EPIDEMIOLOGY, TREATMENT AND ECONOMICAL ASPECTS MULTIPLE OF TRAUMA IN CHILDREN AND ADOLESCENTS IN A PUBLIC HOSPITAL

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SUMMARY

Introduction: the motivation to conduct this study was the reduced number of articles in literature correlating multiple trauma in childhood and infancy. The objective here was to describe the epidemiological profile of traumatic injuries treated in a trauma center, evaluating the economic aspects associated with hospitalized patients' costs and the period of hospital stay according to the treatment provided. Material and Methods: we assessed all Pirajussara Hospital patients' files in the period of December of 2005 to December 2006. We selected 182 patients, 129 (71%) males and 53 (29%) females; 88 (48%) Caucasian and 94 (52%) non-Caucasian children. Results: male patients were prevalent, with 129 (71%) cases. The most frequent trauma mechanism was fall (36%). The mean hospitalization time was 4.1 days with an estimated cost of R$ 649.50 for each patient. The mortality rate was 2.74% with 5 deaths, with skull trauma being accounted for 80% of the deaths, while child abuse accounts for 40%. Conclusion: the pediatric population exhibits particular characteristics that make it unique concerning trauma injuries' epidemiology and handling.

Keywords: *Trauma; Infant; Child, preschool; Child Adolescent, Accidental Falls; Bone fractures/economics; Bone fractures/epidemiology.*

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INTRODUCTION

The assessment and approach employed in cases of multiple trauma in childhood are prioritized according to the same precepts and dogmas applied to the adult population, at first safeguarding patient's life and reserving musculoskeletal system assessment for later, by following, specifically, the principles of the Advanced Trauma Life Support (ATLS).

Traumatic injuries represent the major cause of death among children above one year old across the globe, and the second major cause of hospitalization among individuals below the age of 15[(1)], accounting for approximately 80% of the cases among adolescents and young adults[(2)].

Blunt trauma in younger children usually result from physical abuse and beating; traffic accidents and high falls are, in general, responsible for more serious outcomes[(3)].

In multiple trauma patients, fractures are commonly seen, and we must concomitantly consider soft tissues injuries surrounding the bone, bleeding, pain, stress, contamination, as well as other elements. In a pediatric population, these account for about 10 – 25% when all injuries are considered[(4)] rarely being fatal. The decompensation phenomenon, when detected, develops quickly producing a number of potentially fatal complications, thus must be promptly treated. Bone instability immobilizes the patient and interferes on co-morbidities and brain, thoracic and abdominal trauma care, limits the use of an appropriate action, and prevents intensive care provided by nursing service. The diagnosis of open fractures and of deformities on affected limbs is obvious. We must highlight, however, that trauma involving high kinetic energy usually produces injuries in other areas, which can be potentially much more serious. The risk of fractures before the age of 16 is 40% among boys and 25% among girls[(4)], these being more frequently seen on the distal portion of the forearm and hand (50%). This percentage increases at a direct proportion when age is considered, since there is a peak during the early phases of adolescence[(4)].

In medical literature, we did not find many studies correlating multiple trauma to pediatric populations, and the ones assessed didn't report certain variables involved in treatment such as method, hospitalization time and cost. We prepared a study aimed to assess the epidemiology of trauma injuries in childhood requiring hospital care. We also intend to correlate hospital costs according to the kind of treatment provided and the hospitalization time for each kind of injury.

MATERIALS AND METHODS

Firstly, this study was submitted to the approval by the Committee of Medical Ethics and Research in our institution under a protocol number 0244/07, and the epidemiological assessment on the studied population, from collected data, was performed by a statistical analysis expert professional.

The study was conducted at Hospital Geral de Pirajussara, established in 1999, constituting a reference for about 450,000 people of the region comprehending the cities of Embu and Taboão da Serra (São Paulo state), this being a part of the conceptual remodeling of healthcare management, as provided by the alliance between State and philanthropic non-profit organizations – the OSS (or Health Social Organizations), particularly with UNIFESP-EPM/SPDM. This hospital interacts with local health systems within the culture of universality, regionalization and reporting of the Single Health System (SUS), referring to it children's trauma injuries that require assessment concerning the need of hospitalization and treatment.

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This study consists on a retrospective analysis of all medical files of underage patients admitted in this hospital due to multiple trauma injuries, from December 2005 to December 2006. From the analysis of medical files, the following data were gathered: name initials, ethnicity, gender, date of birth, date of trauma, mechanism of trauma, primary diagnosis, secondary diagnosis, hospitalization time (days), death (if occurred), and treatment (dates and surgeries performed).

Of the 182 patients enrolled, 129 were males (71%) and 53 were females (29%), with 88 Caucasians (48%) and 94 non-Caucasians (52%). The mean age at the time of injury was 6.7 years, ranging from two months to 13 years old (median: 7; MODA, 10).

Concerning mechanism of trauma, we found 66 falls (36%), 28 accidents involving cars or motorcycles and trampling (15%), 21 bicycle accidents (12), and 67 other causes (37%), including 17 cases of falls from staircases, 14 falls from ceilings, five falls from heights of less than one meter, five high falls between one and two meters, three patients had their fingers smashed on the door, two falls from bed, two smashing injuries on the laundry sink, two have fallen from mother's lap, one fall from a swing, one fall from horseback, one trauma caused by a laundry sink falling on the foot, one direct trauma caused by a piece of tile, one trauma resulting from bicycle wheel, one accident with air compressor, one accident with concrete mixer, one horse kick on the head, one cut-blunt wound caused by a piece of glass, one hand injury caused by a gate arrow, one dog bite, one hand injury resulting from an accident with a press machine, and one drawing.

The economical impact on multiple trauma was assessed by applying the values listed on Single Health System – SUS' table effective as of October 22nd, 2003, which is used for charging hospital expenses with procedures, subsidiary tests and hospitalization time for each kind of injury. The final amount achieved was transferred to the hospital upon invoicing.

RESULTS

Concerning the primary diagnosis of injuries, the most frequent ones were the following: supracondylar humeral fracture, with 38 cases (20.9%); cranioencephalic trauma (CET), with 34 (18.7%), and femoral shaft fractures, with 25 (13.7%). The others are listed on Table 1.

Table 1 – *Distribution of patients for primary diagnosis, according to absolute numbers and percentages.*

Primary diagnosis - regrouped	Number	Percentage
Scapular girdle fracture	2	1.1
Foot fracture-dislocation	4	2.2
Other	7	3.8
Tibial fracture	8	4.4
Face bones fracture	9	4.9
Elbow fracture (except supracondylar)	12	6.6
Fingers' fracture, amputation, or dislocation	12	6.6
Distal forearm fracture	13	7.2
Fracture of the medium and proximal third of the	18	9.9
Femoral shaft fracture	25	13.7
CET	34	18.7
Supracondylar humeral fracture	38	20.9
Total	**182**	**100**

CET= Cranioencephalic trauma; Other = one skull deepening, one facial trauma, one upper dental alveolus fracture, one hand burnt, one sharp-blunt wound on the leg, one foot degloving,

Among the patients studied, 47 (25.82%) showed associated injuries, with CET being highlighted, with 11 occurrences (6%). Other injuries included: five abdominal closed traumas (10.6%), three cut-blunt wounds (6%), three soft parts injuries (6%), three parietal bone fractures (6%), two clavicle fractures (4%), two tendinous injuries (4%), one frontal bone fracture accompanied by distal radius fracture and ocular trauma (2%), one distal radius fracture associated to hepato-renal trauma (2%), a cranial fracture with closed abdominal trauma (2%), one tibial fracture associated to distal radius fracture (2%), one frontal bone fracture associated to orbital fracture (2%), one scapular fracture associated to ear injury (2%), one medial epicondylar elbow fracture (2%), one open fracture of the pododactile fourth (2%), one distal radius fracture (2%), one tibial fracture (2%), one orbital fracture (2%), one dental-alveolar fracture (2%), one orbital fracture (2%), one mandibular fracture (2%), one compartmental syndrome (2%), one nasal injury (2%), one traumatic ulcer (2%) and one case of sexual assault (2%).

The total number of hospitalization days was 743, average: 4.12 days (minimum: one day, and maximum 31 days). 46 remained in hospital for only two days (MODA). Considering the associated diagnosis, the average hospitalization time was: nine days for CET associated to other injuries, and 3.8 days for CET alone; 6.6 days for femoral fractures associated to other injuries, and 4.3 days for femoral fractures alone; 2.1 days for supracondylar humeral fractures alone; 3.3 days for medium and proximal third of the forearm alone; 2.4 days for fractures of the distal third of the forearm.

Of the 182 patients, five evolved to death (2.74%). Concerning mechanism of trauma, two were due to falls from the ceiling (40%), two to fall from staircase (40%), and one to drawing (20%). Two of them were characterized as child abuse (one fall from staircase and one drawing, the latter associated with sexual assault). Four of them evolved to death on the first day, and another one, on the tenth hospitalization day. (Table 2).

Table 2 – *List of deaths according to gender, hospitalization time (days), diagnosis and mechanism of trauma.*

Gender	Time	Diagnosis	Mechanism of Trauma
M	1	CET	Fall from ceiling
M	1	CET/Hemorrhagic shock	Fall from ceiling
F	1	CET	Fall from staircase
F	10	CET/Violence by projecting the child from a high level	Fall from staircase
F	1	Lung Hemorrhage/ Sexual Assault	Drowning and Sinking

CET = cranioencephalic trauma

Concerning treatment approach, we found both cast immobilization and surgical methods, as reported on Tables 3 and 4.

Table 3 – *Specification of fractures treated with casted immobilization, its percentages and total number of fractures.*

	Casted immobilization (n) - %	Total fractures
Supracondylar fracture	4 (10.5%)	38
Elbow fracture (except supracondylar fracture)	1 (7.7%)	13
Distal radius fracture	3 (18.8%)	16
Forearm fracture	2 (11.1%)	18
Femoral fracture	8 (32%)	25
Tibial fracture	6 (60%)	10

Table 4 – Surgical treatment method according to the kind of fracture

Treatment method (n= total fractures)	Kirschner's wires n (%)	Flexible IMN n (%)	IMN n (%)	External fixator n (%)
Supracondylar fractures (n=38)	34 (89.5%)	--	--	--
Elbow fractures (except supracondylar) (n=13)	12 (92.3%)	--	--	--
Distal radius fractures (n=16)	13 (81.3%)	--	--	--
Forearm fractures (n=18)	16 (88.9%)	--	--	--
Femoral fractures (n=25)	1 (4.0%) (femoral supracondylar fractures, crossed)	8 (32%)	--	2 (8%)
Tibial fractures n=10	--	2 (20%)	--	2 (20%)

IMN=intramedullary nail

The total estimated amount spent with patients' treatment was R$ 118,206.13, with the average amount spent for each patient treated in this Institution being R$ 649.50 (minimum: R$ 114.44, and maximum: R$ 1,780.62), not including the amounts spent with synthesis materials. The estimated amounts including primary and secondary diagnosis, were R$ 29,928.60 for CET, R$ 24,324.25 for femoral fractures, R$ 18,990.12 for supracondylar humeral fractures, R$ 8,955.72 for medium and proximal third fractures of the forearm, and R$ 4,314.60 for distal fractures of the forearm. (Table 5).

Table 5 – Injuries with strongest economical impact.

	Amount – R$	Incidence	Average hospitalization days without associated injury	Average hospitalization days with associated injury
CET	29928.6	45 (25%)	3.8	9
Femoral fracture	24324.25	25(13.7%)	4.3	6.6
Supracondylar humeral fractures	18990.12	38(20.9%)	2.1	--

DISCUSSION

Literature review showed a scarcity of studies addressing the binomial of multiple trauma and children. Major differences exist when we consider pediatric populations concerning the kind of injuries, mechanisms of trauma, physiopathology and treatment. The interpretation of these variables is essential for planning and determining rules for prevention and treatment.

The first hour after injury is regarded as the most critical one, directly influencing mortality rates, while the quickest possible transportation to trauma centers is essential.

The first medical action is to assess if trauma is life-threatening, and, subsequently, to provide stabilization of the overall status of the patient[5]. Although CET frequency in children is higher when compared to orthopaedic injuries in adults, the ability to recover from injuries by central nervous system is much higher, as well[6]; thus, the orthopaedic doctor should ground treatment on this expectation. Movements on a long bone fracture core influences the increase of intracranial pressure, requiring early immobilization of the fracture core, even imposing the need of providing an early internal or external osteosynthesis, enabling easier nursing care and patient's transportation[7]. This condition triggers a number of secondary effects on the musculoskeletal system, such as heterotrophic ossification, bone union acceleration, and the fast development of spasticity. In our sample, five deaths occurred (2.7%) among the 182 patients, four of them (80%) caused by CET.

Fractures are frequently found in multiple trauma patients and the interpretation of the injuries must consider the damages caused on skeletal tissues and surrounding soft parts, also assessing parameters of pain, bleeding, systemic and emotional changes. Definitive fixation should be provided within 24-72 hours. This approach reduces morbidity and mortality rates[8].

In children with multiple systemic injuries, splints are usually enough as primary orthopaedic care, while the overall picture is stabilized. Although fractures in children and adolescents are preferably treated with closed reduction and immobilization or traction, these principles, most of times, do not apply to multiple trauma.

In adults, the surgical stabilization of fractures reduces lung complications as well as others resulting from long bedding time[9]. In a young patient, medical complications are less frequent, and, thus, early stabilization recommendations are somehow more difficult to be justified; however, orthopaedists should be attentive to thoracic ecchymosis and rip fractures concerning the potential of pulmonary contusion[10]. In our series, we decided to provide a definitive treatment of fractures, casted immobilization in 11.8% of the upper limb fractures and in 37.2% of lower limbs fractures, because of the unavailability of synthesis material for the primary stabilization of such bone injuries.

Early surgical stabilization of fractures within the first two days after injury reduces the hospitalization time, the time of intensive therapy required, and the time of assisted venting, in addition to result in a lower complication rate [11]. In our study, this approach was applied on most of the patients, being notably the short time span between hospitalization, treatment and discharge, characterizing a fast treatment to patients, as recommended by literature.

Intramedullary fixation, under a biomechanical point of view, is the

surgical method of choice for treating femoral and tibial fractures. In our study, the intramedullary fixation was the most frequently employed surgical technique for such fractures (32%).

In the studied series, we found two cases of tibial open fracture (20%) treated with external fixation. It is interesting to highlight that these were the only cases in which external fixation was employed as a treatment method in the study.

Falls represented the major mechanism of trauma in our population, accounting for 36% of the total, which is consistent to other studies performed in our environment[12,13], with the remaining number being divided into 15% of traffic accidents involving cars, motorcycles and trampling, 12% of bicycle accidents, and 8% of other causes.

Physical violence accounts, according to some authors, for 72% of domestic trauma, and child abuse must be considered, as well as the potential coexistence of a condition characterized by bone weakness[14,15]. We found two abused children who evolved to death (1%). One of these children was pushed down stairs from a high point, dying as a result of CET after 10 days in hospital, while the other child was sexually abused and drawn, dying as a result of lung hemorrhage and CET on the first day in hospital. This condition, therefore, accounted for 40% of the mortality rate in our case series. Population-based statistical data related to physical abuse in our environment are probably underestimated. In our study, the incidence rate found was only 1%. This problem, common to all countries, should represent a higher number of involved people, but we don't have enough data to deny it.

Violence against children is a serious social problem hitting all socioeconomical and ethnical groups. This diagnosis should be suspected in all cases of multiple trauma in children below the age of two if there is no obvious and justifiable cause for injuries. This remains being the most common cause of traumatic death among babies and children below three years old[14,15].

Hospital stay, the number of associated injuries and medical procedures used for treatment are directly related to patients' ages and with the energy involved on accidents. In our study, 25 patients showed femoral fractures (13%), being bilateral in one patient (1%), representing a lower frequency when compared to supracondylar humeral fractures, which accounted for 38 cases (21%). Our case series disagrees with data reported by foreign literature assessed, because supracondylar humeral fractures represented the major orthopaedic injury, with femoral fractures occupying the second place in ranking, as for the incidence of fractures determining hospitalization[16]. This is probably because the injuries occurred in our environment reflect a trend to upper limbs fractures in the detriment of lower limbs, as shown by local literature assessed[13] and, also, in our data with 93 upper limb injuries (51%) and 37 lower limb injuries (20%), which is inconsistent to foreign studies assessed, where lower limb injuries are prevalent as well as a higher rate of traffic accidents as mechanism of trauma[17,18]. We find it worthy to highlight that upper limb traumas usually occur as a defense mechanism against falls or aggression, while lower limb traumas are more commonly associated to accidents, particularly car accidents. These considerations lead us to question the sources of such inconsistency, ranging from aspects such as violence and socioeconomical level, to education levels and prevention methods.

Direct costs of pediatric trauma exceed US$ 8 billion, and this amount is only a fraction of the total costs, once indirect costs for families and society cannot be estimated[19]. In Brazil, the total amount spent in 2005, according to DATASUS, for the clinical-surgical specialty was approximately R$ 3 billion, which evidences the contrast of healthcare focus on both countries.

From this compilation, we can evidence that CET and femoral fractures had a longer average hospitalization time, especially when other associated injuries are found. Both constituted the major hospitalization causes and coursed with the highest costs, thus being the injuries with the strongest economical impact in our study, which is consistent to some studies conducted abroad[20].

A child's physiological and psychological recovery is difficult, especially in those with sequels. Psychic, behavioral, emotional and learning changes are recognized for long periods of time and are present in over 50% of treated children. In addition, social and economical disturbances affecting family structure should also be considered, for these make the overall problem worse[21].

The determination of orthopaedic injuries indicators in multiple trauma enables prevention measures to be applied by means of continued education. The orthopaedic doctor participates, not only on treatment, but also on disseminating these data. Healthcare professionals should implement an effective awareness and preventive education system for the population, related to safety, based on the results of the epidemiological studies conducted, especially in view of simple falls as the key mechanism of trauma [12]. We highlight, based on the major mechanisms of trauma found in our study, the emphasis on traffic education, on the mandatory use of safety belt, on conveying children at the back seat, on the mandatory use of helmets when driving motorcycles, and other protective elements such as gloves and kneelers when riding a bicycle or skate, on adult's overview and on the prohibition of risky amusement activities[22,23], especially on ceilings, which are much common in our environment.

A problem we found to conduct this research is related to the analysis of medical files. It is important to highlight that the right data reporting by medical teams is mandatory, and enables an easier retrospective analysis of them. Among the major inconsistencies found, the most relevant one was correlated to the reporting of the patient's Hospitalization Addendum, containing only the primary diagnosis and its relevant International Diseases Code (IDC), in the largest majority of the cases. Associated injuries were usually omitted on the Hospitalization Addendum, thus requiring further investigations through anamnesis and descriptive clinical evolution on the files. We regard as essential the right and thorough compilation of data during anamnesis, evolution and physical tests, always ended by an appropriate approach and clearly expressed on each assessment. We also emphasize that this kind of documentation is important for medical and legal purposes.

CONCLUSION

The pediatric population shows peculiarities that make it different from the adult population in what concerns to trauma injuries epidemiology and handling.

In our environment, upper limbs traumas in children requiring hospitalization are more frequent than lower limb traumas, which is inconsistent with developed countries' literature. This inconsistency is strictly related to trauma etiology, with upper limbs traumas usually implying on a mechanism of defense, especially against falls, while lower limb traumas are usually resultant from traffic accidents.

The injuries showing the strongest economical impact were CET and femoral fractures, because these determine a higher financial burden and lead to longer hospitalization periods, in addition of being the major cause of death of extended in-hospital time.

Expenditures with healthcare in Brazil are very much inconsistent to the amounts spent in developed countries.

Measures prioritizing children's trauma prevention must be implemented.

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