



ARTIGO

PEDIATRIC HEAD TRAUMA: A DESCRIPTION OF CAUSES, NEUROLOGICAL MORBIDITY AND INPATIENT MORTALITY IN A REFERENCE CENTER IN NORTHEASTERN BRAZIL***TRAUMATISMO CRÂNIO-ENCEFÁLICO PEDIÁTRICO: CAUSAS, MORBIDADE NEUROLÓGICA E MORTALIDADE HOSPITALAR EM UM CENTRO DE REFERÊNCIA DO NORDESTE DO BRASIL***QUÉZIA MENDONÇA DA SILVA¹, IGOR LIMA MALDONADO²

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RESUMO

O impacto socioeconômico de crianças portadoras de sequelas de traumatismo crânio-encefálico (TCE) é um importante problema de saúde pública. Neste estudo retrospectivo, foram avaliadas as causas, a morbidade neurológica e a mortalidade do TCE pediátrico, durante o período de permanência hospitalar em um centro de referência no Nordeste do Brasil. Foi examinada uma amostra aleatória de 282 prontuários em um período de doze meses. As características das vítimas, os mecanismos de trauma e os resultados dos exames de imagem foram analisados. A ocorrência dos seguintes desfechos clínicos neurológicos foi contabilizada durante toda a internação, a saber: déficits motores, distúrbios de linguagem, convulsões, fístulas líquóricas clinicamente detectáveis ou morte. A faixa etária mais afetada foi a dos lactentes (41,5%), a causa mais frequentemente relatada foi queda (76,5%) e a maioria das crianças foi vítima de TCE leve (96%). Um total de 11,7% dos exames de tomografia computadorizada mostrava lesões traumáticas, com fraturas em 43,6% delas. Treze crianças apresentaram os desfechos clínicos de morbidade e mortalidade acima mencionados. A crise convulsiva (n=9) foi o mais frequente. A faixa etária com maior incidência foi mais uma vez a dos lactentes (n=6). Para os mesmos desfechos, a morbi-mortalidade foi de 4,6% para a série como um todo e 44,4% para casos de trauma moderado ou grave. A taxa de mortalidade acumulada ao final do período de internação foi de 1,1%. De acordo com os dados do presente estudo, as quedas são a principal causa relatada de TCE pediátrico na unidade estudada. Um total de 4,6% das vítimas apresentou desfechos clínicos de morbi-mortalidade durante a internação, sendo convulsão a mais frequente.

Palavras-chave: Lesões encefálicas; Pediatria; Morbidade; Mortalidade; Traumatismos craniocerebrais.

ABSTRACT

The socioeconomic impact of children with sequelae of head trauma is an important public health concern. This retrospective study assessed the causes, the neurological morbidity and the mortality of pediatric head injury during the hospital stays in a referral center in northeastern Brazil. A random sample of 282 medical records of pediatric head trauma cases from a twelve-month period was examined. Patient characteristics, mechanisms of trauma and imaging results were retrieved, and the occurrence of motor deficits, language impairment, cerebrospinal fluid leak seizures or death was assessed during the whole hospital stays. The most affected age range was that of infants (41.5%), the most frequent reported cause was fall (76.5%) and most children were victims of mild brain injury (96%). A total of 11.7% of the computerized tomography examinations showed traumatic injuries, with fractures in 43.6% of them. Thirteen children presented with the above-mentioned endpoints of morbidity and mortality. Seizure (n=9) was the most frequent one. The age range with the highest incidence was also that of infants (n=6). For the same endpoints, the clinical morbid-mortality was 4.6% for the whole series and 44.4% for moderate and severe trauma. The mortality rate at the end of the period of hospitalization was 1.1%. According to the data from the present study, falls were the main reported cause of pediatric head trauma. A total of 4.6% of victims presented with neurological endpoints of morbid-mortality during the hospital stay and seizure was the most frequent one.

Keywords: Head injury; Pediatrics; Morbidity; Mortality; Traumatic brain injury.



INTRODUCTION

The sequelae resulting from Traumatic Brain Injury (TBI) are variable. Physical disabilities, such as motor deficits, are the most apparent in the acute phase; though the others may also have significant impact on quality of life¹⁻⁶. Cognitive disabilities lead to problems with memory, attention, learning and language, while behavioral-emotional ones produce loss of self-confidence, irritability and aggressive behavior. Additional important complications are seizures and cerebrospinal fluid (CSF) fistulas^{3,7}. They are usually considered as criteria for high-risk Head Trauma (HT) in emergency patients.

TBI is a major cause of death during childhood and adolescence in developing countries. Advances in hospital and pre-hospital care have decreased the mortality rates. However, without similar results in the preventive domain, the morbidity of traumatic brain injury (TBI) seems to rise^{1,2}. The socioeconomic impact of children with disabling neurological sequelae is significant. The victims need medical attention and are often unable to pursue a salaried occupation in the future, requiring special attention from caregivers. It represents a chronic source of costs to the health system and loss of economically active individuals.

Considering these facts, understanding the profile of presentation and the morbidity of HT is a very important subject in public health sciences and health policy. In this context, the present study assessed the causes, the neurological morbidity and the mortality of pediatric HT during the hospital stays in a reference center within the public network of Salvador, the capital of the Bahia state in northeastern Brazil. Salvador is the fourth-most populated city in the country. The medical center where the study was conducted is relatively recent (2010) and receives patients coming from other places within the state, which accounts for approximately 15 million inhabitants. Since the epidemiologic characteristics and outcomes of pediatric HT have been relatively poorly documented in this region of the globe, such data are useful for both epidemiological purposes and planning evidence-based preventive measures.

METHOD

This study was conducted at *Hospital do Subúrbio*. This is a general public hospital located in a region of low socioeconomic status, administered by a private entity, equipped with adult and pediatric emergency units. It is also a referral center for trauma patients. Before opening the study, the research project obtained full approval from the administrative services and from the designed Research Ethics Committee, which exempted the need for Informed Consent, as it was to be an observational and fully retrospective study with no intervention or direct contact with patients.

Firstly, a general list of trauma cases was retrieved from the institution's computerized database. Since files are classified according to the International Classification of

Diseases in this database, an extensive search was performed using codes that were compatible to head trauma cases (all codes in the chapters S00-S09, T00-T07, T74.1; W00-W19; X93; X94; X95; X99; Y00 and Y04). Secondly, a subset was taken by simple random sampling. Selected patients were then filtered to compose the final sample according to the following inclusion criteria: to have been admitted to the pediatric emergency department between January 01 and December 31, 2012 (≥ 1 year after the hospital inauguration); to have been admitted as a victim of head trauma; to be aged up to 16 years old at the moment of admission; and to have had a diagnosis of HT confirmed after detailed examination of their medical records. The patients were excluded from the analysis if they had had a previous disabling neurological deficit (e.g.: secondary to cerebral palsy or perinatal anoxia) or if they were victim of an exclusively orofacial trauma, such as trauma of the lip or jaw.

The retrospective review of medical records allowed examination of the following variables: gender, age, range of age (according to the Brazilian Society of Pediatrics, *infant* - up to 2 years-old, *pre-scholar* - 3 to 6 years-old, *scholar* - 7 to 9 years-old, *adolescent* - 10 to 16 years-old); cause of HT, such as fall, abuse (by an individual whose group of age was above of that of the victim), aggression (by an individual from the same group of age), in-car accident or running over; Glasgow Coma Scale (GSC) score; category of HT severity [mild ($GCS \geq 13$), moderate ($9 \leq GCS \leq 12$) or severe ($GCS \leq 8$)], and presence of changes in the cranial Computerized Tomography (CT), such as fractures, hemorrhages, edema or signs of encephalic herniation. Also, the occurrence of the following clinical neurological endpoints was recorded up to the end of the hospital stay: motor deficit, language impairment, cerebrospinal fluid (CSF) leak, seizures and death.

After a pilot study estimated the proportion of pediatric HT cases in that center, the minimum sample size ($n \geq 243$) was calculated using the method of sample size determination for finite populations, so that it would be representative of the entire database of that year. For descriptive statistics, nominal variables were subjected to the distribution of absolute and relative frequencies. Means, standard deviations and ranges were presented for continuous variables. For analysis of the differences in the frequency of events between groups, the chi-square (χ^2) or the Fisher's exact test was used, while setting a confidence interval of 95% and a level of statistical significance $p < 0.05$. Statistical Analysis was performed using the BioEstat software (*Universidade Federal do Pará*, Belém, Brazil and University of Illinois, Chicago, USA) version 5.0.

RESULTS

Between January 1 and December 31, 2012, from 8,834 emergency admissions listed, 2,444 corresponded to the pediatric range. A total of 351 randomly selected records were consulted in detail and 282 met the inclusion and exclusion criteria.

Profile of age, gender and severity of clinical presentation

Among those 282 pediatric victims of HT, the majority were infants, with 117 cases (41.5%), followed by pre-scholars (n=71, 25%), adolescents (n=53, 19%) and scholars (n=41, 14.5%). The mean age was 4.9 ± 4.5 years (mean \pm SD, range 2 months 12 days - 16 years 11 months 30 days). The mode age was 1 year old, with 51 patients at this age. Half of patients were less than three years old and 75% were less than eight years old.

Boys were more frequent than girls ($p=0.028$). The male gender contributed with 59.6% of the occurrences, accounting for 168 cases in the whole sample.

This gender predominance was particularly noticeable in the adolescent group, in which their distribution was significantly different in comparison to other age ranges ($p=0.032$). In this specific subset, male subjects accounted for 73.6% (Table 1).

Regarding the classification of clinical severity according to the GCS, a total of 271 patients (96%) were victims of mild, 6 (2.1%) of moderate, and 3 (1.1%) of severe TBI. Two patients (0.8%) had no GCS reported in the medical records.

Causes of head trauma

Falls were the most prominent cause of HT, responsible for 216 cases (76.5%), followed by running over (16 cases, 5.7%), car accidents (7 cases, 2.5%) and child abuse (11 cases, 4%). Nineteen patients (6.7%) were victims of trauma by other causes and in another thirteen cases (4.6%) this information was not present in the medical files. Falls were even more common among infants (96.6%). When compared to other age ranges, a statistically significant difference was observed ($p<0.001$). With regard to the eleven cases of abuse, the abuser was a parent or guardian in three cases. Two patients were victims of gunshot trauma.

Of those whose HT had been caused by falling, a total of 52 patients (24.3%) were victims of a fall from height: 40 from a ladder, 8 from a slab and 4 from a tree. There were 49 cases of falls from the patient's own height (22.7%), 28 cases of falling out of bed (13%), 14 cases of falling from a bicycle (6%), 6 cases of falling from someone's arms (3%), 6 cases of falling from a couch (3%) and 27 cases of other falls (12.5%). In 34 cases (15.5%), the exact cause of fall was not specified (Figure 1).

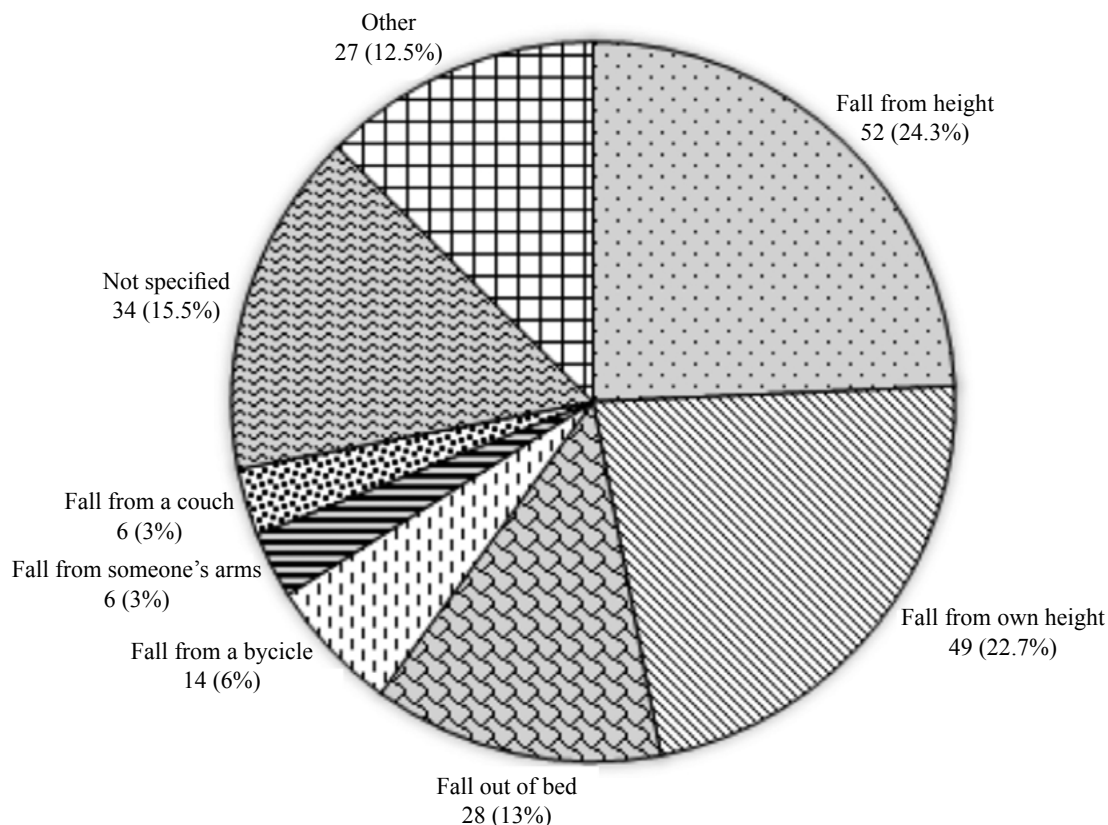


Figure 1. Distribution according to the mechanism of fall of the 216 patients who suffered head trauma for this reason in a random sample of 282 cases

Table 1. Distribution by gender and range of age of a random sample of 282 victims of pediatric head trauma

	Patients (n)	%	<i>p</i> *
Adolescent			
Male	39	73.6%	0.032
Female	14	26.4%	
Scholar			
Male	21	51.2%	0.314
Female	20	48.8%	
Pre-scholar			
Male	43	60.5%	0.955
Female	28	39.5%	
Infant			
Male	65	55.5%	0.301
Female	52	45.5%	
Total			
Male	168	59.6%	-
Female	114	40.4%	

* Reefers to comparison among groups of age

Results of computed tomography examinations

A total of 169 patients (59.9%), had a brain CT performed. Of these, 33 showed signs of acute head injury (19.5%) and six presented with anomalies of non-traumatic nature. Considering the entire sample, 11.7% of patients had visible traumatic lesions in the CT scan.

Table 2. Distribution according to computed tomography (CT) findings of a random sample of 282 victims of pediatric head trauma

Results of CT Scan	Patients (n=282)	%
Fractures	17	6.0%
Subgaleal hematoma	7	2.5%
Cerebral contusion	4	2.5%
Intracranial hematoma	3	1.1%
Soft tissue (extracranial) edema	3	1.1%
Cerebral edema	2	0.7%
Ischemia	2	0.7%
Trauma. subarachnoid hemorrhage	2	0.7%
Other	6	2.1%
No traumatic lesion reported	136	48.2%
Not performed	113	40.1%

The most prevalent lesion type was fracture of the skull. It was present in 17 cases (43.6% of abnormal CTs) of which three were depressed skull fractures. The frequencies of intracranial lesions such as cerebral contusion, intracranial hemorrhage or edema are detailed in Table 2. Extracranial hematomas were also relatively frequently noted (n=7, 17.9% of abnormal CTs).

Clinical endpoints of neurological morbid-mortality

A total of 16 endpoints of clinical morbidity occurred in 13 patients (4.6%) at some point within the period of hospitalization. There were nine cases of seizures (3.2%), two of motor deficit (0.7%), one case of language impairment (0.4%) and one case of CSF fistula (0.4%). The mortality rate at the end of the period of hospitalization was 1.1% (3 cases).

Table 3. Distribution according to clinical outcomes of morbimortality as well as by gender, range of age, etiology of trauma and clinical severity of 13 patients who presented with neurological endpoints in a random sample of 282 victims of pediatric head trauma

	Patients (n=13)	%*
Neurological endpoints		
Seizure	09	69.2%
Motor deficit	02	15.4%
Language impairment	01	7.7%
Cerebrospinal fluid fistula	01	7.7%
Death	03	23.1%
Gender		
Male	09	69.2%
Female	04	30.8%
Age range		
Infant	06	46.2%
Pre-scholar	01	7.7%
Scholar	01	7.7%
Adolescent	05	38.4%
Etiology		
Fall	10	76.9%
Aggression	2	15.4%
Car accident	1	7.7%
Category of severity at admission		
Mild	9	69.2%
Moderate	2	15.4%
Severe	2	15.4%

* Percentages calculated based on the subset of subjects presenting with neurological endpoints (n=13).

Table 3 details the distribution of gender, age, etiology and category of severity at admission for the 13 subjects that presented with neurological endpoints. It is worth noting that nine of those 13 patients were male (69.2%), and that infants and adolescents represented together more than 80% of the cases with clinical complications. With regards to severity according to GCS, nine patients that presented with clinical endpoints (69.2%) had been initially categorized as victims of mild TBI. For the same endpoints, the clinical morbid-mortality was 4.6% for the whole series and 44.4% for moderate and severe trauma.

DISCUSSION

Head trauma is a common cause for requesting urgent medical attention in pediatric practice. In general, mild TBI has been reported to be more frequent than moderate and severe TBI^{2,3,8-12}. Even though HT is usually associated with young adults, significant discussion exists for the most affected pediatric range, since it varies substantially among series and according to the considered region of the globe^{2,3,9,12-21}. The results of the present study showed a distribution in which infants were most likely victims (more than 40% of cases), and adolescents were in third place.

The predominance of the male gender regardless of age is a general finding^{2,10-12,14,15}. In addition, the male to female ratio increases with age in HT due to violent causes^{2,10,22}. Melo *et al.*², in a study performed on another medical center of the same city, observed that 59.2% of the victims in the first decade of life were male, as well as were 84.8% in the second decade. In our study, we also observed an increase with age in the proportion of boys suffering HT: 55% among infants and 73.6% among adolescents. Cultural differences that still exist in the familial education of boys and girls may contribute to this difference, as boys tend to gain relative independence sooner than girls^{3,15,20}.

It is worth noting that a higher age seems to be associated with a higher proportion of moderate to severe TBI⁹. In the present series, the proportion of individuals presenting with clinical endpoints was highest among adolescents (38.4%). In another Brazilian series, Ruy *et al.*¹⁷ reported that most patients that needed hospitalization in an intensive care unit were young male adults.

Fall is an important cause of TBI^{2-4,9-11,23}. According to the World Health Organization, up to 90% of lethal falls in Europe have avoidable reasons²⁴. Data from registries of the Brazilian Ministry of Health show that they are currently the main cause of hospitalization due to external causes for individuals up to 19 years of age²⁵ and the most frequent type of unintentional injury in children²⁶. In most cases the consequences are not severe, but some lead to serious disability or death. A total of 311 children and adolescents died from some type of fall in Brazil in 2011²⁵.

In this study, falls were responsible for the majority of HT cases across all age ranges. However, their proportion

decreased with age. They accounted for 88% of cases in infants and 49% in adolescents, a variation similar to that observed in other national studies such as those conducted by Macedo¹⁰, in 2006, and Machado Filho¹⁵, in 2010. It may be hypothesized that the coexistence of relative motor incoordination and curiosity in some stages of the child development predisposes infants to the occurrence of falls.

It is important to note that the present study analyzed only retrospective data and that most of trauma mechanisms recorded in medical files are generally declared on admission. This means that a considerable proportion of cases of aggression or abuse, such as shaken baby syndrome, may have been omitted. Therefore, it is likely that the values presented underestimate the real frequency of this type of trauma, especially at the most vulnerable ages.

Interestingly, a large proportion of HT (1:4) was due to falls from height: ladders, slabs and trees. A study conducted by the Portuguese Association for Child Safety Promotion reported that most falls occur at home, which reinforces the idea that they are preventable and suggests the need for policies aimed at ensuring domestic safety²⁴. Melo *et al.* pointed out that Salvador is a city with an extremely high number of popular houses with layouts or designs that create potential risks for falling from height, such as stairs and slabs built irregularly¹¹.

The study of the incidence and morbidity of pediatric TBI may be a useful monitoring tool and has the potential to estimate the effectiveness of future preventative public health measures. A typical example in Brazil is the so-called *Pense Bem!* ('Think Well!') Project, which is a partnership of the Brazilian Society of Neurosurgery and the Ministry of Health that promotes public information campaigns for the prevention of head and spine trauma^{27,28}. According to recent data and the results of the present study, significant benefits may be obtained by directing efforts at solving severe housing problems that are very common in large Brazilian cities.

Traffic accidents are another common cause of TBI. In the case of pediatric patients, running over is a relatively frequent type in some series^{9,11}. In this study it was the second most-likely cause of head injury, and most cases occurred in the three to six year-old age group, a period in which the child walks relatively independently and yet still fairly unaware of the dangers of traffic.

In general, the overall mortality secondary to HT tends to be lower in the pediatric population in comparison to adults, possibly a reflex of the difference in the severity of trauma that is considered a reason for seek of medical attention^{19,22,29}. Studies with adults show an incidence of neurological disability as high as 25% and mortality rates from 7.92% to 22.9%^{2,30,31}. The predominance of mild trauma in children and adolescents is probably related to the lower rates encountered in the present study. However, it is noteworthy that 69.2% of patients with unfavorable outcomes were initially categorized with mild TBI, illustrating the fact that the initial

assessment through the CGS does not necessarily reflect the clinical evolution and does not exclude the need of future neurosurgical care³².

This study has limitations. Since it was monocentric, the results were possibly influenced by the characteristics of the studied center. Consequently they might not reproduce perfectly the observations in other regions of the country. The mechanisms of trauma in pediatric TBI are highly influenced by the environmental characteristics and must therefore be interpreted within the socio-cultural context of each population. In addition, its retrospective design limited the possibilities of data collection to the endpoints that were considered to be clearly defined and evenly recorded. There are evidently other possible adverse events following a head trauma beyond those considered in this study. However, it focused on the occurrence of clinically important neurological events for which record-keeping reliability would be maximized.

CONCLUSION

According to the data from the present study, individuals younger than two years of age and boys were the most common victims of pediatric HT in the studied center. Falls were the main cause, accounting for more than 75% of cases and falls from height accounts for approximately 50%. More than 10% of patients showed traumatic changes on brain CT and 4.6% presented with clinical endpoints of morbidity-mortality, such as seizure (the most frequent), motor deficit, language trouble, CSF leak or death. Knowledge of the causes and profile of patients admitted for HT enables the identification of risk factors and may serve as a guide for preventative actions. Finally, information on HT morbidity may be used for planning assistance and early rehabilitation protocols.

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