Epidemiology of severe head injuries in children: 15 years' experience in a pediatric polytrauma unit

Epidemiología del traumatismo craneoencefálico grave pediátrico: 15 años de experiencia en una unidad de politraumatismos infantil

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Severe traumatic brain injury (TBI) is a health and socioeconomic problem worldwide. In developed countries, it is the main cause of death and disability in children over one year of age. In Spain there is no national registry, so a study was carried out to determine the epidemiology of severe pediatric TBI in our environment and its injury mechanism.

A retrospective, observational, descriptive, descriptive cohort study was carried out. Patients with severe TBI who were admitted to a pediatric intensive care unit (PICU), benchmark in the care of polytraumatic children, of a tertiary hospital in the Community of Madrid, during 15 years (from October 2002 to October 2017) were included. The unit admits patients from 0 to 18 years of age, and is the only one in the center that cares for polytrauma patients requiring intensive care. To categorize TBI as severe, Glasgow Coma Scale (GCS) score in prehospital and in-hospital care (GCS < 9) was assessed. Patients with incomplete data and those deceased due to extracranial traumatic injury or unknown cause were excluded. Age, sex, nationality, place of trauma, month of the year, day of the week, mechanism of injury, type of injury on cranial computed tomography (CT) and deaths were analyzed. Quantitative variables were described with measures of centralization and dispersion: mean, standard deviation (SD), median and interquartile range. Qualitative variables were described using absolute (n) and relative (%) frequencies. The analysis was performed with the SPSS version 20 statistical package.

Ninety-eight cases were included with 61.2% (60) being male. Patients were grouped by age range: 19.4% (19) were younger than 2 years, 40.8% (40) between 28 years and 39.8% (39) older than 8 years. The median age of the entire sample was 6.4 years (IQR 2.49-11.23). The months with the highest incidence were September, May, June and December. Forty-six percent of the admissions occurred during weekends (Friday through Sunday). Most accidents occurred in the city/street (41; 41.8%) or home (38; 38.7%). Less frequently, they occurred on the road (9), school (7), field (1), swimming pool/beach (1) or park (1). Falls were the most frequent injury mechanism (40.8%; 40 of the 98). Of these, 50% were due to falls from a window (20/40). The rest of the falls were caused by diverse mechanisms: from their own height (4), from a bed (2), walker (1), skateboard (3), arms of another person (3) and others (7). The height of the fall was recorded in 30 cases, and 70% were higher than 3 meters (21/30). The second most frequent

Table 1. Mechanism of injury and findings in cranial computed tomography

Lesional mechanism	Findings in the brain CT							
	Cranial fracture	EDH	SDH	SAH	IVH	Brain contusion	Brain edema	DAL
Fall	70% (28/40)	15% (6/40)	45% (18/40)	25% (10/40)	10% (4/40)	47.5% (19/40)	25% (10/40)	5% (2/40)
Hit and run	59.4% (19/32)	6.3% (2/32)	25% (8/32)	25% (8/32)	15.6% (5/32)	46.9% (15/32)	21.9% (7/32)	25% (8/32)
Car accident	22.20% (2/9)	0% (0/9)	22.2% (2/9)	0% (0/9)	0% (0/9)	33.3% (3/9)	22.2% (2/9)	22.2% (2/9)
Mistreatment	25% (1/4)	0% (0/4)	100% (4/4)	50% (2/4)	0% (0/4)	25% (1/4)	75% (3/4)	0% (0/4)
Bicycle accident	100% (3/3)	33.3% (1/3)	66.7% (2/3)	0% (0/3)	0% (0/3)	0% (0/3)	33.3% (1/3)	0% (0/3)
Total	**60.2% (53/88)**	**10.2% (9/88)**	**38.6% (34/88)**	**22.7% (20/88)**	**10.2% (9/88)**	**43.2% (38/88)**	**26.1% (23/88)**	**39.8% (12/88)**

CT: computed tomography; EDH: epidural hematoma; SDH: subdural hematoma; SAH: subarachnoid hemorrhage; IVH: intraventricular hemorrhage; DAI: diffuse axonal injury.

mechanism of injury was run over (32.7%; 32/98). Accidents as a vehicle occupant accounted for 9.2% (9/98), mistreatment 4.1% (4/98) and bicycle accidents 3.1% (3/98). Others less frequent were impact of an object against the head, sports accidents or assault. Of the 9 patients who suffered a car accident, 6 were not wearing child restraint systems. The relationship between the mechanism of injury and CT findings was studied. In 76.5% of cases (75/98) there was an intracranial injury (Table 1). Sex, lesional mechanism, intracranial injury and deaths were analyzed according to age group (Table 2). A total of 14.3% of the patients (14/98) died (Table 3).

Severe TBI in children has an important health and socioeconomic impact. Despite this, epidemiological studies to adapt preventive measures are scarce and heterogeneous. Our series included 98 cases and, as in other series, it was more frequent in boys[1-5]. In terms of age, the most affected group was 2 to 8 years of age, which does not coincide with the literature, which describes a bimodal distribution, with maximum incidence peaks in children under 2 years of age and in adolescents[5].

Most injuries occurred on the street or at home, mainly on weekends and during the months of May to September, similar to other series. Overall, falls were the most frequent mechanism followed by road traffic accidents, while car accidents were uncommon in all age groups. These results are in line with other series in that falls are the main mechanism in children under 8 years of age[4,5] and hit-and-run more frequent in children under 2 years of age[5-7]. However, the incidence of car accidents is lower than in other publications[5,8] and the high number of patients who fall from a window is noteworthy.

From the analysis of the data, it is clear that there are two mechanisms that should be prioritized in prevention policies: run-overs (aged 8 years or above) and falls (aged 8 years or below), especially falls from a window. In 1976, in New York, a preventive program called "Children can't fly" was carried out with the aim of reducing the incidence of child falls. It included an educational campaign directed at parents, the distribution of free window safety systems, a legislative change that required the installation of protection systems in buildings where children under 10 years of age lived, and the registration and reporting of all cases. This program reduced accidents by 50% by this mechanism[9].

On the other hand, the mechanism may favor the appearance of a specific type of intracranial lesion, which is important from a clinical and surgical point of view. From a public health point of view, it is essential to know the causes of injury in order to plan specific preventive measures. Bearing in mind that TBI is the main cause of pediatric morbidity and mortality in developed countries, it would be important to establish a Spanish registry system. In our center, the most frequent cause is falls and, within these, falls from a window, so it is necessary to direct measures to their prevention.

As limitations of the study we should point out that it was observational, retrospective and single-center. Patients who died prior to arrival at the ICU were not included, as these would probably be the most severe and could alter some of the results. As this was an epidemiological study, the long-term sequelae of the survivors were not described. The data were obtained from the review of patients' medical records, which implies the possibility of missing data or errors in their interpretation. Subsequent multicenter and prospective studies could overcome these limitations.

Table 2. Results by age group

	Cases	Sex (males)	Most frequent lesional mechanism	ICL	Deaths
< 2 years	19.4% (19/98)	57.9% (11/19)	Falls: 68.4% (13/19) Abuse: 21.1% (4/19)	84.2% (16/19)	21.1% (4/19)
2-8 years	40.8% (40/98)	57.5% (23/40)	Falls: 45% (18/40) Hit and run: 32.5% (13/40)	75% (30/40)	12.5% (5/40)
> 8 years	39.8% (39/98)	66.7% (26/39)	Hit and run: 48.7% (19/39) Falls: 23.1% (9/39)	74.4% (29/39)	12.8% (5/39)

ICL: intracranial lesion.

Table 3. Characteristics of the 14 deceased patients among the 98 that make up the current series

	% (n/total)
Sex (male)	64.3% (9/14)
Age [(median (IQR)]	5 (2-10)
Age group	
– < 2 years	28.6% (4/14)
– 2-8 years	35.7% (5/14)
– > 8 years	35.7% (5/14)
Injury mechanism	
– Fall	57.1% (8/14)
– Precipitation from window	35.7% (5/8)
– Hit-and-run	21.4% (3/14)
– Car accident	7.1% (1/14)
– Mistreatment	7.1% (1/14)
– Scooter	7.1% (1/14)
ICL (100%. 14/14)	
– Brain edema	85.7% (12/14)
– SDH	78.6% (11/14)
– Brain contussion	57.1% (8/14)
– SAH	50% (7/14)
– IVH	42.9% (6/14)
– DAL	21.4% (3/14)
– EDH	7.1% (1/14)

ICL: intracranial lesion; EDH: epidural hematoma; SDH: subdural hematoma; SAH: subarachnoid hemorrhage; IVH: intraventricular hemorrhage; DAL: diffuse axonal lesion.

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