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EPIDEMIOLOGICAL ASPECTS OF POLYTRAUMATISM IN THE PEDIATRIC POPULATION

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Abstract

"Polytrauma" is a term frequently used in the practice and literature of trauma specialities. This term refers to a series of multiple injuries at the level of several organs or systems, in contrast to isolated traumatic injuries, where a single injury is encountered. [Marsden NJ, 2022]

Millions of patients with polytrauma require medical care, some of them suffering injuries that will lead to lifestyle changes with the limitation of multiple activities. Globally, road collision is the leading cause of traumatic death, followed by suicide and homicide.[Marsden NJ, 2022]

"Golden hour" expression coined by Professor Richard Cowley, concludes that most deaths due to polytrauma occur in the first 60 minutes after injury.[Marsden NJ, 2022]

Following the research carried out on deaths from traumatic causes, a trimodal distribution was highlighted from them: immediately, early and late. The first 2 represent 80% of all traumatic deaths, occurring in the first hours after the injury, either due to brain injuries or major exsanguination. On the other hand, late deaths occur within days to weeks of trauma, secondary to sepsis or multiple organ failure. [Marsden NJ, 2022]

Key words: morbidity, mortality, management protocol, polytrauma, children

Introduction

Due to the high morbidity and mortality associated with polytrauma, the initial management of these patients must follow the principles of an organized approach. Management protocols designed for treating the polytrauma patients helps medical teams by promptly and systematically addressing them, leading to improved long-term subsequent outcomes. [Marsden NJ, 2022]

Polytrauma patients can present unexpectedly in any medical service, including those that do not have trauma centers.Care of pediatric trauma patients requires an understanding of the distinct anatomy and pathophysiology of the pediatric population compared to adult trauma patients. Therefore, systematic management of these patients by an interprofessional team is essential in order to initiate the treatment or an eventual transfer when the patient is stable. Thus, the trauma teams are made up of members of the emergency departments, general surgery, orthopedic surgery, neurosurgery, anesthesia, intensive care, radiology department and laboratory. At the same time, pharmacists and trauma/emergency nurses are involved in case management according to medical needs: pharmacists must distribute the necessary drugs as quickly as possible, and the nurses will participate in monitoring the patient's condition and collecting information about the circumstances of the trauma, either from the patient (if possible) or from his relatives. Every member of the trauma team is vital to providing a high standard of patient care. [Marsden NJ, 2022]

Although most pediatric patients with polytrauma survive, long-term sequelae are common. The most common causes of long-term functional deficits after pediatric multiple trauma involve central nervous system and musculoskeletal injuries. Orthopedic care of patients with polytrauma is important to facilitate early mobilization and care of these children, as well as to minimize late damage. [Kay RM, 2006]

Trauma accounts for significant mortality and morbidity in children worldwide. About 830,000 children die each year from accidental injuries. Road collisions, falls and drowning are among the most common mechanisms. Although 95% of these injuries occur in low- and middle-income countries, pediatric injuries also remain a significant

problem in high-income countries, accounting for 40% of all pediatric mortality. [Naqvi G, 2017]

In pediatric trauma, there is significant variation in the pattern of injury and associated mechanisms between age groups, which will be highlighted in what follows.

Material and methods

The present research aimed to expose the extremely large amount of human and material resources that blacks involve the care of a pediatric patient with polytrauma, starting from the time of the accident and until the patient's recovery, along with the social reintegration criteria.

In order to carry out the work, a number of socio-demographic, diagnostic, paraclinical and therapeutic variables were taken into account, with an impact on the management stages of the pediatric patient presented in the Emergency Department of Sf. Ioan Children's Hospital, Galati .The main study group consisted of a number of 710 polytraumatized children, whose information was collected between 2015 and December 2018. Analyzing the databases of the Sf. Ioan Emergency Clinical Hospital for Children in Galati, we continued with centralization of information on pediatric patients and we can conclude the following: from a total number of 17080 presentations to the CPU during the study years for trauma of any kind, 710 polytraumatized pediatric patients (as part or victim of an road accident, by falling, by heteroaggression, hitting by domestic animals).

The establishment of the mechanisms for carrying out the measurements and evaluating the results was based onfrequency indicators. These indicators show the level and intensity of a phenomenon in a certain period of time. Also, the structure indicators were evaluated, which highlight the ratio of the entire study group. The data were collected from the presentation sheets and medical records, later loaded and processed with the help of the statistical functions of MS EXCEL 2021 and SPSS v.26.0 (IBM Statistical Package). Descriptive statistics were used to calculate the central tendency and dispersion of the data, using the 95% confidence interval (IC95% confidence interval), standard error of the mean, minimum and maximum value.

Categorical values were entered into contingency tables and the non-parametric chi square ($\chi 2$) test was applied to them.

The result

The lowest number of presentations in the Emergency Department was detected in 2017 - where 122 cases of polytraumatized patients were reported.At the same time, within the group, there is a higher proportion of male patients (n= 466 patients) compared to a number of 244 female patients (respecting a ratio of approximately 2:1). Performing the test$\chi 2$, through a value p =.031, determines index p = 0.031). In this situation, we will continue with the rejection of the null hypothesis according to which the environment of origin is not a potentially predictive factor of the patients' evolution.

Next, the descriptive statistical analysis of the scalar variable defined as age is characterized by aaverage of 9.98 years, with a standard deviation of ±4.81 years. The lowest incidence of cases is found in patients aged less than one year (n = 28 cases), followed by almost double the number of patients between the ages of 1 and 3 years. The majority is owned by patients aged between 3-10 years (n = 260 cases).

Next, by analyzing the figure presented below, I will highlight a correlation of the incidence of polytrauma cases, by simultaneously referring to two characteristics.

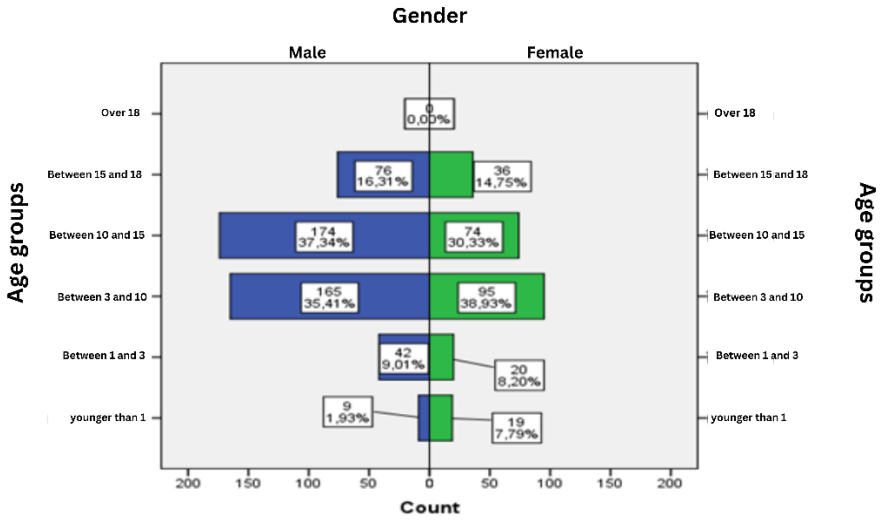


Fig. 1. Correlation between the incidence of presentations according to their ages and gender (source Bogdan Goroftei R., 2020)

Regarding the pediatric population, the most frequent presentations occurred between 10:00 and 20:00, with a peak in the incidence of presentations around 22:00. Means of provenance reported at CPU arrival times show uneven distributions. Thus, it can be observed that although 70% of the patients come from the urban environment, while only 30% from the rural environment, the incidence of presentations is approximately equal compared to the times when the patients arrived in the CPU (between 10 a.m. and 8 p.m.).

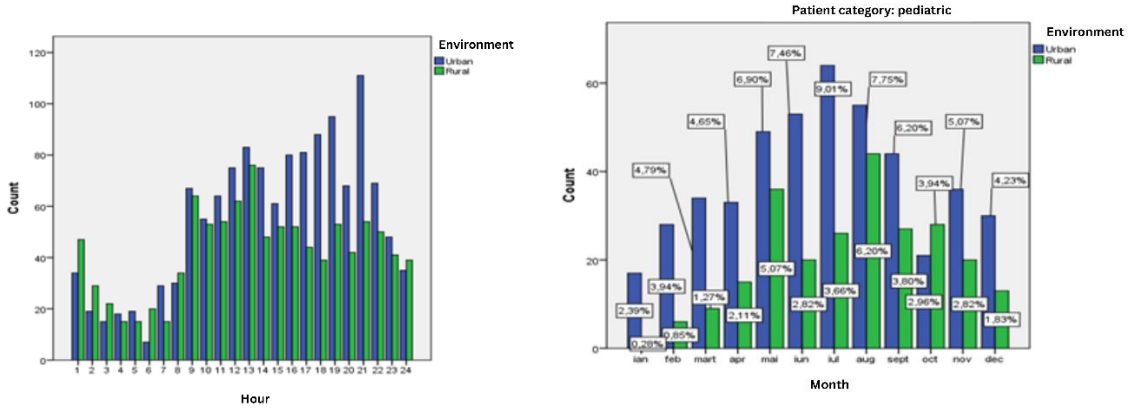


Fig. 2.The number of patients from the urban and rural areas according to the hour (source Bogdan Goroftei R., 2020) - left, Correlation between means of origin and month (right) (source Bogdan Goroftei R., 2020)

On the other hand, the correlation link that exists between the means of origin and the months of presentation in the CPU was statistically followed (p = .001). Thus, the null hypothesis will be invalidated and consequently it is necessary to admit the fact that the weight of pediatric polytrauma cases related to the months of presentation is influenced by the patients' environment of origin.

The scatter plot matrix represents the existing correlations between the 3 scalar type variables tracked previously through representative histograms with the deviations of the Gaussian distribution curves.

Discussing in detail, it can be observed that there exists a series of negative interdependence relationships, inversely proportional, with different degrees of statistical power. Thus, in terms of the relationship between the age of the patients and the hours of presentation, a negative prediction line can be noted, which means that the younger ages of the patients were correlated with hours of presentation concentrated in

the second half of the day, mainly after 8 p.m. The hours of presentation, correlated with the minutes spent in the CPU room (leaving the guard room being possible in any of the previously mentioned ways: discharge, admission, transfer or refusal of admission) presupposes the existence of a dependency relationship negative again with medium statistical significance power.

Last but not least, we bring to light the relationship between the two remaining variables, namely: the ages of the patients related to the number of minutes spent in the CPU. This shows a negative regression line, but with the strongest degree of statistical significance due to its downward slope. Analyzing the corresponding scatter plot, it can be concluded that the smaller waists of pediatric patients are correlated (at the level of our study group) with a longer number of minutes spent at the CPU. We can attribute this negative prediction to the conclusions provided by the numerous international studies carried out that have demonstrated not only that the young age of followed patients (mainly below the 3-year limit) is correlated with trauma with an increased degree of complexity in terms of correct management, but also the difficulty of anticipating any evolution.

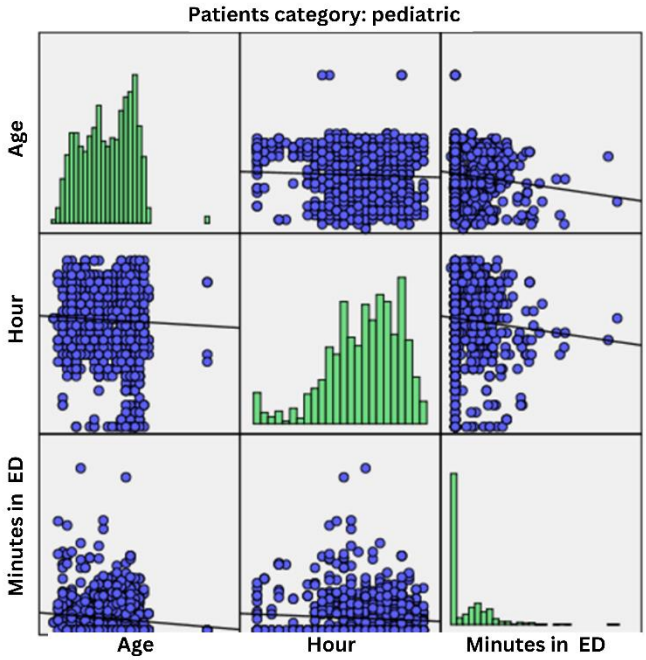
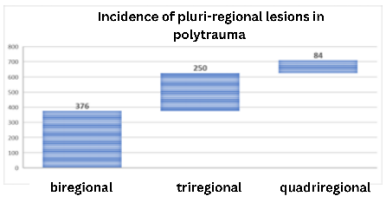


Fig. 3. Matrix scatter plot (source Bogdan Goroftei R., 2020)

The transfer of pediatric patients from the place where the polytrauma occurred to the CPU was mostly carried out by the SAJ service (n = 406), of which SAJ Galați 396 patients, SAJ Tulcea 10 cases. There were also cases of subjects arriving with UTIM/EPA (n= 167 patients), coming with their own means (n= 108), respectively air transport (n= 29).

Most patients with urgent admission were from the urban environment, totaling a number of 329, this fact being possible in part due to greater accessibility to the means of therapy. As for rural patients, they presented to the CPU claiming an urgent nature in approximately 125 cases, closely followed by those with critical care (n = 111).

Regarding the number of affected regions in the patients included in the study, we can follow presentation information in the figure below. The vital parameters were also analyzed, shown in the underlying figure (right).



Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Temperature in C	36,2	38,4	36,975	,1786	,884	,092	11,267	,184
HR	59	193	87,33	14,302	1,875	,092	7,951	,183
SpO2	92	100	99,32	,792	-1,851	,092	10,530	,184
RR	11	58	22,04	4,230	1,370	,092	7,392	,183
SJP	80	156	119,63	11,363	,133	,092	-,152	,183
dBF	40	90	65,51	6,497	,727	,092	2,723	,183

Fig. 4. The incidence of pluriregional lesions in polytrauma (source Bogdan R., 2020) – left

As can be seen, the age of the patients at the time of presentation to the CPU describe, together with the other two scalar variables (FC and FR respectively), an apparently negative dependence relationship. More precisely, as can be seen, ages close to the upper threshold of 18 years are associated with values of heart rates and matching respiratory rates below average. On the other hand, we follow the dependency relationship between the two previously mentioned paraclinical parameters, we refer here to FC and FR. Analyzing the linear regressions corresponding to this relationship we can see that there is a strong relationship of positive statistical significance between these two variables.

An unfavorable evolution of patients under the age of 18 can also be influenced by the existence of younger ages (we are discussing here the fact that in the case of the polytraumatized group, children who were younger than three years of age had associated unfavorable clinical evolutions compared to those with ages over 15).

In the CPU the following surgical maneuvers: 412 sutures, 324 plaster casts, 64 orthopedic reductions, 15 cases that required thoracic drainage, 8 central venous catheterizations. In patients with a GCS less than or equal to 8 points, analgesia was performed followed by IOT + VM. For the follow-up of patients enrolled in the batch, 497 x-rays, 274 CTs, 303 ultrasounds were performed.

We continue with the presentation of the length of stay of patients in the Emergency Department, which proved to be dependent on the complexity of the case history. Most cases of pediatric polytrauma were evaluated and stabilized within 30 minutes in the CPU. These are the patients who required immediate surgical intervention (abdominal trauma with organ ruptures, penetrating abdominal trauma, open fractures, crush syndrome and post explosions).

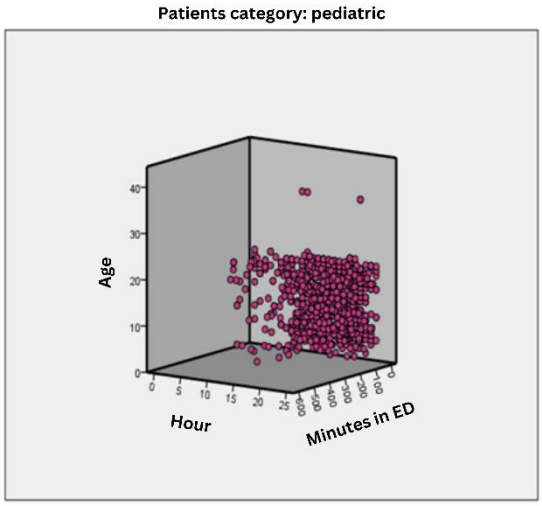


Fig. 5.Cube matrix 3 D - scatter plot (source Bogdan R., 2020)

In this case, through the analysis of the graphic representation, it can be observed that at the level of the entire studied lot, there is a concentration of the population located between the age threshold between 3-18 years, with an average number of stays at the

CPU of 54 minutes. Most of the presentations for these parameters are found between the time interval between the minimum represented by 3 pm, respectively 24.

The first two age groups (totalling the period 0-3 years) mainly presented traumas by falling (94%), resulting in damage to the cephalic extremity, by association with traumas to the limbs and chest. A very small percentage was represented by patients who were victims of road accidents (6%).

In the next age group (3-10 years), TCC/TCF associations predominate along with limb and thoraco-abdominal trauma. The main production mechanisms are: falls from a height (72%), followed by road accidents (17%), heteroaggressions (9%) and being hit by an animal (2%).

Finally, patients aged over 10 years (initially classified into two groups 10-15 years, respectively 15-18 years) were grouped at this point as the existence of approximately equal weights of the production mechanisms was noted:

- falls (from a height – house, trees, garage, falls from an animal-drawn hitch / falls from the same level) in a percentage of 46%
- road accidents 33%
- heteroaggressions (predominant in the 15-18 age group) 19%
- animal strike 3%

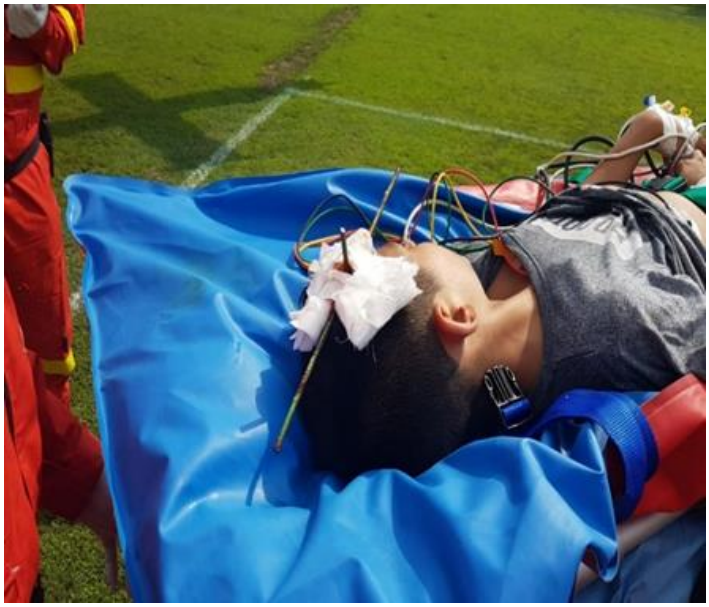


Figure 6 Pediatric patient with head trauma (own archive)

Fig. 7.Open fracture left upper limb (personal archive)

Discussions

As there are not enough comprehensive and accurate statistics regarding the epidemiology and clinic of trauma during the period of COVID-19, the following study conducted during the period of COVID-19 in a care center in northern Iran will describe pediatric trauma. [Reihanian Z, 2022]

This study was carried out by Zoheir Reihanian et al., it is a cross-sectional study that included 543 children under the age of 15, hospitalized in the first 6 months of 2019 (before the COVID-19 pandemic) and in the first 6 months of the year 2020 (peak of the COVID-19 pandemic).[Reihanian Z, 2022]

Of the total of 543 children, 436 were hospitalized before the COVID-19 pandemic, and 107 were hospitalized during the peak of the COVID-19 pandemic. The maximum age of hospitalized patients was between 2 and 6 years, and in terms of gender, 70.5% were male. The main mechanism of injury both before and during the pandemic was falls from height .(46.3%, respectively 42.1%), followed by road accidents (35.6% versus 36.4%). Trauma of a penetrating nature is found in a fairly low percentage among pediatric patients in both periods, 6.9% and 9.3%, respectively. As anatomical regions involved, the most common were the head and neck, followed by the extremities. At the same time, polytraumatism is found among children in a proportion of 35.6% before the pandemic and 35.5% during the pandemic. [Reihanian Z, 2022]

Unlike those of younger ages, among children aged between 12 and 15 years, the main mechanism of trauma production is represented by road accidents, these being reported in a higher proportion during the COVID-19 pandemic (68.4% versus 50.9%). On the other hand, it seems that the proportion of trauma caused by falls from height has decreased during the COVID-19 period.[Reihanian Z, 2022]

Regarding the way a polytraumatism occurs in children, in addition to the mechanism by which it occurs, we can also discuss the way it occurs: accidentally or consciously.[Marie-Louise HJ Loos, 2022]

Thus, the retrospective study conducted byMarie-Louise HJ Loos et al. between January 1, 2010 and January 1, 2016, at the level of 11 trauma centers in the Netherlands, it included 1623 children who presented themselves at these centers with polytrauma. Most cases of polytraumatism, 1452 (89%) occurred accidentally, in contrast to 39 children (2.4%) who suffered polytraumatism following activities performed consciously. Among the activities performed by children that resulted in a polytrauma are: drowning and falling from a height. Even though the number of cases of consciously occurring polytrauma is lower, the mortality rate among them appears to be higher (16% versus 10%). [Marie-Louise HJ Loos, 2022]

Consistent with early studies and the study byAnn R. Coll on trauma among children emphasized the increased incidence of polytrauma among male patients, as well as the main mechanism of their production represented by road accidents.

Thus, the study was carried out over a period of 3 years (January 2012-December 2014) and included 213 children under the age of 16. Following the analyzes performed, it was observed that male patients are in the majority (137 versus 76), and the average age was 7.8 years.[Naqvi G, 2017]

Table 1 -*The incidence of polytraumas according to the sex of the patients*

Sex	**Number (percentage)**
Male	137 (64.3%)
Female	76 (35.7%)

Table 2 –The incidence of polytrauma in the studied group according to the age of the *patients*

Age	Number (percentage)
<1 year	28 (13.1%)
1–5 years	60 (28.2%)
6–10 years	50 (23.5%)
11–16 years	75 (35.2%)

As previously mentioned, the main mechanism of occurrence is represented by the road accident, followed by the fall from a height. In addition to these, other production mechanisms can be found, as follows:[Naqvi G, 2017]

Table 3– The incidence of polytrauma production mechanisms within the studied group

The production mechanism	**Number (percentage)**
Vehicle related incident	98 (46.0%)
Fall from <2m	57 (26.8%)
Fall from >2 m	26 (12.2%)
Coup	13 (6.1%)
Non-accidental injury (suspected)	8 (3.6%)
Hanging	3 (1.4%)
Crush	2 (0.9%)
Explosion	1 (0.5%)
Stabbing	1 (0.5%)
Other	4 (1.9%)

Table 4– The relationship between the child's age and the mechanism of production of polytraumatism

Age	Related incident of vehicle	Fall of <2m	Fall of >2 m	Coup
<1 year	5 (2.3%)	8 (3.8%)	3 (1.4%)	3 (1.4%)
1–5 years	18 (8.4%)	25 (11.7%)	10 (4.7%)	3 (1.4%)
6–10 years	29 (13.6%)	9 (4.2%)	7 (3.3%)	3 (1.4%)
11–16 years	46 (21.6%)	15 (7.0%)	6 (2.8%)	4 (1.9%)

Analyzing the link between the age of the patient and the production mechanism (analysis performed on the mechanisms with higher frequency) we can see that although the number of polytraumas encountered in children younger than 5 years is relatively small, it seems that the mechanism most often incriminated is the fall from the less than 2m. On the other hand, road accidents are more often incriminated in children aged between 6-10 years, respectively 11-16 years. However, it can be observed that polytraumas caused by falls from a height greater than 2m and by blows are encountered in small numbers in all age groups. [Naqvi G, 2017]

Regarding the affected regions of the body, it is observed that the injury to the head is the most frequent (54%), followed by the injuries to the limbs (39.9%). Isolated head injuries were the only type of injury that was fatal in isolation.[Naqvi G, 2017].

Table 5 –Injury patterns and associated mortality

Regional lesions	Isolated lesions	death rate	Associated injuries	death rate
Head	48 (22.5%)	2 (4.2%)	67 (31.4%)	8 (11.9%)
Face	2 (0.9%)	0 (0%)	37 (17.4%)	3 (8.1%)
thorax	0 (0%)	0 (0%)	36 (16.9%)	5 (13.9%)
Abdomen	18 (8.4%)	0 (0%)	21 (9.8%)	2 (9.5%)
limbs	38 (17.8%)	0 (0%)	47 (22.1%)	4 (8.5%)
Spine	7 (3.3%)	0 (0%)	15 (7.0%)	2 (13.3%)
PELVIC	1 (0.5%)	0 (0%)	14 (6.6%)	1 (7.1%)

As previously mentioned, a management plan together with a multidisciplinary team are necessary for the best possible outcome for the polytrauma patient. [Payal P, 2013]

Following what was presented, a study conducted in 2013 in northern India aimed to highlight various problems in the management of polytraumas. At the level of the emergency department in India, an average of 6-7 patients with polytraumatism are presented daily, some presenting with their own means, others being transferred from other hospitals.[Payal P, 2013]

The study carried out was a retrospective one, which included 210 patients with polytrauma who presented themselves in the emergency department over a period of 2 months. The results were emphasized that the male people presentmore often

polytraumas, unlike female patients. Regarding the major etiological factor, road accidents are frequently incriminated. Regarding problems encountered in patient management, out of a total of 210 patients, 32 encountered problems that involved coordination between various specialties participating in case management. [Payal P, 2013]

The final idea of this study was appropriate trauma management team and a well-defined standard operating procedure are the keys to effective management of trauma patients by minimizing the problems encountered. [Payal P, 2013]

Conclusions

The most frequent localizations of the lesions were at the level of the locomotor system (affecting the limbs, the pelvis as well as the vertebral column), data that can be corroborated with the information obtained at the international level.

The general condition of the subjects was predominantly influenced, so we could conclude that for 33 of them it was necessary to transfer to another hospital unit, while 543 patients required hospitalization in one of the wards of the Children's Hospital in Galati. The rest of the subjects presented favorable evolution to the application of emergency treatments.

During the study period, nine patients were declared dead in the CPU. Statistically significant differences were recorded in the number of deaths, from one year to another, with a higher frequency of deaths for the age group 0-2 years and 16-18 years, and the lowest for 8-10 years. More than two-thirds of the deaths occurred among children in rural areas. The most cases of polytrauma resulting in death were reported in July, the Friday's and the fewest in February and Monday's, and traffic accidents represented the highest incidence of the mortality that occurred. Regardless of the particularities of the death, the lack of supervision from the family, including at home, draws attention.

We can define the characteristics of the case: a child of approximately nine years of age, most likely male, from an urban environment, with polytrauma from a road accident, fall or aggression, with a Glasgow score>13, with multiregional polytrauma (often TCC/TCF/Spinal trauma vertebral/ Abdominal contusion/ Thoracic contusion,/

Non-penetrating or penetrating wounds and possibly the association with limb fractures).

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