Paediatric intentional head injuries in the emergency department: A multicentre prospective cohort study

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Abstract

Objective

Although there is a large body of research on head injury (HI) inflicted by caregivers in young children, little is known about intentional HI in older children and inflicted HI by perpetrators other than carers. Therefore, we set out to describe epidemiology, demographics and severity of intentional HIs in childhood.

Methods

A planned secondary analysis of a prospective multicentre cohort study was conducted in 10 EDs in Australia and New Zealand, including children aged <18 years with HIs. Epidemiology codes were used to prospectively code the injuries. Demographic and clinical information including the rate of clinically important traumatic brain injury (ciTBI: HI leading to death, neurosurgery, intubation >1 day or admission ≥2 days with abnormal computed tomography [CT]) was descriptively analysed.

Results

Intentional injuries were identified in 372 of 20 137 (1.8%) head-injured children. Injuries were caused by caregivers (103, 27.7%), by peers (97, 26.1%), by siblings (47, 12.6%), by strangers (35, 9.4%), by persons with unknown relation to the patient (21, 5.6%), other intentional injuries (8, 2.2%) or undetermined intent (61, 6.4%). About 75.7% of victims of assault by caregivers were <2 years, whereas in other categories, only 4.9% were <2 years. Overall, 66.9% of victims were male. Rates of CT performance and abnormal CT varied: assault by caregivers 68.9%/47.6%, by peers 18.6%/27.8%, by strangers 37.1%/5.7%. ciTBI rate was 22.3% in assault by caregivers, 3.1% when caused by peers and 0.0% with other perpetrators.

Conclusions

Intentional HI is infrequent in children. The most frequently identified perpetrators are caregivers and peers. Caregiver injuries are particularly severe.

Key findings

- There is limited data on intentional head injuries in children beyond abusive head trauma.
- In an ED based multicentre prospective data set from Australia and New Zealand intentional head injuries were overall infrequent.
- Head injuries caused by caregivers had high morbidity and mortality, whereas head injuries caused by peers and strangers infrequently caused clinically important traumatic brain injuries.

Introduction

Intentional traumatic injuries in children are associated with higher mortality compared with accidental paediatric trauma.1 Abusive head trauma (AHT), or head injuries (HIs) inflicted by caregivers, is the leading cause of traumatic death in the first year of life and the most common cause of death due to child abuse.2 Only 22% of victims of AHT survive without any impairment of social, cognitive or motor abilities.3 However, as research has to date focussed on HIs due to assault by caregivers or AHT,4 there is limited understanding of intentional HIs in general. In studies of paediatric trauma patients in the UK, Israel, Malawi and Australia, intentional injuries made up 3.1–10.5%1,5–7 of all injuries. ED reports of HIs describe variable but low rates of intentional causation; however, these are often hampered by their single centre and retrospective methodology.8–13 Reports from the USA show high levels of intentional HIs, many in adolescents, and many caused by weapons.12 Specific information on perpetrators and circumstances surrounding intentional His outside AHT is very limited.

We set out to investigate in a prospective multicentre study the characteristics of intentional HIs in children presenting to the EDs of 10 hospitals in Australia and New Zealand, focusing on epidemiology, demographics and severity of intentional HIs.

Methods

Study design, setting and patients

We performed a planned secondary analysis of children with intentional HIs enrolled into a prospective multicentre observational study performed in 10 paediatric EDs in Australia and New Zealand between April 2011 and November 2014. All EDs are members of the Paediatric Research in Emergency Departments International Collaborative (PREDICT) research network.14 In the primary study, we aimed to externally validate clinical decision rules (CDRs) for neuroimaging in mild traumatic brain injury (TBI); as such we collected and analysed the CDR-specific predictor and outcome variables in all children aged <18 years presenting with HI.15,16

The parent study enrolled patients with HIs of any severity, but excluded the following: trivial facial injury only, patient/family refusal to participate, referral from ED triage to an external provider (i.e. not seen in the ED), did not wait to be seen or neuroimaging done prior to the transfer to a study site. The study was approved by the institutional ethics committee at each participating site. We obtained informed verbal consent from parents/ guardians. However, in instances of significant life-threatening or fatal injuries, ethics committees granted a waiver of consent. The study was registered with the Australian New Zealand Clinical Trials Registry (ANZCTR) ACTRN12614000463

Study procedures

The study protocol is described in detail elsewhere.16 Children were enrolled by the treating ED clinician who collected data points for the HI CDRs. A research assistant (RA) recorded ED and hospital management data after the visit and conducted a telephone follow up for patients who had not undergone neuroimaging. In addition to data related to CDRs, we collected demographic and epidemiological information about neuroimaging, admission and neurosurgery.

To identify the intentional injuries among our population, we searched the study database for all cases with a human intent code other than nonintentional codes. These codes are part of routinely collected epidemiology codes in several Australasian jurisdictions; standardised epidemiology codes based on Victorian state codes17 were incorporated into the clinical report forms (CRFs) across all study sites. In addition, the CRFs included the question 'Do you suspect nonaccidental injury (physical abuse of a child, not other assault)?' as this was a feature in some of the CDR derivation studies we investigated in the parent study. We reviewed the 309 cases where the clinicians ticked 'yes' or 'unknown'. CRFs and radiology reports of all identified cases were manually reviewed.

For this analysis, we excluded cases coded as intentional injury caused by peer where the activity code related to sports, as the historical determination of accidental versus intentional HI is difficult in game play.

Definitions

We used the Glasgow Coma Scale as initially assigned by the ED clinician in the analysis, or if not available, used the Glasgow Coma Scale at triage.18 Senior radiologist reports were used to determine the results of computed tomography (CT) scans and operative reports for patients who underwent neurosurgery. Abnormal CT was defined as intracranial haemorrhage or contusion, cerebral oedema, traumatic infarction, diffuse axonal injury, shearing injury, sigmoid sinus thrombosis, midline shift of intracranial contents or signs of brain herniation, diastasis of the skull, pneumocephalus19 or any skull fracture (depressed, non-depressed, basal

and unknown type). Clinically important TBI (ciTBI) was defined as death, neurosurgical intervention, intubation >24 h for TBI or hospital admission of two nights or more for traumatic HI associated with abnormality on CT.19 Neurosurgical intervention was defined as intracranial pressure monitoring, elevation of depressed skull fracture, ventriculostomy, haematoma evacuation, lobectomy, tissue debridement or dura repair.

The categorisation of intentional injuries was based on the judgement of the treating ED clinician or subsequent hospital clinician based on information collected in the CRFs. These included information from the

ED visit and medical records, but records were only accessed by site RAs immediately after the visit; subsequent assessments in case conferences or as assessed by external agencies (police, courts) were in general not available at the time of RA data extraction to determine whether the presumed diagnosis or initial

assessment was confirmed. For ease of description in abstract and manuscript, we use the term 'caused by x' instead of 'presumed assault by x'.

Epidemiology codes

We used epidemiology codes based on Victorian government codes17 that included activity, place, mechanism of injury and human intent. Codes were assigned by trained RAs at each site based on information recorded by the clinician at the time of the ED visit and by RAs during the follow-up call. Table 1 shows the human intent codes used. We combined the small number of cases of intentional HIs due to self-harm, legal intervention and other causes into a category of 'other intentional injuries' to avoid case identification.

Statistical analysis

Data were entered into Epidata (The Epidata Association, Odense, Denmark), and later REDCap,20 and analysed using Stata 13 (StataCorp, College Station, TX, USA).

Results

Of the 20 137 head-injured children recruited, we identified 372 children (1.8%) who had suffered intentional injuries, based on clinician suspicion or RA-assigned epicodes (Fig. 1). Injuries caused by caregiver (103, 27.7%) was most common, followed by injuries caused by peers (97, 26.1%), siblings (47, 12.6%), street attacks by strangers (35, 9.4%), attacks by person with unknown relation to the patient (21, 5.6%) and other intentional injuries (8, 2.3%). In 61 cases (16.4%), human intent could not be determined (Fig. 1). Overall, 66.9% of victims were male, and in every category of intentional injuries, male victims predominated with largest male dominance in adolescent peer injuries and street attacks (Table 2).

In children <2 years, caregiver assault accounted for 89.7% of intentional HIs. In the age group of 2 to 10 years, intentional injuries were mainly caused by peers (47.1%) and siblings (29.4%) and less by caregivers (20.0%). In children aged 11 to 18 years, injuries were predominantly peer assaults (41.0%) and attacks by strangers (25.2%). Children aged <2 years accounted for 75.7% (78 out of 103) of cases of caregiver assault and only 4.9% (9 of 208) of cases of assault by other perpetrators (Fig. 2, Table 2). None of the HIs was caused by gunshot wounds.

Where the place of injury was specified, the places where the highest number of intentional injuries occurred were school grounds and home living area (Fig. 3). Victims of assault by caregivers underwent CT in 68.9% (71 out of 103) of cases, and 69.0% (49 of 71) were abnormal. The most common injuries were skull fractures (69.4% of abnormal CT scans) and intra-cranial haemorrhage/contusion (61.2%). Of children and adolescents attacked by strangers, 37.1% (13 of 35) had a CT scan, and 15.4% of these scans were abnormal.

Out of 97 peer-injured children, only 18 (18.6%) underwent CT, and in 27.8% of these, abnormalities were detected. Only 1 out of 47 children injured by their siblings underwent a CT scan (Table 3, Fig. 4).

Major signs and symptoms are shown in Table 2. A high rate of known or suspected loss of consciousness was found in attacksby strangers (51.4%) and attacks by persons with unknown relation to the patient (42.9%).

Admission rates varied from 77.7% for injuries caused by caregivers, 37.1% attack by strangers, 23.7% by peers and 8.5% by siblings. About 22% of injuries by caregivers were categorised as ciTBI. Three cases (3.0%) of injury by peers were the only other cases with an injury meeting our ciTBI definition. There were two fatalities

(1.9%), both from injury by caregivers (Table 2). Peer assault occurred mainly on school days (93.8%), assault y strangers peaked on weekends, especially on Saturdays (28.1%), whereas caregiver assaults presented evenly across the days of the week. In terms of reported time of injury, peer injuries peaked between 10.00 and 15.00 hours, whereas most siblinginjuries occurred after school between 16.00 and 21.00 hours (Fig. 5). In assaults by caregivers, the timing of the injury was missing in 27.2%.

Discussion

In this large multicentre prospective data set, we have provided detailed information about intentional HIs in children and adolescents presenting to EDs. In this population, intentional HIs were infrequent, accounting for only 1.8% of all His presenting to major EDs in Australia and New Zealand. Adolescents aged 11–18 years were most likely to sustain intentional HIs overall. The most common perpetrators were caregivers in young children and peers in adolescent patients. The rate of intentional injuries in the present study was similar to the 3.3% reported in an earlier retrospective review of head-injured children presenting to one of the tertiary referral centres included in the present study in 2004.8

Although CT imaging was completed based on the concern of individual clinicians for intracranial injury and in assaults by caregiversmay also have been driven by local protocols or practices for the work up these patients. Detected abnormalities and the uneven distribution of ciTBIs and fatalities show that the severity of injuries are associated with the perpetrator and the age of the child victim. Assaults by caregivers were associated with moresevere injuries, whereas injuries inflicted by peers and siblings were less likely to involve detectable cranial or intracranial abnormalities.

This is broadly in keeping with several studies reporting higher severity of TBI associated with caregiver assaults compared with accidental injuries21 and research showing that paediatric trauma caused by child abuse is more severe than trauma from other causes.1

Assaults by strangers or persons with unknown relation to the patient were associated with a higher rate of CT scanning compared with attacks by peers or siblings (20/56 [35.7%] vs 19/144 [13.2%]). Yet, the rate of abnormal neuroimaging was about the same in these groups (3/56 [5.4%] vs 6/144 [4.2%]), and symptoms were similar between the two groups. The reasons for the higher rate of CT scanning are unclear. However,

those attacked by a stranger or a person with unknown relationship were older and less likely to have a fall as mechanism of their HI.

There were very obvious relationships between age at injury and type of intentional injuries. The median age for suspected assault by caregiver was 0.8 years, by peer 13 years and by stranger 15 years, whereas the median age for non-accidental trauma overall was 4 years. This is consistent with studies of paediatric trauma, which have reported that caregiver abuse almost exclusively occurs during the first years of life, whereas peer and stranger assault is more common in teenagers.1,5

Almost all intentional peer injuries happened during weekdays at school. In some cases, bullying was explicitly mentioned in the CRF, yet this information was not systematically elicited. In the clinical setting, it is important to consider and ask about this issue, as bullying victimisation may also be associated with a high level of psychosomatic or psychosocial health problems.22 Most incidents occurred during lunchtime.

Locations of assaults by strangers included street, railway station and park and most frequently happened during the weekend. Assaults by caregivers were characterised by a high rate of unknown place and time (27.2%) recordings. This is consistent with a missing, vague, variable or possibly false history provided by caregivers and an inability to gain this information accurately from young children and infants. This is also in keeping with Hettler and Greenes' finding that no history of trauma had a high specificity for the detection of injuries inflicted by caregivers.23 In young patients with HI and unclear history of trauma, clinical prediction rules for AHT may assist clinicians in deciding which patients to evaluate for abuse.20,24 A striking finding in our data set is the complete lack of gunshot wounds among the over 20 000 children enrolled in APHIRST.

Limitations

The present study has several limitations. It relies on epidemiology coding by trained site RAs, which is dependent on the accuracy and detail of the history recorded by nursing and medical staff during the ED and hospital stay. We included all cases in which assault by the caregiver was considered and/or investigated, not cases in which abusive head trauma was confirmed. This methodology varies from many previous reports on child abuse that have included only cases of confirmed AHT. The finding that injuries are especially severe in children abused by caregivers could be influenced by an increased consideration of suspected abuse in severely injured children. It is also possible that patients with intentional HIs were not identified by clinicians as such and assumed to be non-intentional HIs on the basis of a false history by the caregiver or the patients. Furthermore, a small number of caregiver assaults may have presented with HIs in the care of child protection officers or caregivers who may have declined consent, or were unable to give consent to participate in the study. In addition, children assaulted by caregivers may also have been admitted with initial medical diagnosis and diagnosed as intentional injuries later in the hospital course. Our study would not have identified these children as our entry point was the ED setting. Although we included all assaults by siblings and peers, the perpetrators may have been relatively young; we were unable to determine at what perpetrator age these should be considered genuine safeguarding concerns.

Conclusions

Intentional HIs are infrequent in children presenting to the ED in Australia and New Zealand. The most frequent causes are assault by caregivers and by peers. Suspected assaults by caregivers are associated with high rates of CT abnormalities, ciTBI and mortality.

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Author contributions

FEB conceived the study, obtained grant funding, designed the study, provided overall supervision, interpreted the data, gave final approval to be published and agreed to be accountable for all aspects of the work. HP identified the patients for this secondary analysis, wrote the initial draft and revised the article. SRD, EO, VA, MLB, NP, AK, SD, JAC, YG, JF, JN, MDL, SB and LC designed the study, obtained the data, provided supervision, interpreted the data and drafted or revised it critically. SD and SJCH designed the study, analysed the data, contributed to the interpretation of the data and revised the paper critically.

Competing interests

None declared.

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