

Head Trauma in Paediatric Patients Referring to a Spoke Hospital

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Abstract: *Introduction:* Head trauma (HT) is a leading cause of morbidity and mortality in children worldwide. The primary aim of this study was to describe patients presenting to our first-level Emergency Department (ED) following a HT. The secondary aims were to compare both the epidemiology and the management of paediatric patients with literature data, analyzing the appropriateness of management of children's traumatic brain injuries according to the current guidelines.

Methods: We conducted a retrospective review of medical records of patients aged < 14 years who attended our first-level ED due to head trauma from July 1, 2021, and June 30, 2022. Clinical data, including age, gender, injury mechanism, location of trauma, time from traumatic event and ED arrival, symptoms at first evaluation, physical examination findings, radiological investigation results, medications administered in ED and prescribed at home, and outcome were collected and compared with data available in literature and current guidelines.

Results: A total of 117 children aged < 14 years who attended our first-level ED due to head trauma from July 1, 2021, and June 30, 2022, were analyzed. Most of them were males aged 1-3 years. Frontal bone was the commonest side of trauma (43% of HT). Only eleven patients (9%) had a brain CT scan and 4 of them showed pathological findings. None had signs of bleeding. Four of the patients were transferred to a HUB hospital, provided with a paediatric neurosurgery and more important none of them has developed neurological sequelae or death.

Discussion: Our 1-year observation of HT showed how this is a frequent indication for ED referral, especially in young children. In our hands less than 10% of cases required CT scan that reported pathological cases in 4 patients only (3%). We can conclude that the reduction of ionizing radiation exposition can be obtained with skilled experienced physicians.

Keywords: Computed tomography (CT) scan, Paediatric head trauma (HT), Traumatic head injury, First-level emergency department (ED).

INTRODUCTION

Head trauma (HT) represents a frequent cause of Emergency Department (ED) visits and hospitalizations in children worldwide, and traumatic brain injury is an important cause of paediatric death and disability [1]. Every year an estimated 475,000 children in the USA apply to an ED because of an accidental HT, of which up to 90% are discharged home with mild injuries. Over 30,000 children are hospitalized and almost 3,000 dies because of their injuries [2]. European data about brain injury are even more warning, probably due to the differences in the National Health System policy and the following bigger facilities to access the ED [3]. Data collected in the UK show that approximately 350,000 children are admitted to the ED for head injury every year, and this is in line with what is estimated in Italy, where around 300,000 paediatric patients per year

attend the ED [3]. Common mechanisms of injury include falls, motor vehicle accidents, and acts of violence.

Closed HT has been historically classified as mild, moderate, or severe based on the Glasgow Coma Scale (GCS) score, whereas penetrating HT is less common and is always considered severe. Although the majority of accidental paediatric HT is mild (defined by a GCS of 14 or 15 [4, 5]. Children with brain injuries who require neurosurgical treatment should be quickly identified, leading to diagnostic challenges for physicians who handle children with head traumas. Computed tomography scan (CT-scan) of the head is the gold standard for identifying complications from traumatic brain injuries [6], but it should ideally only be performed in carefully selected patient groups as ionizing radiation is associated with an increased risk for leukaemia and brain tumours as a late effect [7]. Therefore, the primary objective in the emergency management is to reliably diagnose the small fraction of children with brain injuries, but also to avoid excessive radiation caused by CT-scanning.

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There are different guidelines available for the management of brain trauma and variable CT indications [8-10], and few of them validated for the paediatric population are about minor HT [6]. In 2018 Italian guidelines for assessment and management of paediatric head injuries were published [11], but only few clinical studies about paediatric head trauma have been documented [12]. Moreover, paediatric epidemiological data are often incomplete.

The primary aim of this study was to describe patients presenting to our first-level ED following a HT. The secondary aims were to compare the epidemiology and management of paediatric patients with literature data and analyze the appropriateness of management of children's traumatic brain injuries according to the current guidelines.

PATIENTS AND METHODS

We conducted a retrospective review of medical records of paediatric patients who attended our first-level ED because of HT from July 1, 2021, and June 30, 2022. Patients aged under 14 years, who were referred to our centre because of HT during the study period were included in the study. Criteria for exclusion were: 1) patients older than 14 years, 2) no clear history of trauma as primary event (e.g., primary seizure) and 3) patients returned for reassessment of the same head injury.

Clinical data, including age, gender, injury mechanism, location of trauma, time from traumatic event and ED arrival, symptoms at first evaluation, physical examination findings, radiological investigation results, medications administered in ED and prescribed at home, and outcome were collected. Data was filled using Microsoft Excel software.

The choice to perform head CT-scans was taken according to Italian guidelines on the assessment and management of paediatric head injury in the emergency department [10], to help in the diagnosis and reduce the need for head CT-scans.

Head CT scans were examined by local radiologists and were considered positive for traumatic brain injuries if they showed any pathological finding (e.g. skull fracture, subdural, epidural, subarachnoid bleeding) not attributable to events other than trauma.

In accordance with current legislation, this research is not among the types that require a formal opinion from the ethics committee. This is a secondary use of data for research purposes for which a specific informed consent was requested ab initio from patients who would undertake a treatment process. All parents or legal guardians gave written consent for the anonymous collection of their children's information.

Univariate analysis was performed with the Chi-square or Fisher's test for dichotomous variables while for continuous variables the Kruskal-Wallis test for nonparametric measures was used. The univariate analysis was conducted by VassarStats (Statistical Computation Web Site). The P-value below 0.05 was defined as statistically significant.

RESULTS

During the study period, 3246 patients were evaluated in our paediatric ED. Among these, 117 children (4% of all) reported a HT.

Patients Features

Most were boys ($n = 81$, 69% of all) and 36 were girls (31% of all, $P < 0.0001$). The mean age of our

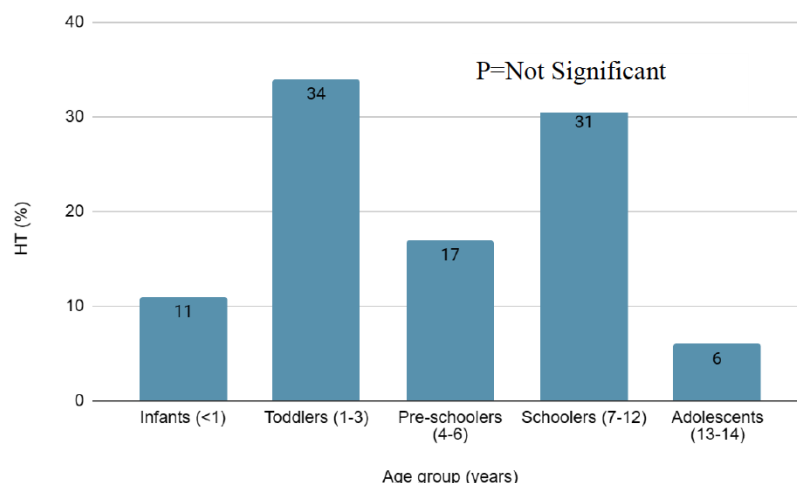


Figure 1: Age distribution of paediatric HT patients accessed to our ED.

cohort patients was 66.6 months (range 5-170 months). The most common age group was represented by toddlers (1-3 years old, 34%), followed by schoolers (7-12 years old, 31%), as shown in Figure 1. No newborns (aging from 0 to 1 month) applied to our ED due to HT during the analyzed period. The analysis of the patient's gender distribution and the age had not allowed to highlight statistically significant differences ($P=0.57$).

Eighty-two percent of total HT were triaged as green colour (less urgent), 8% as orange, and only 1 case (1% of all) was triaged as red. Figure 2 shows triage colour-tag distribution.

Thirty-seven patients (32% of all) had already recorded one or more accesses to our ED due to HT. Only 8 children presented comorbidities (e.g., Arnold-Chiari malformation, epilepsy, Turner syndrome and congenital cardiopathy); none of them had coagulopathy or cerebral ventricular shunts.

Seasonal Distribution of HT

We recorded two seasonal peaks in HT ED visits: a first during spring months (from March to May) and another one in October. ED visits due to HT were less common in summer months (from June to August), as shown in Figure 3 ($P=0.0016$).

Trauma Characteristics

The most common place where HT occurred was home (48%) followed by school (20%) and street (6%). Other settings of trauma included a playground and

sports field. In 22% of cases the place of HT was not known.

Most injuries ($n = 74$, 63% of total) were fall-related, mostly from furniture (e.g., bed, changing table, sofa, baby hammock) ($n = 26$; 35%) or a stroller ($n = 6$; 8%). The second most common cause of injury was direct impact with an object or person ($n = 20$; 17% of all). In two cases trauma were due to motor vehicle accidents and one case was suspected of physical abuse. In 20 cases, the cause of trauma was not known. There were no significant differences between patient age and the cause of the injury.

Most children ($n = 65$, 88% of all fall-related head traumas) fell onto a hard surface (e.g., tile, parquet, asphalt, bathtub).

Frontal/facial was the most common skull impact site ($n = 50$; 43% of total) followed by occipital ($n = 14$; 12%), and parietal/temporal ($n = 9$; 8%). The site of impact was not known in 42 children (36% of all).

The median time from traumatic event to ED arrival was 1,5 hours (ranging from 0,5 to 96 hours). The data was not available in 54 cases. One hundred and nine children arrived at the hospital with their caregiver's, means of transport while 8 patients were transported by ambulance.

Clinical Features

Most patients ($n = 114$, 97% of all) reported a minor HT. Among these, 112 children presented a GCS of 15, and 2 children had a GCS of 14 when visited. Two

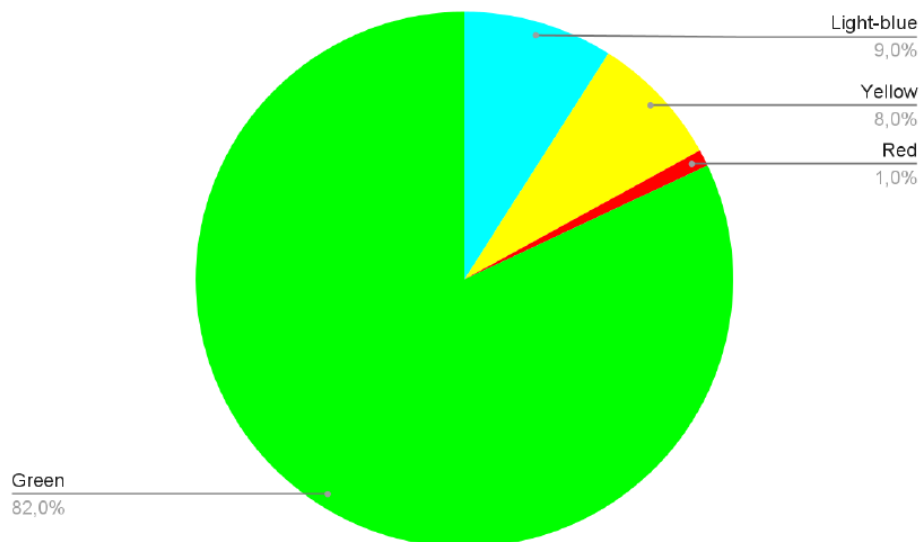


Figure 2: Triage colour-tag distribution.

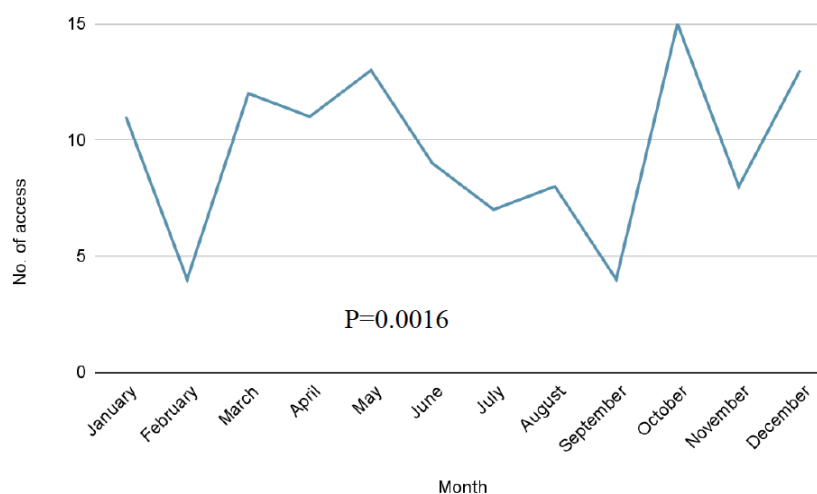


Figure 3: Seasonal distribution of ED access because of HT.

patients had a GCS of 13 and only one patient reported a GCS less than 13 when they arrived at our ED.

Sixty-four children who had a HT (55% of total) reported no symptoms related to the trauma. In 8 children (7%) transient loss of consciousness after trauma was reported concussive head trauma. Signs and symptoms on physical examination are shown in Table 1.

Table 1: Reported Symptoms and Signs on Physical Examination

Symptoms	No. (%)
Asymptomatic	64 (55)
Vomit	23 (20)
Headache	17 (14)
Concussive head trauma	8 (7)
Pain in trauma site	8 (7)
Drowsiness	5 (4)
Parent-reported changes in behavior	5 (4)
Visual impairment	3 (3)
Signs	No. (%)
No signs	35 (30)
Erythema or laceration on the head or face	43 (37)
Scalp hematoma	19 (16)
Glasgow Coma Scale of 14 or less	5 (4)
Palpable skull fracture	1 (1)
Bulging fontanel	0

Most children (95% of total number) were discharged home from ED; 8% of them were discharged after a brief intensive observation lasting from 6 to 96 hours.

Only two patients were admitted to our paediatric ward needing an observation longer than 96 hours, and 4 patients (3% of total) were transferred to a tertiary referral hospital provided with a paediatric neurosurgery.

Fourteen children underwent sutures in the ED, but local anaesthesia was administered to only 7 of them (50%). Only 12 patients (10% of all) were discharged with prescription of analgic therapy (acetaminophen or ibuprofen) at home, while only 5 patients (4% of all) were administered analgic therapy directly in the ED (mostly acetaminophen) to treat pain symptoms. Three patients were treated with ondansetron in the ED due to repeated vomits. No other medications were administered or recommended at home.

Imaging

Eleven children (9% of all) underwent brain CT-scan: among these, one had been triaged as red-coloured tag, 4 as yellow-coloured tag, and 5 as green-coloured tag on arrival to the ED. All patients who underwent brain CT-scan had neurological symptoms (e.g., repeated vomits, headache, mental confusion, drowsiness, or visual impairment), except for one child who was asymptomatic and underwent head CT because of the fall dynamics (fall from higher than 1,5 meters). Among the 106 children who did not undergo head CT, 35 (33%) presented at least one neurological symptom but had no other criteria to undergo imaging.

The analysis of the CTs performed according to the age did not allow to show statistically significant differences ($P=0.19$), as well as statistically significant differences between the sex of the patients and the indication to perform CT-scans ($P=0.99$).

Abnormal imaging findings were detected in 4 cases (37% of all brain CT executed). The most common findings were fractures, detected in 3 patients (75% of all children with abnormal radiologic findings), while subdural hematoma was detected in two patients. Intracerebral hemorrhage were not detected in any patient. All children with abnormal radiologic findings were male and reported HT caused by falls onto a hard surface. Three of them reported a mild HT (GCS 14 or 15), while one child reported a moderate head trauma, presenting a GCS of 13. Three patients with abnormal radiological findings on brain CT-scan reported at least two neurological symptoms, while the fourth patient had no symptoms. Characteristics of patients who reported abnormal CT findings are resumed in Table 2.

Brain CT-scan executed in the only child arrived at our ED with a red-colored tag triage, who was unconscious and presented with repeated vomits, did not detect any brain nor skull abnormal findings. This can be explained by the early execution of the radiological imaging from the trauma.

DISCUSSION

Head is the most common site of trauma in children, representing an important cause of death and disability worldwide [1-2]. However, only a small fraction of HT is associated with intracranial injuries, while the vast

majority is uncomplicated and do not require intervention [13]. The need to identify potentially treatable injury must be carefully evaluated, considering the risks derived by performing unwarranted imaging studies that imply radiation exposure with potential risks, especially for children [7].

Overall, the incidence of ED visits due to HT in our study was lower than those reported in studies from England, Wales, and the United States [14,15]. These differences could be explained by differences in organization of health care systems or differences in safety awareness by parents and differences in mandatory safety measures between countries, leading to fewer and less severe traumas.

According to GCS and the rate of normal CT-scan, the majority of the children included in our study reported mild HT, with no brain or skull injuries. Several studies identified infants and adolescents as having a higher incidence of HT [16, 17], while in our study populations these two age groups were the least represented.

Payne *et al.* found that the most common aetiology of HT in children younger than 2 years old was a fall at home. In that study, child abuse accounted for 7% of head injuries [18]. In our study, the main cause of HT was also falling at home, especially in children aged 0-3 years old, but child abuse was not reported as a frequent cause of HT. We found that falls from furniture were the most common trauma mechanism in patients with head injuries.

Table 2: Characteristics of Patients who Reported Abnormal CT Findings

Age (years)	Gender	Injury mechanism	Transient loss of consciousness	Colored-tag triage	Symptoms	Signs	GCS	Brain CT findings
2	male	falling off the bike	yes	yellow	repeated vomits, drowsiness	depression on temporal region	14	parietal fracture and subdural hematoma
3	male	fall from higher than 1,5 m	yes	yellow	drowsiness, headache	drowsiness, hyporeactivity	13	frontal fracture
8	male	fall from higher than 1,5 m	no	light blue	none	occipital lacerated bruised wound	15	subdural hematoma
12	male	stumbling on the ground	no	green	repeated vomits, headache	parietal-occipital oedema	15	occipital fracture

A recent Swedish study on a paediatric population of more than 5,000 children applied to ED due to HT reported a percentage of head CT-scan of 5.4%, with a rate of abnormal CT findings of 0.37% [19]. This study reported rates of CT-scanning and incidence of intracranial injuries lower than those reported in several previous studies [13, 20, 21].

In our study, 9% of all children (n = 11) who applied to our ED underwent head CT-scan, according to Italian guidelines [11]. Abnormal imaging findings were detected in 4 cases, corresponding to 37% of all brain CT executed. Among all, only two patients returned for reassessment of the same head injury, after 24 and 96 hours respectively. None of them showed neurological symptoms or signs nor underwent a CT-scan when reassessed. Despite the small number of patients included in our study, we recorded a high guideline adherence with a consequent high appropriateness of execution of CT-scan, with a high rate of abnormal imaging findings, even if we performed CT-scan compared to literature.

The limited number of the sample is the most relevant limitation of the present study. In addition, the retrospective nature of data collection represents another limitation. There is a risk of information bias which prevents us from drawing more than cautious conclusions from this study.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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Received on 06-12-2023

Accepted on 08-01-2024

Published on 15-01-2024

DOI: <https://doi.org/10.12974/2311-8687.2024.12.01>© 2024 Ragusa *et al.*

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