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# **The Quality of Prehospital Medical Care Provided to Children with Traumatic Injuries**

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Additional information is available at the end of the chapter

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## **Abstract**

Injuries in children reach epidemic proportions worldwide as they are the most common cause of death among children above 1 year of age. It is a well-known fact that first aid properly administered to the child with severe bodily injuries can save his or her life. That objective was pursued through a prospective analysis of data concerning the management of children who presented with an injury to the Paediatric Emergency Medicine Teaching Department at the Maria Konopnicka University Teaching Hospital No. 4, to which they were brought by emergency medical service teams or referred by a primary care physician, physicians from other hospitals or a school nurse. The study enrolled all children (1493) aged 0–18 years who, due to an injury, presented to the Paediatric Emergency Medicine Teaching Department and had had prehospital aid administered by different healthcare entities. In the group of 489 children with an injury, in whom there were indications for the administration of analgesics, only 32.8% received analgesics, while 45.6% did not receive any. In children with an injury, there was no transport immobilisation in 18%. Among children provided with transport immobilisation, 10.2% were improperly immobilised. The management of the child with an injury in the Łódzkie region is unsatisfactory.

**Keywords:** children, injuries, prehospital aid, analgesia, transport immobilisation

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## **1. Introduction**

For many years now, injuries in children have invariably constituted a serious medical as well as economic and social problem worldwide, as they are the most common cause of death in children above 1 year of age. Every year hundreds or even thousands of children die due to injuries and part of them suffer the irreversible consequences of sustained injuries, which prevent them from functioning in daily life. According to the World Health Organisation

(WHO), traffic accidents (22% of all unintentional injuries in the world) and violence are among main causes of deaths of young people below 18 years of age. The WHO data of 2008 indicate that about 950,000 children and adolescents die annually as a result of injuries throughout the world. What is more, it is estimated that 90% of those children lose their lives due to random accidents [1–5]. It is worth mentioning that a large majority of random injuries occur at home or in family environment; hence, a place which should ensure safety to the child. And although world organisations have implemented various prophylactic programmes aimed at decreasing the incidence of injuries among children (parents' education, introducing the duty to transport children in car safety seats and wear helmets for head protection while doing different sports), injuries in children remain a worldwide epidemic.

### 1.1 Injuries in children in the European Union

Paediatric injuries constitute a serious health problem in the European Union countries. Injuries are the most commonly sustained by children >5 years of age [6–8]. That is confirmed by Austrian researchers' observations which reveal that children above 5 years of age accounted for more than 50% of children with injuries, whereas children aged 1–4 years represented 28.4% and those below 1 year of age – 14% of the study group [9]. The incidence of injuries in children in Poland is not precisely determined due to the lack of the national register of paediatric injuries. According to Okłot and colleagues [6], in the 1990s about 120,000 children and adolescents were annually hospitalised as a result of injuries, including 80,000 children aged 0–14 years. Epidemiological analyses performed in consecutive years suggest a further increase in the incidence of paediatric injuries.

Boys incur injuries much more often than girls [8–12]. There was a relationship observed between sex and causes of injuries in the group of children who sustained injuries. According to the WHO, boys more commonly than girls suffer injuries owing to traffic accidents, drownings, falls and poisonings, whereas girls more often than boys sustain injuries due to burns [1].

Children most commonly incur injuries as a result of traffic accidents, drownings, burns, falls and other causes [13].

In Europe, as in the United States, traffic accidents are the main cause of deaths among children. The study by Pearson and colleagues of Glasgow indicates that main causes of deaths in the group of studied children included traffic accidents with participation of pedestrians, followed by asphyxia, assaults, burns and falls [12].

Paediatric injuries most commonly lead to traumas to the osteoarticular system and head. As common in children are burns. Recent years' studies reveal a further rise in the number of fractures within the osteoarticular system with a simultaneous fall in the number of cranio-cerebral injuries [9–11].

Mortality rates from injuries among children vary considerably, from the highest in Lithuania and Latvia (21.9–22.4 per 100,000) to the lowest in Sweden and the Netherlands (5.8 per 100,000), the main cause of deaths in the group of children aged 10–19 years being random

accidents [1, 2]. Although observations by Finnish researchers indicate a further increase in the number of injuries in children, they simultaneously show a decrease in the mortality rate (4.0 per 100,000 of children up to 18 years of age in 2006) [11]. In Poland, children's mortality from injuries is high and the mortality rate due to accidents among children and adolescents aged 1–14 years of age is about 13.4 [14]. Epidemiological research carried out in the European Union area revealed that adolescents >15 years of age and small children up to 4 years of age bear the highest risk of mortality from injuries [2, 6, 15, 16]. As indicated by the European report on injury prevention in children, if the EU countries achieved the mortality rate from injuries in children similar to the rates in Sweden and the Netherlands, it would allow to reduce fatal consequences of injuries by 75% [7].

## **1.2. Prehospital management of the child with an injury**

The proper administration of aid to the child with an injury requires the knowledge of the child's anatomical and physiological differences, ability to establish contact with the injured child and his/her parents/guardians, knowledge of the proper traumatic examination and interpretation of its results, as well as having at one's disposal equipment appropriate for the child.

The general protocol of managing the child with an injury is similar to that applied in adults. Upon securing the scene of the incident and initial determination of accident circumstances, the preliminary assessment of the child's condition is performed according to the International Trauma Life Support (ITLS) quick injury examination protocol. It is recommended that the systematic quick assessment of the child with an injury be performed according to the AcBCDE protocol, which allows to recognise life-threatening conditions within a few minutes.

When approaching the child, his or her general condition is assessed based on 'the first impression', that is conscious state according to the AVPU scale, patency of airways and manner of respiration, apparent injuries or bleeding. The assessment of airways is performed along with the stabilisation of the cervical spine. If airways are obstructed or their patency is threatened with the presence of foreign bodies, blood or vomit, they should be sucked out and the patency of airways should be restored manually or using devices. The cervical spine can be stabilised manually but ultimately a cervical collar of an appropriate size and subsequently a paediatric spinal board or Pedi-Pack should be used. Before applying the collar, attention should be paid to the widening of jugular veins, position of the trachea and possible wounds to the neck. When assessing the child's breathing, the respiratory rate and volume, the presence of respiratory effort and cyanosis should be checked. In the case of any respiratory difficulty, passive oxygen therapy or ventilation using a bag valve mask with a reservoir filled with pure oxygen are necessary. If tension pneumothorax is recognised, it should be decompressed as quickly as possible by puncturing the second intercostal space in the mid-clavicular line. All open chest wounds should be protected with a seal dressing [17].

When assessing the circulatory system function in the child, the first step is to secure possible external bleeding with a pressure dressing. It should be kept in mind that in the small child compensatory mechanisms allow to maintain normal systemic blood pressure in the event of

loss of even up to 25% of circulating blood volume. Tachycardia and hypokinetic pulse in the child are the most definite signs of developing shock. Decreased arterial blood pressure is a late sign. When hypovolemic shock is recognised, it is essential to use intravenous fluids in order to compensate for lost blood volume by administering fluids in boluses (initial bolus is 20 ml/kg of body weight of isotonic crystalloids). In children with decompensated circulatory failure, when intravenous access is difficult to provide, intraosseous access should be considered (if attempts at providing intravenous access last more than 1 min) [6, 17–19].

The neurological assessment of the child includes the assessment of pupil widths and the evaluation of conscious state according to the Glasgow Coma Scale.

Upon performing the above actions, the next step is the quick injury examination (ITLS) of the child, paying attention to bleedings, fractures or other signs proving the sustained injury. According to standards, ITLS examination is performed from the head to feet, commencing from head and neck examination, subsequently examining the chest, abdomen, pelvis, upper and lower extremities. The child's back and buttocks are examined while transferring the child onto the board [6, 18, 19].

Prehospital aid in the case of the child with burns always consists in isolating the child from the burning agent (through undressing, removing wet or burnt clothes) with the simultaneous assessment of the child's basic vital functions. Thereafter, the extensiveness and depth of the burn wound is assessed along with its simultaneous cooling (using wet compresses). After a dozen or so minutes of cooling, the burn wound should be provided with sterile or hydrogel dressing. It is important to protect the child from hypothermia (covering with a blanket) and commence pain and shock-controlling management [20, 21].

In turn, various kinds of equipment are used to immobilise injuries to upper or lower extremities in children. The most commonly used splints are as follows: Kramer's, Sam Splint, vacuum splints. In a suspected extremity fracture, immobilisation is vital as it fulfils the following functions: analgesic, anti-inflammatory and anti-oedematous and protects against the further displacement of fragments and damage to soft tissues. In order for immobilisation to perform the above-mentioned functions, it has to be properly applied. Transport immobilisation should be well adjusted to the child's size and properly secured with bandage. It should cover the injured extremity to an appropriate extent (according to Pott's principle) [22].

Pain is always a consequence of an injury and its intensity depends on the extensiveness, severity and location of the injury. Increasing pain may lead to pain shock; hence, pain management is among the most crucial actions when administering aid to the child with an injury. Pain management is carried out non-pharmacologically, for example cooling the injured site or immobilisation of fractures, or pharmacologically.

In the case of mild pain, analgesic medicines should be administered as follows: ibuprofen 10 mg/kg of body weight every 6–8 h or paracetamol 10–15 mg/kg of body weight every 4–6 h orally or *per rectum*; maximum dose is 60 mg/kg of body weight/day. When pain is severe and IV access has been provided, analgesics ought to be administered intravenously: morphine 0.1–0.2 mg/kg of body weight or petydyna 1 mg/kg of body weight, fentanyl 1–5 mg/kg of body weight or metamizole 0.1 ml/kg of body weight [23, 24].

## 2. Assessment of medical services provided to the child with an injury

The quality of prehospital medical aid administered to the child with an injury radically affects his or her further prognosis. Nevertheless, our own observations and literature data indicate many irregularities in procedures in the prehospital period. The irregularities most commonly concern the manner of transport immobilisation, lack of IV access provision, pain management in children with burns or injuries of the osteoarticular system [25–27].

Multicentre studies assessing prehospital pain management in the child with an injury revealed that the percentage of injured children who did not undergo pain management by emergency medical service teams ranged from 22 to 70% [28, 29].

The American Academy of Pediatrics together with the American Pain Society report that main barriers to administering analgesics in children include as follows: the myth that newborns and infants feel milder pain, lack of appropriate assessment of the presence of pain, lack of knowledge of pain management and fear of side effects of analgesia including, in particular, respiratory system depression [23].

Along with studies indicating the abandonment of pain management in children with an injury, there are also isolated reports of irregularities in fracture immobilisation in children [30].

Although mistakes and oversights in the prehospital management of the child with an injury are the subject of deliberations, especially related to emergency medical service teams, the literature offers no evaluation of that management carried out by other healthcare entities.

Therefore, based on their own experience, the authors of the present study have undertaken the task of assessing the (prehospital) management of the child with an injury by different healthcare entities taking into account the manner of wound and burn dressing in children, the manner of management of fractures and dislocations within the osteoarticular system, the provision of intravenous access and pain management.

The study enrolled 1493 out of 7146 children aged 0–18 years who due to an injury presented to the Department of Paediatric Emergency Medicine (Hospital Emergency Department) at Maria Konopnicka Memorial University Teaching Hospital No. 4 from 1 May 2009 to 30 April 2010 and had received prehospital aid provided by emergency medical service teams (EMST), primary care (PC) physicians, hospital emergency departments for adults in the Łódzkie region and school nurses (**Figure 1**).

It was a prospective study which, in each child with an injury, along with demographic data, investigated information concerning: the cause, circumstances and site of the wound, entity administering medical aid, assessment of pain management, regularity of transport immobilisation, assessment of local wound and burn dressing, and assessment of medical records transferred to the Department with the child. The study used a child with injury card developed for the purposes of the study, which allowed to perform the above assessments in a uniform manner. The child with injury card was worked out based on the literature on the aetiology of paediatric injuries [26, 31, 32].



**Figure 1.** Poland compared to the rest of the world.

Every card was entered in the database created by us in the Excel program and statistically processed. The collected data underwent statistical analysis for measurable and non-measurable traits. Qualitative traits were also analysed by calculating structure ratios. In the statistical analysis of empirical data, the following tests were used to verify hypotheses on the independence of two qualitative traits in the population: Pearson's  $\chi^2$  significance test for qualitative variables and  $\chi^2$  test with Yates' correction.

Children with an injury accounted for 30.6% of patients from the territory of the Łódzkie region who presented to the Department of Paediatric Emergency Medicine at Maria Konopnicka Memorial University Teaching Hospital No. 4 in Łódź over the year.

Boys decidedly predominated among the injured (60.3%),  $p < 0.001$ .

Almost 80% of children with an injury were those >5 years of age. No relationship was observed between the child's sex and age,  $p > 0.05$ .

Prehospital medical aid was the most commonly administered to children by emergency medical service teams (42.7%), less often by a PC physician (28.1%) and other hospitals (23%), and the least commonly by a school nurse (6.1%).

In the study group, children with an injury most often necessitated out-patient treatment (67.1%).

Among children who sustained an injury, traumas to the head (42.1%), upper extremities (32.2%) and lower extremities (19.9%) were noted. Injuries to the abdomen (2.5%), spine (2.1%), chest (1.7%) and neck (1.1%) were less often observed.

In children with a head injury, superficial traumas to the head predominated (53.3%), head wounds (24.3%) and concussions (20.3%) were less common, and fractures of the cranial bones (2.1%) were the least common.

As for children with other bodily injuries, blunt traumas to the neck, superficial chest, abdomen and spine injuries predominated.

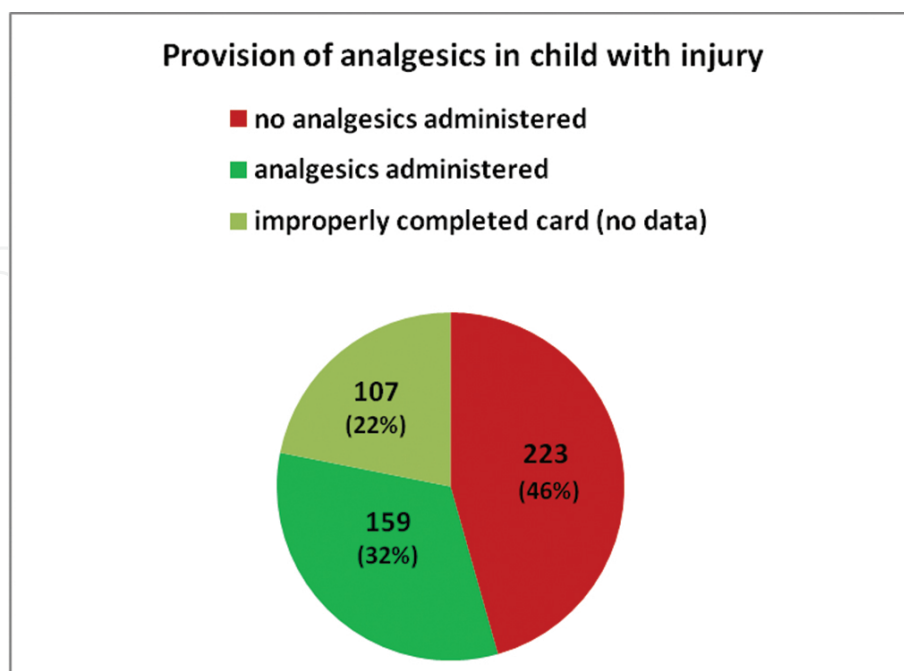
Among children in whom upper extremity injuries were observed, traumas to the forearm were the most (42.7%) and to the carporadial joint the least (1.3%) common.

In the group of children with injuries to the lower extremity, ankle joint traumas (26.2%) were the most and traumas within the pelvis, hip joint and kneecap were the least often (1.7%) found.

Burns were the reason for presenting to the Department for 79 out of 1493 patients, which accounted for 5.3% of all children. They were the most often caused by a thermal factor (77 patients), while a chemical burn was found in 1 and an electric burn in 1 child, respectively.

In the group of 1493 children administered first medical aid by different healthcare entities indications for pain management were found in 489 children (32.75%).

Among children who required analgesia, only 159 children (32%) received analgesics, while 223 children (46%) did not receive any and there was no information about analgesia in medical records of 107 patients (22%) (**Figure 2**).



**Figure 2.** Provision of analgesics in children who sustained injuries.

The provision of analgesics in children with injuries by different healthcare entities is shown in **Table 1**.

Provision of analgesics	Healthcare entity							
	Emergency medical service team		School nurse		PC physician		Another hospital	
	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]
No analgesics administered	92	44.44	6	40.00	47	49.47	78	45.35
Analgesics administered	104	50.24	8	53.33	15	15.79	32	18.60
No information in the patient transfer card	11	5.31	1	6.67	33	34.74	62	36.05
Total	207	100.00	15	100.00	95	100.00	172	100.00
Statistical analysis	chi <sup>2</sup> <sub>Pearson</sub> test = 87.33 p < 0.001; chi <sup>2</sup> <sub>MV</sub> test = 96.30 p < 0.001							
Note: statistical analysis did not consider the school nurse.								

**Table 1.** Pain management in the study group.

The performed statistical analysis indicates that all the examined healthcare entities failed to administer analgesics in over 40% of cases (due to their scarce number, patients managed by school nurses were not taken into account). The lack of information about the administration of analgesics in the patient transfer card is also a matter of concern. That was significantly more common in children referred for treatment by a PC physician (34.7%) and patients referred by other hospitals (36%),  $p < 0.001$ , while that was the least common in children brought to the Department by emergency medical service teams (5.3%)—chi-square<sub>Pearson</sub> test = 87.33  $p < 0.001$ ; chi-squared<sub>MV</sub> test = 96.30  $p < 0.001$  (**Table 1**).

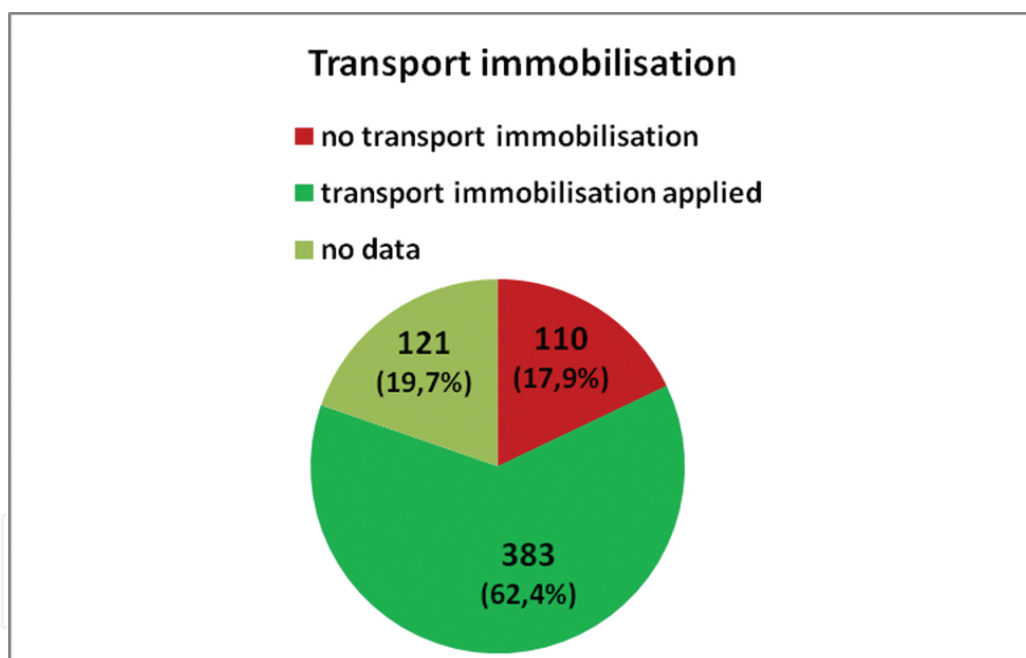
Among children who did not receive analgesics, children with upper extremity fractures—92 cases (41%) and lower extremity fractures—21 cases (9%) predominated. Detailed characteristics of injuries in children who were not provided with analgesics (despite indications) are presented in **Table 2**.

Location of injuries	Injury, contusion	Wound	Fracture	Dislocation	Sprain	Burn
Head	18	14	1	0	0	2
Neck	2	1	0	0	0	0

Location of injuries	Injury, contusion	Wound	Fracture	Dislocation	Sprain	Burn
Chest	3	0	0	0	0	4
Spine	2	0	2	0	0	0
Abdomen	3	0	0	0	0	1
Upper extremity	14	7	92	5	0	3
Lower extremity	8	11	21	1	4	4

**Table 2.** Characteristics of injuries in children who were not provided with analgesics n = 223.

In the group of 1493 children administered first medical aid by different healthcare entities transport immobilisation of sustained osteoarticular system injuries was required by 614 children (41.1%). 383 children (62.4%) were properly immobilised for transport, whereas 110 children (17.9%) presented to the Department with no transport immobilisation of fractures, dislocations or sprains. In 121 cases (19.7%), there was no information about applied transport immobilisation in the patient transfer card (**Figure 3**).



**Figure 3.** Application of transport immobilisation in children with injury.

Among 383 children immobilised for transport, 261 children (68.1%) were properly and 39 children (10.2%) improperly immobilised. In 83 children (21.7%), it was impossible to determine the quality of applied immobilisation (**Table 3**).

Transport immobilisation	Healthcare entity							
	Emergency medical service team		School nurse		PC physician		Another hospital	
	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]
Application of transport immobilisation	179	72.18	60	84.51	49	39.84	95	55.23
No transport immobilisation	48	19.35	10	14.08	32	26.02	20	11.63
No information in the patient transfer card	21	8.47	1	1.41	42	34.14	57	33.14
Total	248	100.00	71	100.00	123	100.00	172	100.00
Statistical analysis	chi <sup>2</sup> <sub>Pearson</sub> test = 61.92 p<0.001; chi <sup>2</sup> <sub>MV</sub> test = 66.81 p<0.001							
Note: statistical analysis did not consider the school nurse.								

**Table 3.** Healthcare entity and osteoarticular system immobilisation.

The regularity of transport immobilisation applied in the studied group of children was analysed taking into account the healthcare entity which applied such immobilisation (**Table 4**).

Regularity of transport immobilisation	Healthcare entity							
	Emergency medical service team		School nurse		PC physician		Another hospital	
	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]
Properly applied immobilisation	126	70.39	51	85.00	30	61.22	54	56.84
Improperly applied immobilisation	18	10.06	4	6.66	5	10.21	12	12.63
Appraisal impossible	35	19.55	5	8.34	14	28.57	29	30.53
Total	179	100.00	60	100.00	49	100.00	95	100.00
Statistical analysis $\chi^2_{\text{Pearson}}$ test = 41.14 p < 0.001; $\chi^2_{\text{MV}}$ test = 42.11 p < 0.001								
Note: statistical analysis did not consider the school nurse.								

**Table 4.** Healthcare entity and regularity of osteoarticular system immobilisation.

The carried out statistical analysis, which due to their scarce number did not take into account patients managed by school nurses, indicated that transport immobilisation in children who required that was most commonly applied by emergency medical service teams, followed by hospital emergency departments/emergency rooms of other hospitals and PC physicians. Those observations were statistically confirmed: chi-squared<sub>Pearson</sub> test = 61.92  $p < 0.001$ ; chi-squared<sub>MV</sub> test = 66.81  $p < 0.001$ .

It should also be noted that transport immobilisation was abandoned by emergency medical service teams in about 20%, by PC physicians in over 26% and by other hospitals in about 11% of cases.

Transport immobilisation was significantly more often properly applied by emergency medical service teams (70.4%) and PC physician (61.2%). On the other hand, only half of the patients from other hospitals presented to the Department properly immobilised (56.9%). Those observations were statistically confirmed: chi-squared<sub>Pearson</sub> test = 41.14  $p < 0.001$ ; chi-squared<sub>MV</sub> test = 42.11  $p < 0.001$ .

It is worth noticing that in the case of one-third children referred to the Department by a PC physician or from other hospitals there was no information about applied transport immobilisation in medical records. It should also be noted that there was no information about the regularity of transport immobilisation in patients transferred by other healthcare entities in almost 30% of cases, while it was known that children had had transport immobilisation applied as such a note had been made in the patient transfer card (Tables 3 and 4).

Among children who were not immobilised for their transport to the Department, children with upper extremity fractures—33 cases (30%) and lower extremity fractures—14 cases (12.7%) predominated. Children with contusions of various regions of the body—41 cases (37.2%) and sprains within the ankle joint—13 children (11.8%) were also referred to the Department. Detailed characteristics of injuries in children without transport immobilisation are shown in Table 5.

Location of injuries	Injury, contusion	Wound	Fracture	Dislocation	Sprain
Head	12	0	3	0	0
Neck	0	0	0	0	0
Chest	2	0	0	0	0
Spine	2	0	2	0	0
Abdomen	3	0	0	0	0
Upper extremity	9	2	33	0	0
Lower extremity	13	0	14	2	13

**Table 5.** Characteristics of injuries in children without transport immobilisation  $n = 110$ .

Examples of improper transport immobilisation in children who presented to the Department referred by different healthcare entities are shown in Figures 4 and 5.

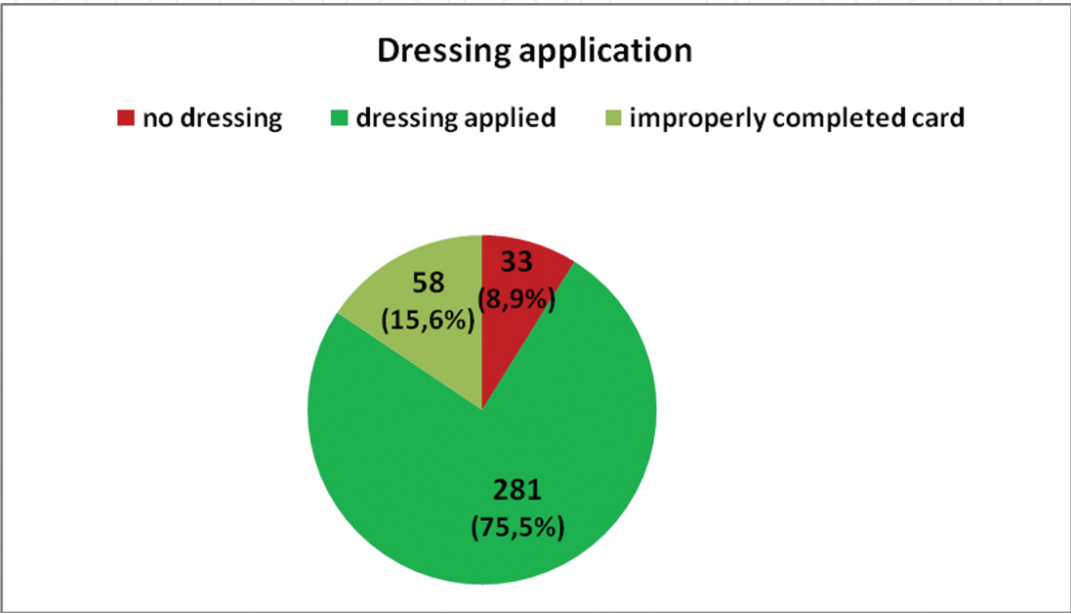


**Figure 4.** Transport immobilisation in a boy with displaced fractures of both forearm bones.



**Figure 5.** Transport immobilisation in a girl with a humeral bone fracture—bandage fixing the splint to the arm ends at the height of the fracture crevice.

Among 1493 children who were prehospitally managed by different healthcare entities, the integrity of the skin was breached due to an injury in 372 children (24.9%). The medical management of wounds, abrasions or burns in children with an injury is shown in **Figure 6**. Among children not provided with dressing, children with head traumas—15 cases (45%), upper and lower extremity injuries—6 children (18.2%) and burns of different body regions—12 children (36%) predominated.



**Figure 6.** Medical management of wounds, abrasions and burns in the study group.

Among 281 children with dressed integumentary traumas, dressing was properly applied in 260 cases (92.5%), improperly applied dressing was observed in 5 children (1.8%), while no assessment of dressing regularity was noted in 16 cases (5.7%) (**Table 6**).

Wound management	Healthcare entity							
	Emergency medical service team		School nurse		PC physician		Another hospital	
	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]
Dressing applied	174	82.86	10	100.00	42	55.26	55	72.37
No dressing	16	7.62	0	0.00	13	17.11	4	5.26
No information in the patient transfer card	20	9.52	0	0.00	21	27.63	17	22.37
Total	210	100.00	10	100.00	76	100.00	76	100.00

Wound management	Healthcare entity							
	Emergency medical service team		School nurse		PC physician		Another hospital	
	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]
Statistical analysis	chi <sup>2</sup> <sub>Pearson</sub> test = 26.67 p < 0.001; chi <sup>2</sup> <sub>MV</sub> test = 25.75 p < 0.001							
Note: statistical analysis did not consider the school nurse.								

**Table 6.** Analysis of wound management regularity depending on the healthcare entity.

The regularity of dressing applied in the studied group of children was analysed taking into account the healthcare entity which applied such dressing (**Table 7**).

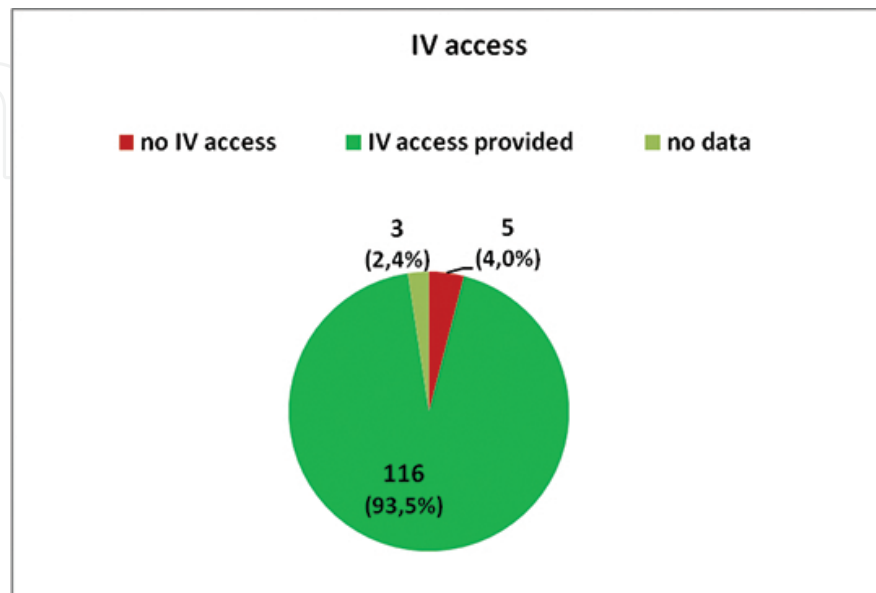
Regularity of wound management	Healthcare entity							
	Emergency medical service team		School nurse		PC physician		Another hospital	
	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]	Number of children	Structure ratio [%]
Properly applied dressing	166	95.40	10	100.00	37	88.10	47	85.45
Improperly applied dressing	1	0.57	0	0.00	2	4.76	2	3.64
Appraisal impossible	7	4.03	0	0.00	3	7.14	6	10.91
Total	174	100.00	10	100.00	42	100.00	55	100.00
Statistical analysis	chi-squared <sub>Pearson</sub> test = 23.15 p < 0.001; chi-squared <sub>MV</sub> test = 24.11 p < 0.001							
Note: statistical analysis did not consider the school nurse.								

**Table 7.** Analysis of wound management regularity depending on the healthcare entity.

Although the statistical analysis indicated significantly common proper management of wounds and integumentary injuries, irregularities of that management were observed. Detailed information is shown in Tables 6 and 7.

In the study group, 124 out of 1493 children (8.3%) necessitated prehospital IV access provision for the intravenous administration of medications or fluids. Among those 124 children, a majority—116 (93.5%) patients—were provided with a peripheral venous catheter, while IV

access was not provided in 5 children (4%), and there was no information about IV access in the patient transfer card in 3 children. Among children provided with IV access, irregularities were observed in 2 cases. They consisted in placing a peripheral venous catheter on the fractured extremity in one case and improper securing of IV access in the other (**Figure 7**).



**Figure 7.** Provision of IV access in the studied population.

Prehospital aid properly administered to the child with an injury significantly affects the prognosis and fate of the patient. Therefore, the knowledge of the rules of management and administration of first aid to the child with bodily injuries is essential to every physician, nurse and paramedic working in the emergency medical service system and primary healthcare.

Own experience and data from the world literature indicate that prehospital medical aid administered to the child with an injury is not always proper. Irregularities most often concern the manner of transport immobilisation and pain management in children with fractures within the osteoarticular system and in children with burns [25, 33, 34]. Main barriers limiting the administration of analgesics (morphine) to children with an injury include difficulty with pain severity assessment in the child, lack of the patient's/legal guardian's consent to receiving analgesics and difficulty with providing IV access [25–27].

Our own study evaluating the manner of administering prehospital aid to the child with an injury by different healthcare entities was based on the observation of 1493 cases.

Boys significantly predominated girls in the study group. The male to female ratio among children was 1.52:1,  $p < 0.001$ . Similar observations were made by other authors unanimously emphasising that the higher incidence of injuries in boys arises from their increased cognitive activity [5, 13, 35].

The age in the study group ranged from 1 day to 18 years (the median age was 11.4 years, and the mean age was 11.2 years). It was noted that, similarly to other studies in Poland and the

world, over 50% of injuries occurred in children aged 5–14 years,  $p < 0.001$ , which may result from very intense activity and curiosity about the world as well as children's lack of ability to evaluate threatening dangers during play [3, 9, 35].

In the studied group of children prehospital medical aid was most commonly administered by emergency medical service teams (42.7%) and the least commonly by a school nurse (6%), although school was often the place where an injury was sustained. The phenomenon stems from the fact that an emergency medical service team not only administers first medical aid but also ensures professional transport to a hospital emergency department.

When comparing how the administration of prehospital aid to the child with an injury is organised in Poland and the world, some similarities can be observed. In the United States and Canada, when emergency medical service teams are called, prehospital aid is most often administered by emergency medical technicians of the first and second level, paramedics, nurses and the least commonly—physicians [36]. In Poland, in emergency medical service teams, aid is mostly administered by paramedics, and slightly less often—by nurses and physicians.

Among injuries in the children in the study group head injuries were more often observed than in studies by other authors (the study group: 42.1% *vs.* studies of the National Hospital Ambulatory Medical Care Survey ED files: 23.1%), whereas the incidence of extremity injuries was similar to observations by other authors. The predominance of head injuries over extremity injuries observed in our study results from the customary referral of every child with a head injury to the surgeon by the paediatrician. Also, similarly to reports by other authors, minor head injuries predominated among injuries [33, 37, 38].

Neck injuries were rarely found in children and those were mainly blunt traumas and integumentary wounds. Chest and abdominal injuries were slightly more often observed. Among patients who sustained chest injuries, those were mostly superficial chest injuries, with chest wounds and rib fractures being less common. Similarly, in children who suffered an abdominal injury superficial abdominal injuries predominated, while crotch and external genitals or parenchymatous organs injuries were less often observed.

Damage to the upper and lower extremity was among the most common consequences of injuries in children. Our own study indicated that, similarly to the study by Erik M. Hedstrom of Sweden, the most common fracture within the upper extremity was the fracture of the forearm bones, whereas the fracture of the femoral bone shaft was the most common lower extremity injury [3, 15, 38].

The analysis of the management of children with an injury by different healthcare entities showed that a majority of children (72%) were properly administered prehospital medical aid. However, some oversights were found in medical management concerning the administration of analgesics, lack or irregularities of applied transport immobilisation and irregularities in the dressing of integumentary injuries.

Main irregularities observed in 'post-traumatic' children included the lack of the appropriate pain management of children with an injury. As indicated by our own study, pain relief efforts were made in merely 32.5% of children with indications for pain management. Almost a half of patients (45.6%) did not receive any analgesics despite indications. Among children who did not receive analgesics, children with upper extremity fractures (41%) and lower extremity fractures (9.5%) predominated. Similarly to the study by Rawlins [39], we noted the lack of pain management in 6.3% of children with burns. According to the American Academy of Pediatrics and American Pain Society, main barriers to managing pain in children include as follows: the myth that newborns and children feel milder pain than adults, lack of appropriate assessment of the presence of pain, lack of knowledge of pain management and fear of side effects of analgesia (particularly respiratory system depression) [23, 24, 26]. It arises from the study performed by physicians of the paediatric emergency department in Auckland that the fear of causing to the child pain connected with injection resulted in the lack of administration of analgesics [28]. Similar observations were made by the Toronto team [36]. Researchers from the United States also noted that abandoning the administration of analgesics was not associated with the specialty of physician providing aid [26].

Another reservation as to the management of children with an injury regarded the transport immobilisation of children with osteoarticular system injuries. The world and Polish literature offers few studies dedicated to that issue [29, 30]. Out of 614 children requiring transport immobilisation, immobilisation was applied in only 62.4% of cases, out of which in 90% properly. On the other hand, 17.9% of the injured children presented to the Department with no transport immobilisation of fractures, dislocations or sprains, while in 19.7% of cases, there was no information about applied transport immobilisation in the patient transfer card. Among children with improperly applied transport immobilisation, the irregularity of immobilisation concerned the extent of immobilisation and sloppy securing of the transport splint on the injured extremity.

The irregularity of applied transport immobilisation was observed mainly in children with fractures within the osteoarticular system of the upper extremity. Immobilisation irregularities were most common in children with forearm bones' fractures (improper extent), clavicular fractures (sloppy bandaging of the extremity to the chest), humeral fractures (improper extent) and within the hand (2 children—incorrect securing with bandage). Irregularities were also observed in children with lower extremity fractures (improper extent, sloppy securing). There were also cases of improper securing of children after traffic accidents during transport (*e.g.* lack of the cervical collar and incorrect laying on the spinal board (only three straps without side head supports)). The lack of transport immobilisation and its irregularity can be explained by both the lack of knowledge of the proper extent of injured extremity immobilisation and lack of awareness of the fact that properly applied transport immobilisation not only protects against additional injuries but is also a basic method of pain management in the child with an injury within the osteoarticular system. The child with a properly immobilised injured extremity suffers less. Sloppiness in applying transport immobilisation may result from the lack of appreciation of the importance of that medical procedure. During classes, students think that the proper application of transport immobilisation is a very simple task and are not

interested enough in that issue. The lack of transport immobilisation may also result from erroneous consideration that handling the child when applying immobilisation may be painful to the child. The lack of medical equipment used to immobilise the extremity which is properly adjusted to the size of the child may also be among reasons behind the lack of the transport immobilisation of the child.

The manner of the dressing of wounds and burns in the study group was also questionable as the lack of dressing was found in 8.9% of patients, improper dressing of a wound—in isolated cases and lack of information about dressing in medical records—in 15.6% of cases. Irregularities in wound dressing concerned burn wounds.

Oversights in administering prehospital aid to children with an injury and gaps in medical records concerned all the studied healthcare entities. Observations concerning neglect while administering first aid to the child with an injury by emergency medical services were described by other authors too [28].

### 3. Conclusions

1. The management of the child with an injury in the Łódzkie region is unsatisfactory.
2. Despite the training of physicians, nurses and paramedics in the management of paediatric injuries, the lack of analgesic provision is still encountered in almost half of the patients, irregularities in transport immobilisation—in about 10% of the patients and irregularities in wound management and IV access provision—in isolated cases. In one-fourth of the cases, gaps in medical records were also noted.
3. The observed irregularities indicate that it is necessary to intensify training related to medical aid for children after injuries and supplement equipment adjusted to the size of the child available in emergency medical service teams, primary care physicians' surgeries and surgeries at schools.

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