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CLINICAL STUDY

Pediatric polytrauma at intensive care unit

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Abstract: *Background:* Polytrauma and its consequences present a rising diagnostic and therapeutic problem we face at ICU every day. The goal of this research was to analyze and improve the diagnostic and treatment procedures.
Patients and methods: A prospective research carried out at the multidisciplinary Intensive Care Unit during a period of over 2 years included 126 patients aged less than 15 years. Immediately on admission, all patients received the necessary care strictly complying with polytrauma treatment algorithms. We recorded the patients basic data (age, sex), cause of injury (fall, traffic accidents etc.) and injury type (blunt or penetrating) as well as the immediately performed procedures. The analysis of patients and calculation of mortality rates was based on time that had elapsed from injury to arrival at ICU, and severity of their injuries assessed as ISS score. Injury severity was assessed on admission also by using GCS, PTS, NISS and TRISS. Performed surgical interventions, mechanical ventilation duration, and total ICU time were recorded, as well as the need for transfer to a pediatric trauma centre.
Results: 96 patients arrived within 2 hrs from injury, with ISS>15, and/or PTS<8.
52 patients arrived within "golden hour"; 37 of them had ISS 16–26 and 15 had ISS>26 with mortality rate 3 (8 %) vs 3 (20 %) ($p<0.001$). Of the remaining 44 patients, 30 had ISS 16–26 and 14 had ISS>26, with mortality rate 7 (23.3 %) vs. 5 (35.7 %) ($p<0.001$).
Conclusion: The arrival at ICU during "golden hour", precise algorithms, high quality of diagnosis, monitoring and therapeutic procedures had an essential influence on the positive end-outcome and improved the survival and recovery rates in polytraumatized children *(Tab. 4, Fig. 1, Ref. 18)*. Full Text (Free, PDF) *www.bmj.sk*.
Key words: pediatric trauma, ICU, ISS, PTS.

Polytrauma presents a rising healthcare and economic problem in the modern world (1). In childhood and adolescence, it is the leading cause of death and requires sophisticated and specific diagnostic and treatment algorithms (2). There is evidence that pediatric trauma centers have lower mortality rates when compared with general hospitals (3). However, due to high costs of such centers, especially in developing countries, most pediatric polytrauma patients are cared for at general hospitals, or adult trauma centers. Furthermore, a large number of trauma scores are used in children, making it difficult to compare the results from different studies in terms of mortality rates and overall treatment outcome (4). Fortunately, most pediatric trauma victims are young individuals with otherwise healthy organisms, thus their recovery potential is far greater than that of adult patients in regard to musculoskeletal as well as other system injuries (5, 6).

Therefore, the goal of this prospective study conducted at a general hospital was to evaluate and compare mortality rates of patients who had arrived from the site of accident within "golden hour". We used Injury Severity Score (ISS) and Pediatric Trauma Score (PTS). Furthermore, our study was aimed at comparing different trauma scores used in children, ISS, Glasgow Coma Score (GCS), PTS, New Injury Severity Score (NISS) and Trauma Related Injury Severity Score (TRISS) (7), as well as at evaluating and comparing the treatment outcome results (complications occurrence, mortality rates, need for special surgery or other treatment at clinical hospital centers) of general hospitals like ours to the results of sophisticated pediatric trauma centers.

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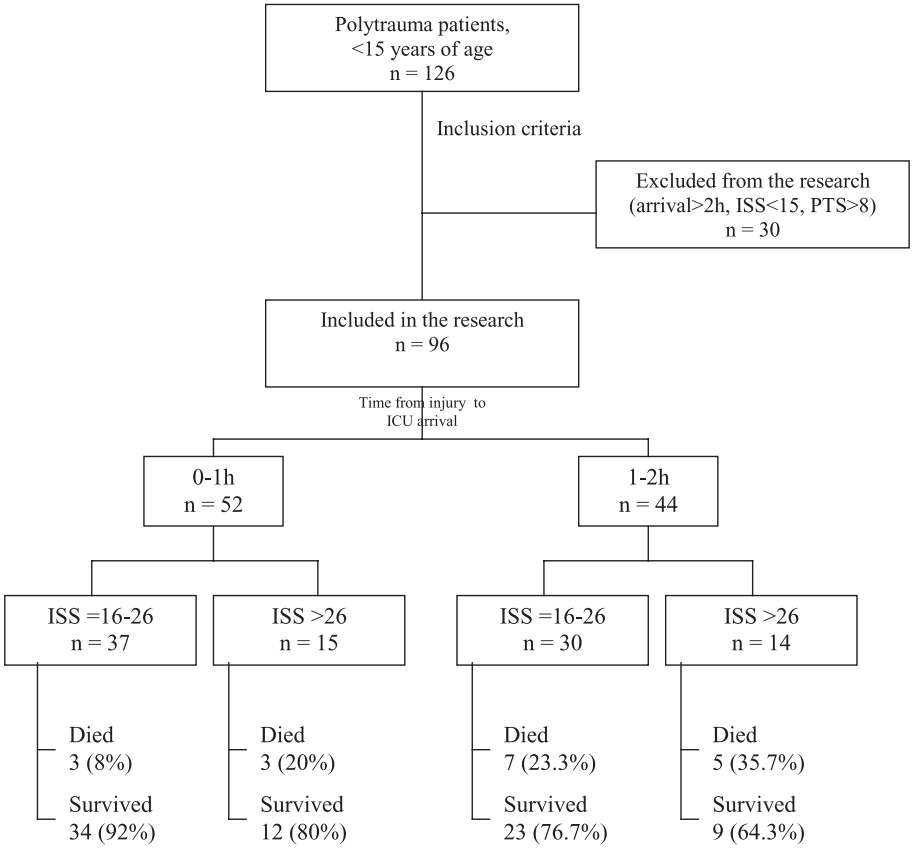
Patients and methods

A prospective study included 126 polytraumatized pediatric patients aged less than 15 years. The study was conducted at a multidisciplinary Intensive Care Unit (ICU) at a general hospital and covered a period of 24 months. Polytrauma was defined as a simultaneous occurrence of injuries incurred to a number of body regions or organ systems, while at least one of them or their combination represents a life-threatening condition(8). Immediately on admission, basic pediatric trauma care was performed. Primary and secondary surveys were conducted, appropriate subspecialists consulted and necessary surgical and other interventions performed. During ICU stay, continuous monitoring of vital signs as well as appropriate medical treatment were performed.



ICU – Intensive Care Unit, n – number of patients, PTS – Pediatric Trauma Score, ISS – Injury Severity Score

Fig. 1. Flow of patients through the study.

Before the beginning of the study, a questionnaire was developed in order to standardize the recording of medical history and important patients parameters and events. Using this questionnaire, patient's gender, age, time elapsed from traumatic event to ICU admission, nature and cause of the traumatizing event, type of transport to the hospital and existing comorbidities were recorded on admission. Furthermore, all medical interventions prior to ICU arrival: venous access, endotracheal intubation (ETI) and cardio-pulmonary resuscitation (CPR), were also recorded.

All interventions performed immediately on admission to the ICU (initial fluid resuscitation with crystalloid and/or colloid solutions, analgesics, inotropic support, CPR, ETI and chest tube placement) were recorded. Of the patient's physiological parameters, respiratory rate (RR), heart rate (HR) and systolic blood pressure (SBP) were measured and recorded. Each patient's trauma scoring systems were calculated, namely GCS, PTS, ISS, NISS and TRISS. GCS is a scale that evaluates the state of consciousness (9). It includes verbal response (1–4 points), eye opening (1–5) and best motor response (1–6). Values are from 3 to 15, while 15 indicates normal findings and a score of less than 8 defines a comatose condition indicating the need for endotracheal intubation. PTS includes respiration, alertness, SBP, estimated body weight, and the presence and severity of soft tissue injuries and fractures, each scoring between -1 and +2. Scores below 0 indicate a life-threatening condition (10). ISS is a score based on the Abbreviated Injury Scale (AIS) where each injury is classified from 1 to 6 according to its severity. ISS is calculated for 6 body regions, by squaring the AIS scores of the three most severe injured body parts. The maximum achievable figure is 75, while an included score of 6 is automatically translated into maximum ISS score of 75 (11). NISS is a modification of ISS in which three injuries that have the highest AIS are taken into count regardless of the body region (12). The pediatric TRISS score is a combination of the pediatric trauma score, ISS and patient's age (13).

For study purposes, of all patients who arrived later than 2 hrs from injury, those with ISS <15 and PTS >8 were excluded from the study. The latter patients were excluded since all of them had been previously treated at some other small hospitals and their mortality rates were low (0–5 %). The fact that we had over 30 % of such patients would influence the statistical significance of the study results. After this, the remaining 96 patients were included in the study. These patients were than divided in two groups according to the time of their arrival (0–1

Tab. 1. Characteristics of polytraumatized children admitted to the ICU.

	n=126	%
Sex (M/F)	86/40	68.3/31.7
Age (years) (0–5/6–14)	17/109	13.5/86.5
Time to ICU (hours) (0–1/1–2/>2)	68/46/12	53.9/36.5/9.6
Transport to ICU (MT/PV)	114/12	90.4/9.6
Type of injury (blunt/penetrating/other)	109/11/6	86.5/8.7/4.8
Cause of injury (traffic/fall/pedestrian)	69/23/34	54.8/18.3/26.9

ICU – Intensive Care Unit, n – number of patients, MT – medical transport, PV – personal vehicle

Tab. 2. Vital parameters and score values.

	n=126	%
RR (n/min) (0–10/11–20/>20)	12 / 63 / 51	9.5 / 50 / 40.5
HR (n/min) (0–70/71–120/>120)	23 / 69 / 34	18.3 / 54.8 / 26.9
SBP (mmHg) (0–60/61–90/>90)	17 / 29 / 80	13.5 / 23 / 63.5
GCS (3–8/9–12/12–15)	30 / 33 / 63	23.8 / 26.2 / 50
PTS (<0/0–8/>8)	23 / 69 / 34	18.3 / 54.8 / 26.9
ISS (0–15/16–26/>26)	40 / 63 / 23	31.7 / 50 / 18.3
NISS (0–15/16–26/>26)	17 / 57 / 52	13.5 / 45.2 / 41.3
TRISS (0–21/22–36/>36)	28 / 80 / 18	22.2 / 63.5 / 14.3

n – number of patients, RR – respiratory rate, HR – heart rate, SBP – systolic blood pressure, GCS – Glasgow Coma Score, PTS – Pediatric Trauma Score, ISS – Injury Severity Score, NISS – New Injury Severity Score, TRISS – Trauma Related Injury Severity Score

hr/>1 hr). Each of these groups was then divided according to ISS values (16–26/>26). Mortality rates were then recorded and calculated for each of these groups.

The need for urgent surgery (under 24 hrs from ICU admission) and/or delayed surgery (after 24 hrs from ICU admission) was recorded. Mechanical ventilation (MV) was used when necessary and total MV duration was recorded as well as the need for tracheostomy. MV was performed using controlled mechanical ventilation, with tidal volume (Vt) in range from 6 to 8 ml/kg and RR according to patients age. The weaning process was conducted using pressure support ventilation (14). The need for tracheostomy was assessed using evidence-based guidelines for weaning and discontinuing ventilatory support (15, 16). Outcome data included those of incidence of hospital pneumonia, sepsis and/or multi-organ failure (MOF), time spent at ICU, and transfer either to the surgical department in our hospital or to the trauma centre for treatment continuation.

Quantitative and numerical data were analyzed by use of descriptive statistic parameters, namely median, minimum and maximum values, ranges and centile distributions. Due to the small sample size, some statistical calculations were omitted in order to avoid small sample size error.

The study was carried out in line with ethical principles, approved by the Hospital Ethics Committee and conducted in accordance with the Declaration of Helsinki.

None of the authors has a conflict of interest in regard of devices discussed in this publication. Support was provided from institutional and departmental sources.

Tab. 3. ICU treatment and outcome parameters.

	n=126	%
OP (<24h/>24h)	75/17	59.5/13.5
MV (days) (0/1–2/>2)	46/63/17	36.5/50/13.5
Tracheostomy	4	3.2
Hospital pneumonia	12	9.5
Sepsis	12	9.5
Multi-organ failure	8	6.3
Time in ICU (days) (0–2/3–10/>10)	75/40/11	59.5/31.8/8.7
Transfer (department of traumatology/clinic)	102/6	80.9/4.8

ICU – Intensive Care Unit, n – number of patients, OP – surgical procedure, MV – mechanical ventilation

Results

The flow of patients through the study presents the main research algorithm. After the exclusion of patients who had not met the inclusion criteria, the remaining patients were divided in two groups according to the time elapsed from injury to ICU arrival. Each group was then divided in two groups according to ISS values. Finally, mortality rates were calculated for each group and subgroup as presented in Figure 1.

Characteristics of polytraumatized children admitted to the ICU (patient's gender, age, time elapsed from traumatic event to ICU admission, nature and cause of the traumatizing event and type of transport to the hospital) are presented in Table 1.

Vital parameters and score values on ICU arrival (RR, HR, SBP, GCS, PTS, ISS, NISS, TRISS) are presented in Table 2.

ICU treatment procedures and outcome parameters (surgical interventions in the first 24 *h*rs and/or after 24 hrs, MV, tracheostomy, hospital pneumonia, sepsis, MOF, time spent at ICU and transfer either to the Department of Traumatology in our hospi-

Tab. 4. Differences in mortality rates between groups.

Groups	t_1=0–1 h n (%)	t_2=1–2 h n (%)	p
ISS 16–26	3 (8%)	7 (23.3%)	p<0.001
ISS >26	3 (20%)	5 (35.7%)	p<0.001
Overall t_1 vs. t_2	6 (11.5%)	12 (27.2%)	p<0.001
Overall t_1+t_2	18 (18.75%)		
Overall ICU mortality (t_1+t_2+excluded patients)	18 (14.3%)		

t – time from injury to ICU arrival, ISS – injury severity score, ICU – Intensive Care Unit, n – number of patients, p – statistical difference between groups

tal or to the Trauma Centre for treatment continuation) are presented in Table 3.

Differences in mortality rates between groups according to ISS values are presented. Mortality rates are calculated for each group, for both groups combined and finally for all patients, including those initially excluded from the research as presented in Table 4.

Discussion

Trauma scores represent the basis for the triage of polytraumatized patients. Indications for ETI, non-invasive and/or invasive ICU monitoring, and specific therapy decisions are also based on these scores. Finally, treatment outcome parameters, such as ICU mortality, can be calculated and compared between different institutions with the help of such scores. Furthermore, due to physiologic and anatomic peculiarities of children (large relative body surface, different cardio-vascular parameter values etc.), standard trauma score has been modified to PTS in attempt to achieve higher predictive values for pediatric patients.

In our analysis, we included the time needed for the patient to arrive at ICU. We recorded only 53.9 % of patients arriving from the site of accident within "golden hour". When comparing the mortality rates of the latter patients with those of patients arriving from the site of injury within the interval of the second hour we recorded a statistically significant advantage in mortality and survival rates in favor of patients arriving within "golden hour". In order to avoid errors in this calculation arising from the severity of injury, we divided both groups according to ISS values to those with ISS score 16–26 and >26. These results represent the main point in our future trauma care development. Unfortunately, from ICU point of view, we have little influence on ICU arrival time and can therefore only present the data we collected and analyzed.

Furthermore, we were surprised to record that only 18.2 % patients had venous access upon ICU arrival. These are all difficulty factors when providing for polytraumatized patients, and represent some of the key problems that should be dealt with in the future. Furthermore, only 9.5 % of children were intubated before ICU, and 68.2 % immediately upon ICU arrival, the fact of which also influences the therapeutic and outcome evaluation. This probably means that a certain number of these patients should have been intubated before ICU arrival.

Also, when analyzing the cause of injury, 54.8 % of patients were injured in traffic accidents, with additional 26.9 % injured as pedestrians in traffic accidents, which makes a total of 81.7 % polytraumatized children as a result of traffic accidents. USA report more than 250 000 injuries and more than 1700 deaths per year involving children as victims of motor accidents (17).

23.8 % of our patients had GCS equal to or below 8, and 18.3 % had PTS below 0, and 68.3 % had ISS equal to or over 15. These are all signs of serious polytrauma, with GCS below 8 also representing an indication for ETI. Furthermore, 86.5 % had NISS score of 15 or higher. ICU mortality in our study was 14.3 %, which is less than in the study of Ott et al from the year 2000 (4). They reported a mortality rate of 27 %. This difference could be explained by the fact that we had about 23.8 % of patients that in other studies would have hardly fulfilled the criteria for polytrauma (in our study these patients had ISS under 15 and/or PTS over 8). Nevertheless, even when taking into count only the remaining 76.2 %, our ICU mortality rate is 18.75 %. In their study involving 1509 traumatized children, Eichelberger et al (18) reported a mortality rate of 39.4 % for the subgroup with ISS >15 points (mean 29.3), which is higher than that in our patients' population. Here we must point out that 6 (4.8 %) of our patients were transferred to a specialized pediatric trauma centre, and therefore excluded from our further research.

As to the incidence of septic complications, we had similar results to those in the study of Ott et al (4), namely 9.5 % in our study vs 10 % in their study. As to the incidence of MOF, in our study we report 6.3 % vs 8.6 % in their study.

Median time spent at ICU was 4.6 (1–17) days in our study. During this time, only 17 (13.5 %) patients required MV longer than 48 hrs, 12 (9.5 %) patients acquired hospital pneumonia, and 4 (3.2 %) patients required tracheostomy.

Further research is still needed to be conducted, because available studies have not yet proved the fact whether any of the currently available trauma scores provides an advantage in estimating ICU mortality in polytraumatized pediatric patients.

In conclusion, children's trauma requires a complex of costly treatment. Precise algorithms, high quality of diagnosis, monitoring and therapeutic procedures have an essential influence on the positive end-outcome and improved survival and recovery rates in polytraumatized children.

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