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Epidemiological Assessment of Child Trauma Resulting in Emergency Calls

Ocena epidemiologiczna wymagających wezwania ambulansu urazów u dzieci

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Abstract

Background. Trauma is considered to be the leading cause of mortality and disability in children. Evidence-based statistical data are applicable in creating systems of child trauma prevention and enhancing emergency service effectiveness.

Objectives. Reviewing data on trauma epidemiology in children, including preventable trauma.

Material and Methods. Retrospective analysis was conducted based on medical records of the Wrocław-Fabryczna ambulance service for the period of Jan. 1 to Dec. 31, 2004. Two hundred sixteen cases of trauma in children under sixteen years of age were investigated. The study population consisted of 85 girls and 131 boys. Trauma not typical of the child's age was considered preventable. Burns under the age of two, falls in infants, trauma due to domestic violence, falls from heights unusual for the physical activity of the child's age, and injury from a toy improper for the child's age were included to this group.

Results. The mean age of the patients was 10 years (± 0.8). The most common mechanism of injury was falling (18.5%). The mechanism of injury was not noted in the medical documentation in 23.5% of cases. Children experienced mostly head (32%), leg (23%) and arm (17%) trauma. Head trauma dominated under the age of six, while older children more often experienced extremity trauma. Accidents took place mostly at home (31.5%), on the street (25%), and at school (20%). The season of year was a statistically insignificant factor for the number of trauma cases in children. In most cases (90%), the children were transferred to a hospital after the first survey at the scene of the accident. The authors consider 10% of all the investigated cases of trauma were possibly avoidable with proper care of the children.

Conclusions. Age was an important factor in the kind of trauma in children. Head trauma was diagnosed in half of the injured children under six years (50%), while older children experienced mostly trauma of the extremities (42%). Boys experienced trauma more often than girls in all age groups. The number of emergency calls for trauma in children did not increase during vacation time. The majority of children treated by ambulance service were transported to the hospital for further investigation and treatment. About 10% of trauma incidents in children who require ambulance service intervention are caused by improper care of the children (*Adv Clin Exp Med 2006, 15, 6, 1029–1036*).

Key words: children, trauma, epidemiology, EMS.

Streszczenie

Wprowadzenie. Urazy są główną przyczyną śmiertelności oraz niepełnosprawności u dzieci. Oparte na faktach dane statystyczne mają zastosowanie w tworzeniu systemów zapobiegania urazom i poprawie skuteczności ratownictwa medycznego.

Cel pracy. Przegląd epidemiologii urazów u dzieci oraz ocena urazów możliwych do uniknięcia.

Materiał i metody. Badanie oparto na retrospektywnej analizie dokumentacji wyjazdów ambulansów podstacji Wrocław – Fabryczna w okresie od 01.01.2004 r. do 31.12.2004 r. Do badania wybrano 216 dzieci poniżej 16. r.ż., u których przyczyną uruchomienia systemu ratownictwa medycznego były urazy. Badana populacja składała się z 85 dziewcząt i 131 chłopców. Urazy nietypowe dla wieku dziecka uznano za możliwe do uniknięcia. Do tej grupy włączono: oparzenia dzieci poniżej drugiego roku życia, upadki niemowląt, urazy wynikające z przemocy w rodzinie, upadki z wysokości nieadekwatnych dla rozwoju fizycznego, zranienie zabawką niedostosowaną do wieku dziecka.

Wyniki. Średnia wieku pacjentów to 10 lat ($\pm 0,8$). Najczęstszą przyczyną urazu był upadek (18,5%). Mechanizmu urazu nie odnotowano w dokumentacji medycznej w 23,5% przypadków. Najczęściej dochodziło do urazów

głowy (32%), kończyn dolnych (23%) i górnych (17%). Urazy głowy dominowały u dzieci poniżej 6. r.ż., podczas gdy starsze dzieci doznawały głównie urazów kończyn. Zdarzenia miały miejsce najczęściej w domu (31,5%), na ulicy (25%) i w szkole (20%). Pora roku okazała się czynnikiem statystycznie nieistotnym dla częstości występowania urazów u dzieci. W zdecydowanej większości przypadków (90%), po wykonaniu niezbędnych zabiegów medycznych w miejscu zdarzenia, dzieci przewożono do szpitala. W ocenie autorów 10% wszystkich urazów było możliwych do uniknięcia przez zapewnienie dzieciom odpowiedniej opieki.

Wnioski. Wiek dziecka jest ważnym czynnikiem predysponującym do określonego typu urazów. Urazy głowy rozpoznano u połowy dzieci poniżej 6 r.ż. (50%), podczas gdy dzieci starsze doznawały głównie urazów kończyn (42%). We wszystkich grupach wiekowych do urazów częściej dochodzi u chłopców. Liczba wezwań ambulansów do urazów u dzieci nie wzrastała w okresach ferii letnich i zimowych. Większość dzieci zaopatrywanych przez zespoły ratownictwa medycznego przewożono do szpitali w celu dalszej diagnostyki i leczenia. Około 10% przypadków urazów u dzieci, które wymagały interwencji zespołów ratownictwa medycznego było spowodowanych niewłaściwą opieką nad dzieckiem (*Adv Clin Exp Med* 2006, 15, 6, 1029–1036).

Słowa kluczowe: dzieci, uraz, epidemiologia, EMS.

Due to its peculiarity, trauma in pediatric patients is the subject to numerous publications. Trauma is the leading cause of mortality in this age group [1]. Because of the specific mechanisms of trauma and pediatric patients' unique metabolism and ability of shock compensation, different from that in adults, they demand different treatment [2]. Authors recommend creating emergency wards specialized in pediatric care or separating properly equipped divisions with personnel educated in appropriate pediatric procedures as parts of emergency departments [3–5]. Data on environmental conditions of trauma in children can be useful in creating and improving pediatric emergency medicine [6].

Trauma in children is the subject of research conducted by the Pediatric Trauma Surgery Section of the Polish Association of Pediatric Surgeons. Pediatric trauma epidemiology in the Wrocław area has been the subject of research and provided the basis for creating an emergency system [7, 8]. Along with progress in technology, motorization, and changes in lifestyle, the distribution of trauma in children may change with time, making modifications in the operating emergency system necessary. This assumption was the reason to attempt a statistical analysis of the current causes of pediatric trauma. In Polish literature, no reports on trauma caused by improper childcare in a large urban area were found, which prompted the authors to include their own research.

Material and Methods

An analysis of ambulance service interventions in the Fabryczna section of Wrocław for the full calendar year from Jan. 1, 2004, to Dec. 31, 2004, was carried out. The evaluation was based on a retrospective analysis of pre-hospital medical documentation (written reports made by doctors during and after every intervention using forms

edited by the ambulance service in Wrocław). The population of the Wrocław Fabryczna district numbers 200,000 people living in an area of 119 square kilometers. In the investigated period there were 21,467 emergency missions completed, of which 1732 were for children under the age of 16. Two hundred sixteen cases of trauma in children under the age of 16 were investigated. The following data were analyzed: date of the emergency call, cause of the emergency call, kind of trauma, age of the patient, place of accident, mechanism of trauma, decision of hospitalization.

The data were analyzed statistically using the non-parametric ANOVA Kruskal-Wallis test; average values and standard deviations were calculated. The level of statistical significance was assumed at $p < 0.05$.

For the assessment of trauma considered to be preventable, types of trauma untypical for the child's age were selected: burns under the age of two, falls in infants, trauma due to domestic violence, falls from heights unusual for physical activity for the child's age, injury by a toy improper for the child's age, electrocution in infants, and dog bites.

Results

Demographic Data of the Investigated Group

The average age of the patients was 10 (± 0.8) years. For the purpose of the study the patients were divided into three age groups: 1) neonates, infants, and pre-school children, 2) elementary school pupils, and 3) middle-school pupils (Fig. 1). The number of patients in each of these age groups is shown in Table 1.

The study population consisted of 85 girls and 131 boys. A statistically significant difference in the number of boys in relation to girls was revealed ($p = 0.03$). The predominance in ambu-

Table 1. Gender of children treated by the ambulance service of Wrocław Fabryczna

Tabela 1. Płeć dzieci zaopatrywanych przez zespoły ambulansów Wrocław – Fabryczna w poszczególnych grupach wiekowych

Age group (Grupa wiekowa)	Boys (Chłopcy) %	Girls (Dziewczeta) %
0–6	54	46
7–12	72	28
13–16	57	43

lance calls for boys over girls was most significant in elementary school age children (Table 1).

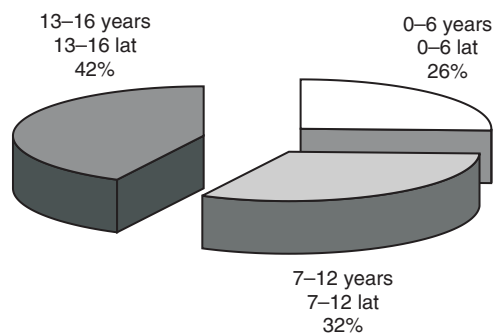
Cause of Emergency Call

The most frequent causes of emergency calls were head (22%), leg (18%), and arm (16%) trauma. The rarest cause was vertebral column trauma (2.5%). Other traumas which were the reason for calling the ambulance service in single cases, such as eye trauma, fall due to slipping, dog bite, electrocution, suicide attempt by cutting veins, being hit by a train, chest trauma, and laceration of the buttocks, qualified jointly as “others”, constituted

Table 2. Causes of emergency calls for trauma in children

Tabela 2. Przyczyny wezwania ambulansów do urazów u dzieci

Cause of call (Powód wezwania)	Number of cases (Liczba przypadków)	Percentage (Odsetek) %
Head trauma – with no given cause (Uraz głowy – bez podania przyczyny)	48	22
Lower limb trauma – with no given cause (Uraz kończyny dolnej – bez podania przyczyny)	40	18
Upper limb trauma – with no given cause (Uraz kończyny górnej – bez podania przyczyny)	35	16
Being hit by a vehicle (Potrącenie przez pojazd mechaniczny)	17	8
Fall (Upadek z wysokości)	15	7
Traffic accident (Wypadek komunikacyjny)	12	5.5
Being beaten up (Pobicie)	12	5.5
Burns (Oparzenie)	11	5
Vertebral column trauma – with no given cause (Uraz kręgosłupa – bez podania przyczyny)	5	2.5
Indeterminate trauma – with no given cause (Uraz bliżej nieokreślony – bez podania przyczyny)	4	2
Other (Inne)	17	8

**Fig. 1.** Age groups of children treated by the ambulance service of Wrocław Fabryczna

Ryc. 1. Grupy wiekowe dzieci, do których dysponowano wrocławskie zespoły ratownictwa medycznego dzielnicy Wrocław – Fabryczna

8% of all emergency departures. It is worth mentioning that the kind of trauma was not documented as the reason for ambulance departure by the emergency dispatcher in 2% of cases (Table 2).

Seasonality in the Occurrence of Trauma

Despite differences in the number of traumas in particular months (Fig. 2) no statistically significant difference was found ($p > 0.05$).

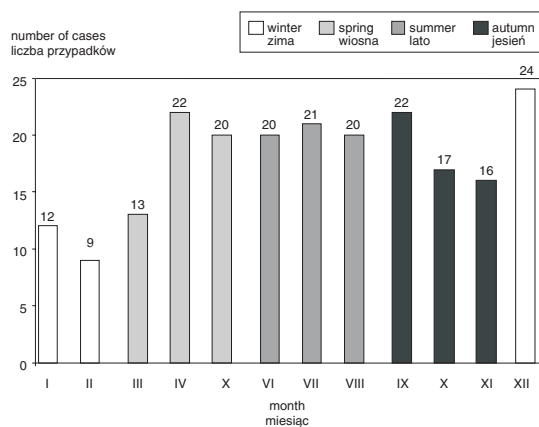


Fig. 2. Seasonal frequency of ambulance departures for trauma in children

Ryc. 2. Sezonowy rozkład wyjazdów ambulansów do urazów u dzieci

Place of Accident

Most traumas treated by the ambulance service took place at home (31.5%). Other frequent places of accident were the street (25%) and school (20%). Injuries also took place on playgrounds (8%), at swimming pools (5%), and in reformatories (2%).

Mechanism of Injury

In the majority of medical records the mechanism of trauma was not documented (23.5%); the most frequent cause of trauma was falling (18.5%). The next most common causes were: impact (12%), falls from an altitude (10%), being hit by a mechanical vehicle (8%), being beaten (7%), burns (5%), traffic accidents (4%), injury with a sharp instrument (4%), cycling accidents (4%), and single cases of: slipping, injury due to a fireworks explosion, dog bite, weight crush, and electrocution.

According to the American College of Surgeons guidelines concerning the mechanism of trauma assessment, medical documentation of patients sustaining a fall from a height often (43% of documented cases) contains information about the altitude, but only in a few cases (12%) was the kind of ground on which the patient fell described. In documentation on burns, the degree and size of the burn as well as the kind of substance causing the burn was described in each case. The investigated medical records did not provide information allowing an assessment of the trauma prevention applied to children who were car passengers. Only in one record concerning a road traffic accident was the fact of the use of a child's chair noted, while whether or not a crash helmet was used was described in the none of the records of child trauma experienced during cycling.

Experienced Injuries

The most frequent trauma diagnosed by emergency physicians in the investigated group was head trauma (32%). The next in order of frequency were lower limb trauma (24.5%) and upper limb trauma (17%). Vertebral column (5%) and chest trauma (2%) occurred more rarely. Twelve percent of the victims experienced trauma in two body regions and 6% in three or more regions. Analysis of trauma incidence in particular body regions in relation to patient age revealed that the youngest children most often experienced head trauma, which was found to be 50% of all traumas in this age group. The increased incidence of head trauma in comparison with other trauma in children aged 0 to 6 was statistically significant ($p = 0.027$). In children older than seven, trauma of the arms and legs predominated (42.1%). The frequencies of trauma occurrence in particular regions of the body in this age group were more differentiated than in younger children (Tab. 3).

Decision of Hospitalization

Ninety percent of the children were taken to hospital after the initial treatment. In one case, a child (15-year-old girl) left the scene of the accident, which made it impossible to give her any treatment. No cases of parental refusal of the child's treatment and hospitalization were observed in the investigated group.

Avoidable Trauma

About 10% of all traumas in the children of the investigated group were possibly preventable. Among the traumas untypical for the child's development and physical activity, the most frequent were falls in infants who are unable to climb by themselves on objects from which they fell (sofa, table, baby carriage) (Table 4). Other injuries qualified as avoidable were burns in infants (average age: 11 ± 2 months, 5 cases). The burns were most commonly caused by hot tea. Dog bite in a 3-year-old child and electrocution in a 13-month-old child were also considered to be caused by improper care, the same as in children who were beaten due to domestic violence [2]. A toy unsuitable for the child's age was the cause of one case of trauma, where the child plunged the protruding part of a toy (car antenna) into his palate.

Medical Documentation of the Clinical Condition of Patients

Evaluation of the clinical status of a child by means of the Glasgow Coma Scale was documented in 17% of cases and the appearance of the

Table 3. Experienced trauma depending on child's age**Tabela 3.** Obrażenia doznane w wyniku urazów w zależności od grupy wiekowej

Trauma (Uraz) %	Age of children – years (Wiek dzieci – lata)			Total (Łącznie)
	0–6	7–12	13–16	
Head (Głowy)	50	27.1	25	31.9
Upper limb (Kończyny górnej)	9.3	14.3	25	17.6
Lower limb (Kończyny dolnej)	14.8	25.7	29.35	24.5
Multiple body regions (Wielu obszarów ciała)	20.4	20	15.2	18.1
Vertebral column (Kręgosłupa)	0	10	4.35	5.1
Unknown body region (Nieustalonych części ciała)	5.5	2.9	1.1	2.8
Total (Łącznie)	100	100	100	100

Table 4. Trauma caused by improper care of children**Tabela 4.** Urazy, do których doszło w wyniku niewłaściwej opieki nad dziećmi

Mechanism of injury (Mechanizm urazu)	Age of children – months (Wiek dzieci – miesiące)	Mean age of children – months (Średni wiek dzieci – miesiące)	Number of cases (Liczba przypadków)
Falls from a height (Upadek z wysokości)	1–13	9.6	12
Burns (Oparzenie)	1–13	11.6	5
Domestic violence (Pobicie w wyniku awantury rodzinnej)	6–96	51	2
Dog bite (Pogryzienie przez psa)	36	36	1
Electrocution (Porażenie prądem)	13	13	1
Injury with a toy (Uraz zabawką)	12	12	1

pupils in 50% of cases. The Trauma Scale or Revised Trauma Score values were not documented in any of the patients' records. Terse descriptions of injuries made it impossible to assess both the Injury Severity Score and the probability of survival using TRISS methodology.

Discussion

The organization of an effective emergency medical system for pediatric patients requires knowledge about the demographic and epidemiological situation in the region [9]. Such a statement supports the idea of necessary research essential for progress in emergency medicine based on evidence.

As in other authors' observations, boys were the majority in the investigated group. As shown before, this predominance is independent of race or environmental factors of the children [1, 6, 10–14]. The average age of the patients in the study (10 years) was higher than in the Gurses et al. report and lower than in the Marcin et al. (12.6 years), Dueck et al. (12.8 years), and DiScala et al. (12.8 years) studies [1, 6, 10, 11, 15]. Letts et al. reports on a similar average age of investigated children (10.6 years).

Dueck et al. found road traffic accidents to be the most frequent (69.8% of 223 children) cause of trauma, more frequent than falls. However, this author investigated a group of children with serious trauma (Injury Severity Score > 4) and exclud-

ed children under the age of 6, who often experience falls. Similarly, in the Letts et al. trial performed on a group of 149 children, the wide spectrum of multiorgan trauma in children was the result of injuries concerning road traffic accidents (car accidents, hitting pedestrians, bicycle crashes in 39, 21, and 14%, respectively) [10]. According to Letts et al., the cause of multisystem trauma next in order of frequency was falls from an altitude (14%), which, together with falls, are the predominant reason of emergency calls in the investigated group of children in Wrocław.

Hayes et al. showed that the reason for hospitalization of children depended on their nationality; among white American children the most often cause of visiting an emergency ward was burns, while children of minorities were mostly treated for consequences of falls [12]. DiScala et al. reported that 10.6% of blunt injuries in children in the USA is experienced due to domestic violence. This involves, contrary to accidental trauma, younger children; such injuries are more severe and their treatment more expensive than in cases of accidental traumas [15]. In older children, above the age of 6, serious injuries caused by domestic violence were the reason for 1.3% of hospitalizations [1]. According to DiScala et al., falls accounted for 58.4% of all accidental injuries found during a 10-year period in the National Pediatric Trauma Registry (NPTR). As in this study, falls and falls from an altitude are the most common causes for trauma in children.

Interesting is the fact that, in the investigated group, no cases of battered child syndrome were documented, except for a few cases of beating the child at home. This might be due to inaccurate pre-hospital diagnosis or, typical for such situations, avoidance of an emergency call by the battering parent. The places where the injuries were sustained in the investigated group were more typical of accidental trauma than of battering. The latter, according to DiScala et al., take place mostly at home (88.4% of 1997 battered children, selected from almost 19,000 injured children whose medical records were collected in the NPTR) [15]. In the cases of injuries not caused by domestic violence, trauma also occurred most often at home, but this predominance was not so distinctive (54.9%). Children in the investigated group experienced trauma most frequently at home, although places where injury was sustained were more varied. In interpreting this fact one must take into consideration the differences between the investigated groups; in this study only patients transported to hospital by an ambulance service were analyzed.

The kinds of trauma described in the study have a distribution typical for the age of the chil-

dren. In younger children, because of their anatomical condition, head injury is postulated to be the most prevalent, which was confirmed in the investigated group [2]. In older children, due to their fast growth and significant physical activity, limb trauma is most common, which was also confirmed in the investigated group. Such a distribution is, according to DiScala and co-authors, typical of accidental trauma in contrast to battered children, where trauma of the chest and abdomen is more frequent [15]. Similarly, head and limb injuries predominated among the components of multiple trauma in the Letts et al. study [10]. Gurses et al. indicated head trauma as the most frequent element of multiorgan trauma in the whole age group of 91 investigated children (74%) [11]. The second in order of frequency is trauma of organs located in the abdomen (57%), followed by extremity trauma (37%) [11].

Dog bite is considered to be a preventable injury [16]. In the United States, dog bite is the reason for almost 1% of all visits of children to the emergency ward, which shows a significant prevalence of such an injury. The average age of children with such trauma is 6.2 years according to Ghandi et al. In the investigated group, only one case of dog bite was documented, what might be a result of parents bringing their children to the hospital on their own in such cases.

The so-called "Chain of Survival", which presents a combination of important factors essential for survival, has been modified for injured children in comparison to the same algorithm for adults. The American Health Association together with the American Academy of Pediatrics indicate in their educational programs prevention of trauma as the first step in the "Chain of Survival" [17]. Various medical communities have put special programs into practice dedicated to the prevention of trauma in children. In the USA, the task of education was partly taken over by the nursing environment, providing educational programs adapted for risks related to the age of the children [18]. Programs related to prevention of trauma and proper behavior should, according to American Academy of Pediatrics, be an integral part of the emergency medical system dedicated to children [9].

Avoidable trauma, according to the American College of Surgeons, is the cause for 1/5 of child deaths due to experienced injuries. In the opinion of this organization, 40% of the above deaths could be avoided by implementing the various programs of prevention [17]. Data on patients of the Wrocław Fabryczna ambulance service are inadequate to fully assess the cases of possibly avoidable deaths. Especially interesting is the fact that there is absolutely no information about any

means of preventing trauma in vehicle accident cases. Purposeful selection of types of injury which could not be experienced in the course of a child's natural activity at a particular age suggests that in the investigated group, 10% of all traumas were avoidable.

This study did not prove the expected seasonally increased frequency of trauma in children during their summer and winter school vacations when insufficient care of children together with more free time might have caused such an increase. As in the Letts et al. study, trauma occurred with similar frequency during all seasons, with a little decrease in the winter [10].

What draws one's attention is the low quality of the documentation which had been recorded for the investigated group by the medical emergency teams, especially in the area of the clinical description of the patients. Assessment of consciousness with the Glasgow Coma Scale was documented only in 17% of cases and the condition of the pupils was mentioned in 50% of patients. Despite the fact that the investigated group consisted of traumatic patients, the Trauma Scale was not calculated in any case, even though special tables making such a calculation easier are an integral part of the documentation forms.

Trauma in children is common and may have serious consequences, such as long-lasting disability, loss of health, or even death. In Poland, 20 to 30 thousand children are hospitalized every year due to head trauma alone [14]. For effective treatment it is crucial to perform specialists' procedures at the scene of the accident quickly and to transport the injured child as fast as possible to

a casualty ward specialized in treating children. In order to optimize the emergency system's work in a large urban area, it is essential to recognize the epidemiology of life risks in children, which presents a good reason to continue this research.

On basis of an analysis of medical records it was shown that patient age is a factor predisposing to specific kinds of trauma. Half of the injuries experienced in children under the age of 6 were head injuries (50%), while in older children extremity trauma was most frequent (42%). In all age groups, boys experienced trauma more often than girls. Among the children treated by medical emergency teams of the Wrocław Fabryczna district, there was no seasonal increase in the frequency of trauma during vacation times. The vast majority (90%) of the children who experienced trauma were treated initially by medical emergency teams and then transported to hospital. Injuries caused by improper care of the children amounted to 10% of all traumas which resulted in emergency calls.

The quality of the pre-hospital medical records made by the ambulance crews do not allow an assessment of the severity of trauma using any of the physiological and anatomical assessment scales. TRISS methodology based on these calculations should be used in assessing the utilization and effectiveness of ambulance services, according to the American College of Surgeons [19]. This was not the aim of this study and should be the subject of further investigation.

Trauma is an important issue in pediatric medicine. The documentation of medical emergency team calls concerning trauma in children is not satisfactory and requires quality improvement.

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