolescents are often victims of firearms.
- Assault in children is associated with a high mortality risk.

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ABSTRACT

Importance: While assault is commonly reported or suspected in children with traumatic wounds, a recent overview of these injuries, especially those requiring trauma surgery consultation is lacking in the literature.

Objectives: Explore the incidence, demographics and injury patterns of children presenting to trauma centers following an assault.

Design: Retrospective review of the National Trauma Data Bank 2007 to 2011.

Setting and participants: Subjects up to 18 years old with "assault" reported as the intent of injury. Patients were divided into infants (<2 years), young children (2–5 years), children (6–11 years), and adolescents (12–18 years).

Main outcomes and measures: Mechanism of injury, injury severity and mortality based on age groups and race.

Results: Of 609,207 children, 58,299 (9.6%) were victims of an assault. The median age was 16 years and 81% were male, with a median injury severity score (ISS) of 8. The majority of patients were adolescents (76%), followed by infants (17%) and young children (4%). There was a stepwise increase in the proportion of assaulted Black children with increasing age (23.2% for infants and up to 46.7% for adolescents, trend $p < 0.01$, effect size: 0.175) while the opposite applied for White children (46.0% for infants and down to 19.5% for adolescents, trend $p < 0.01$, effect size: −0.230). With increasing age, White subjects had the highest trend of being assaulted during an unarmed fight or brawl ($p < 0.01$, effect size: 0.393), while for Black victims the highest trend was noted for assault with a firearm ($p < 0.01$, effect size: 0.323). Almost 2 out of 3 infants sustained severe head trauma (59%). The overall mortality was 8%, highest among young children, where it reached 16% ($p < 0.01$).

Conclusions: Up to 10% of children admitted following trauma are victims of assault with traumatic brain injuries predominant in infants and firearm injuries predominant in adolescents. Injury patterns largely correlate to age and race. Assault in children is associated with a high mortality risk. These data highlight the magnitude of the problem and calls for further involvement of trauma surgeons to improve outcomes, bring awareness and promote preventative strategies to eliminate assault in children.

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1. Introduction

Child abuse is recognized as a major social phenomenon affecting both developing and developed countries. The World Health Organization estimates that more than 20% of adults worldwide were physically abused as children [1]. In its 25th annual report in 2014, the Children's Bureau of the United States Department of Health and Human Services estimated that 3.2 million children received either an investigation or an alternative response related to maltreatment or abuse. The victimization rate was 9.4 per 1000 children, which translated into 702,000 children who were victims of physical abuse that year. Of those, 1,580 died as a result of the abuse [2]. Extension of this problem is found in adolescent and youth violence. It is estimated that every year, more than 200,000 homicides occur among youth and young adults worldwide [3]. In 2014 alone, over 385,000 patients aged 10–19 years sustained a violence related non-fatal injury in the United States [4]. Bullying is another form of adolescent and youth violence. The National Center for Education Statistics of the Institute of Education Sciences reported in 2014 that almost 1 out of 4 children experiences bullying at school at least once a day and up to 10% of these incidents result in physical trauma [5].

Abuse in children undoubtedly results in innumerous short and long-term physical and psychological effects [6–10], in addition to the remarkable associated healthcare costs, which in 1996 were estimated to exceed $12.4 billion [11]. Screening children for signs of abuse is essential in preventing further injuries, maltreatment, and even subsequent deadly attacks. Screening protocols have been developed and healthcare personnel are encouraged to be vigilant in recognizing children in need for social intervention. Many of these children are admitted to the emergency department with simple injuries such as contusions, isolated fractures, limited degree burns, or lacerations and involvement of a trauma surgeon may not be considered necessary. As a result, trauma surgery literature examining child abuse and assault is scarce.

The purpose of this study was to examine child maltreatment from the trauma surgeon's perspective and to characterize injuries in children admitted to trauma centers related to intentional abuse based on age, race and mechanism of injury.

2. Methods

The National Trauma Data Bank (NTDB) is the largest aggregation of trauma registry data maintained by the American College of Surgeons Committee on Trauma. Over 900 trauma centers voluntarily contribute data to the NTDB in a standardized fashion using the National Trauma Data Standards (NTDS). Inclusion criteria for the data bank are patients with International Classification of Diseases- 9th Edition (ICD-9) codes for discharge diagnoses 800.00–959.9, excluding 905–909, 910–924 and 930–939 and who were admitted or died after receiving any evaluation or treatments or were dead upon arrival. Research datasets 2007 to 2011 were combined and a database was created including all subjects up to 18 years of age who had “assault” as a recorded intention of injury. Subjects with unknown age, mechanism, and/or intent of injury were excluded. For the remaining subjects, demographics including age, gender, race, location of injury, mechanism of injury, and external ICD-9 injury codes (E-codes) were extracted. Injury characteristics collected included injury severity score (ISS) and regional Abbreviated Injury Scale (AIS) for body regions head/neck, chest, and abdomen/pelvis. Lastly, specific injuries and procedures including laparotomy, thoracotomy and craniotomy/craniectomy based on ICD-9 codes were included. Emergency department and hospital dispositions were reviewed to identify patients who died.

For the purpose of analysis, patients were divided into four groups based on age [12]: infants (<2 years), young children (2–5 years), children (6–11 years), and adolescents (12–18 years). Clinically relevant stratifications were created and included injury severity (ISS < 16 vs. 16 to 25 vs. > 25) and regional severe trauma (regional AIS $\geq$ 3 vs. < 3). More specifically, severe traumatic brain injury (TBI) was defined as a head AIS $\geq$ 3. The primary outcome was in-hospital mortality. Secondary outcomes included hospital and intensive care unit (ICU) length of stay.

Data were reported utilizing descriptive statistics including means with standard deviations (SD), medians, interquartile ranges (IQR) and percentages. Analysis of variance (ANOVA) was used to compare the four age groups and a $p < 0.05$ was considered statistically significant. In order to identify the pairs of means that are statistically different, a post hoc analysis was performed utilizing the Fishers's least significant difference (LSD) test. Trend analyses were obtained from a Jonckheere-Terpstra test and effect size was calculated from a correlation Kendall's tau test. All statistical analyses were performed using the IBM SPSS Statistics for Windows, Version 24.0 (Armonk, NY: IBM Corp.). This study was Institutional Review Board exempt as this research involves the collection or study of existing data, documents, records that are publicly available with the information recorded in a de-identified manner.

3. Results

Of 609,207 patients 18 years or younger injured over the 5-year study period, 58,047 (9.5%) were victims of a reported assault. The median age was 16 years (IQR: 6 years) with infants comprising 17.1% (n = 9934), young children 4.3% (n = 2524), children 2.6% (n = 1494), and adolescents 76.0% (n = 44,095) of the study population. The majority of patients were male (81.0%) with 41.9% being Black and 25.3% White. The most common mechanism of injury was a firearm assault (34.9%), followed by injury from a perpetrator of abuse (17.8%), stabbing (16.9%), and unarmed fight or brawl (15.2%). The median ISS was 8 (IQR: 11) with 21.5% having a severe TBI.

Fig. 1 depicts the distribution of race among age groups of patients who were assaulted. There was a stepwise increase in the proportion of assaulted Black children with increasing age from 23.2% for infants and up to 46.7% for adolescents (trend $p < 0.001$ and effect size: 0.175) while a stepwise decrease was noted in the proportion of White children with increasing age from 46.0% for infants and down to 19.5% for adolescents (trend $p < 0.001$ and effect size: −0.230). Although a trend was noted for an increase in the cases of Latino/Hispanic children with increasing age, the most significant increase was noted between children and adolescents (from 16.5% to 22.9%, $p < 0.001$).

Overall, the most common locations in which the assault occurred were at the subject's home (30.1%) and the street (22.9%). The majority of infants were assaulted at home (76.3%). For adolescents, assault occurred most commonly in the street (29.3%), although a large proportion (16.3%) were assaulted at home (Fig. 2). Of note, in 29.5% of assaults the location was unreported or unknown; therefore, no further analysis of location of assault based on age or race was carried out.

The mechanism of injury for these assaults was analyzed based on age groups and race. With increasing age, there was a trend towards fewer injuries by a perpetrator of abuse ($p < 0.001$, effect