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Original Article

The Neglected Disease of Modern Society: Trauma. Outcomes and Prognostic Factors for Pediatric Trauma Patients in PICU

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ABSTRACT

Objective: In this study it was aimed to investigate the demographic and clinical characteristics of pediatric trauma patients requiring follow-up in Pediatric Intensive Care Unit (PICU) and to contribute the data in this field by assessing the outcomes and prognostic factors.

Methods: This retrospective, observational study was carried out in the 12- bed medical PICU. We reviewed the clinical records of all trauma patients.

Results: A total of 99 patients (61 males and 38 females) were enrolled in this study. Eight patients died and the mortality rate was found as 8%. In univariate logistic regression analysis, presence of brain edema was associated to 12 folds increase in the mortality [Odds ratio (OR): 12; 95% confidence interval (CI): 2.23-64.48]. Presence of subarachnoid hemorrhage (SAH) was associated to 15 folds increase in the mortality (OR: 15; 95% CI: 2.75-81.58). Pediatric trauma score (PTS)<8 was associated to 1.17 folds increase in the mortality (OR: 1.17; 95% CI: 1.05-1.31). In the multivariate logistic regression analysis presence of brain edema was associated to 6,492 folds increase in the mortality (OR: 6,492; 95% CI: 1.078-39.06) and presence of SAH was associated to 8.68 folds increase in the mortality (OR: 8.68; 95% CI: 1.451-51.933).

Conclusion: The Glasgow coma scale score, PTS score and presence of SAH and brain edema are the factors effective on mortality in PICU.

Keywords: Trauma, child, PICU

INTRODUCTION

Although there have been improvements in supportive care in pediatric intensive care (PICU), trauma continues to be the leading cause of death and acquired disability among children. It has been reported that over 1 million children die due to trauma annually worldwide.[1] In 1966, a special report by the American National Academy of Sciences defined trauma as the "neglected disease of modern society".[2] United States (US) data shows treatment costs exceed 20 billion dollars annually in pediatric trauma cases. In addition, while the mortality rate is 1.9:1000 in leukemia, commonly seen in the pediatric age group, 10 of 100,000 child dies due to trauma every year.[3] These data demonstrate that trauma is a severe public health issue in childhood.

Mechanisms and types of injury depend on age, anatomy, environment, and children's interest. The most common causes of traumas are falls, motor vehicle accidents, pedal cyclist accidents, drowning, burns, and child abuse. Injuries with severe or multi-trauma requiring a high level of care are followed in the PICU. Many studies reported on adult trauma patients' outcomes treated in intensive care units in the literature. However, pediatric

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trauma cases have distinct vital signs and clinical problems, and there are few studies about trauma patients treated in PICUs. Therefore, outcomes and risk factors associated with mortality in PICU are needed to establish the optimal clinical management of pediatric trauma patients.

The present study aimed to investigate pediatric trauma patients' demographic and clinical characteristics requiring follow-up in PICU and contribute the data in this field by assessing the outcomes and prognostic factors.

MATERIALS AND METHODS

This retrospective, observational study was carried out in the 12-bed medical PICU of the Erciyes University Children Hospital in Kayseri. The clinical records of all trauma patients were reviewed. The study included 99 patients with available data. The following information was abstracted from the medical charts of the patients: age (1 month-18 years), gender, Glasgow coma scale (GCS), mechanism of injury, seasonal distribution, injured body region, type of injury, therapeutic interventions (positive inotropic support, mechanical ventilation (MV), MV day, blood transfusion), length of PICU stay and outcome (survivors vs. nonsurvivors). Patients were categorized into three groups to define the severity of traumatic brain injury (TBI) based on the initial GCS as follows: mild TBI (GCS: 13-15), moderate TBI (GCS: 13-8), and severe TBI (GCS<8). According to the pediatric trauma scores (PTS), patients were also divided into two groups: severe (PTS≤8) and mild (PTS >8). By Helsinki Declaration, the study was approved by the Ethics Committee on Clinical Research of Erciyes University, Medicine School (approval#2018/501). Informed consent forms were obtained from parents.

Statistical Analysis

Statistical Package performed statistical analyses for Social Sciences (SPSS) version 22.0. The Shapiro-Wilk test assessed normal distribution. Variables with skewed distribution are summarized as median and interquartile ranges, while categorical variables are summarized as count and percent (%). In binary group comparisons, the Mann-Whitney U was used to compare variables with skewed distribution, while the chi-square test was used to compare categorical variables. Pairwise correlation tests were used to assess relationships among variables. Univariate logistic regression analysis was performed to determine gender, brain edema, epidural hematoma, subdural hematoma, subarachnoid hemorrhage (SAH), and PTS<8 on mortality, while multivariate logistic regression analysis was performed to assess the combined effects of SAH and brain edema. A p-value<0.05 was considered statistically significant for all comments.

RESULTS

Ninety-nine patients (61 males and 38 females) were enrolled in this study (Table 1). The median age was 62 months (33-115). Eight patients died, and the mortality rate was found as 8%, lower than the yearly overall PICU mortality rate (16%) (p<0.001). The study population was categorized according to GCS, and it was detected that 41 cases (41.4%) with mild TBI, 41 cases (41.4%) with moderate TBI, and 17 patients (17.2%) with severe TBI. The study population detected a significant relationship between mortality and severe TBI (p<0.001).

Survivors and non-survivors were assessed by the Pediatric Risk of Mortality Score III (PRISM III). It was found that the PRISM III score was 5 (2-11) among survivors and 38 (21-48) among non-survivors (p<0.001).

The most common trauma type was out-of-vehicle traffic accidents. When non-survivors were assessed according to trauma type, it was found that 4 patients died due to out-of-vehicle traffic accidents, 2 patients due to in-vehicle traffic accidents, one patient due to crush injury, and one other due to drowning (Table 1).

Table 1. The evaluation of demographic characteristics and trauma types of the cases

Variable	N	%
Gender		
Male	61	61.6
Female	38	38.4
Glaskow Coma scale (GCS)		
GCS: 13-15	41	41.4
GCS: 13-8	41	41.4
GCS: <8	17	17.2
Pediatric trauma score (PTS)		
PTS>8	67	67.7
PTS≤8	32	32.3
Outcome		
Survivor	91	92
Non-survivor	8	8
Mechanism of injury		
Pedestrian	30	30.3
Vehicle	17	17.2
Fall	28	28.3
Crush	9	9.3
Press	3	3
Drowning	7	7.1
Electric shock	1	1
Gunshot injury	2	2
Hanging	2	2
	Median (25-75)	p-value
PTS		
Survivor	7.5 (5-99	<0.001
Non-survivor	0.5 (-0.75-4.75)	
Pediatric risk of mortality score III		
Survivor	38 (31-48)	<0.001
Non-survivor	5 (2-11)	

The patients were assessed according to the PTS, and it was found that 32 cases (32.3%) were in the mild trauma group, and 67 cases (67.7%) were in the severe trauma group. The median PTS value was 7 (5-9), while it was 7.5 (5-9) in survivors and 0.5 (-0.75-4.75) in non-survivors (p<0.001) (Table 1). In addition, in all non-survivors, PTS was found ≤8. In terms of mortality, there was a significant relationship between groups (p=0.035). The median value of the PRISM III score was 10 (3-21) in patients with PTS≤8, whereas 2 (1-8) in patients with PTS>8 (p<0.001). In addition, GCS showed a significant, negative correlation with PTS and PRISM III (r=-0.688, p<0.001 and r=-0.588, p<0.001, respectively) (Table 2).

The median length of PICU stay was 3 days (1-5). It was found that the length of PICU stay was negatively correlated with GCS and PTS scores (r=-0.235, p=0.020 and r=-0.392, p<0.001, respectively). Table 2 presents correlation coefficients among variables evaluated.

Forty-three patients (43.4%) required intubation, and the mean length of stay on MV was 2 days (2-4). The intubation was required in 7 (17.0%) of 41 patients with mild TBI, in 22 (53.0%) of 41 patients with moderate TBI, and 14 (82.0%) of 17 patients with severe TBI (p<0.001). The relationship between the requiring intubation and PTS score was assessed, and it was found that intubation was needed in 40 (60%) of 67 patients with severe trauma and 3 (9%) of 32 patients with mild trauma (p<0.001).

The highest number of admission was observed in August (and=17; 17.2%), while the lowest number of admission was observed in February (n=1; 1%) (Figure 1).

The head was the most commonly involved region of the body (62%), followed by extremity injury (17%), chest (33%), and abdomen (13%).

Diffuse axonal injury was detected in 11 patients (11.1%); including one patient with mild TBI (2.4%), 6 patients with moderate TBI (14.6%) and 4 patients (23.5%) with severe TBI (23.5%) (p=0.431). Brain edema was detected in 24 patients (24.2%); 3 patients with mild TBI (7.3%), 12 patients with moderate TBI (29.3%) and 9 patients with severe TBI (52.9%) (p=0.001). In univariate logistic regression analysis, brain edema was associated with 12 folds increase in mortality [Odds ratio (OR): 12; 95% CI: 2.23-64.48]. It was found that the presence of subarachnoid hemorrhage (SAH) was associated with 15 folds increase in the mortality (OR: 15; 95% CI: 2.75-81.58) while PTS<8 was associated with 1.17 folds increase in the mortality (OR: 1.17; 95% CI: 1.05-1.31). In the multivariate logistic regression analysis, it was found that the presence of brain edema was associated with a 6,492 folds increase in the mortality (OR: 6,492; 95% CI: 1,078-39.06), while the presence of SAH was associated with 8.68 folds increase in the mortality (OR: 8.68; 95% CI: 1,451-51,933). Table 3 presents logistic regression analysis results regarding risk factors influencing mortality.

Table 2. Correlation coefficients between variables

	PRISM III	Length of PICU stay
Pediatric trauma score	- 0.588*	- 0.392*
Glasgow Coma scale	-688	- 0.235

*In these correlations, p<0.05
PRISM III: Pediatric risk of mortality score III, PICU: Pediatric intensive care

It was found that 12 patients (12.1%) experienced seizures during follow-up, while 3 patients (3%) underwent tracheostomy. Surgery was performed in 22 patients (22.2%). In addition, blood transfusion was performed in 23 patients. Of the patients received blood transfusion, 20 patients (86%) were discharged while 3 patients died (14%) (p=0.334). Inotropic support was initiated in 4 cases, all of which died (p<0.001).

DISCUSSION

Trauma is a significant health issue due to resultant mortality and morbidity, in which incidence increases due to technological advances and violent events. It causes work labor loss and social and economics, as it more commonly affects the younger population in particular.

It is crucial to record trauma data to compare care and clinical outcomes across healthcare facilities. The present study is one of the few on pediatric trauma patients needing PICU admission. In this study, we have evaluated the data of 99 trauma patients to identify the prognostic factors that affect the outcome of the disease.

The frequency of trauma can be affected by several factors such as age, gender, year's season, time of day, and development level of the countries.[4] In our study, the male: female ratio (1.6) favored males, agreeing with the literature.[5] A higher frequency of trauma in boys may be attributed to more errant and aggressive behaviors. When seasonal distribution was assessed, it was seen that trauma cases most commonly occurred during June, July, and August (Figure 1). This may be because our province is at the crossing of important tourism centers with substantial migration and agricultural labor during summer. Our results have proven that males are more commonly injured in pediatric traumas and that traumas most widely occur during summertime.[6] Traffic accidents account for the majority of cases presented with trauma. A study by Doğan et al.[7] suggested that traffic accidents are the most

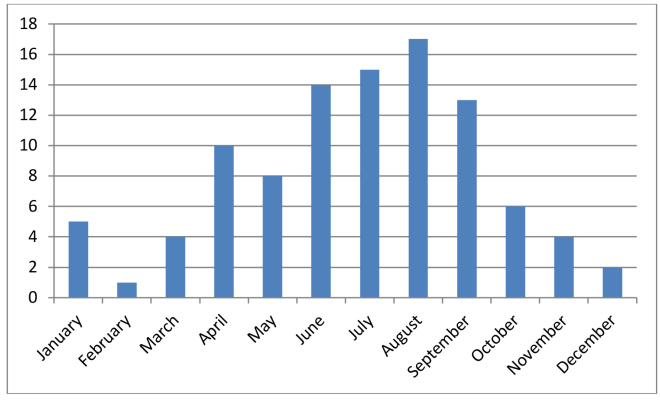

Figure 1. Distribution of the cases according to the months

Table 3. Logistic regression analysis of risk factors in pediatric trauma patients

	Univariate logistic regression			Multivariate logistic regression		
Variable	**p-value**	**Odds ratio**	**95% CI**	**p-value**	**Odds ratio**	**%95 CI**
Gender	0.938	1.06	0.212-4.195			
Brain edema	**0.004**	12	2.23-64.48	0.041	6.492	1,078-39.06
Subdural hematoma	0.798	1.24	0,23-6.67			
Epidural hematoma	0.644	1.69	0.182-15.79			
Subarachnoid hemorrhage	**0.002**	15	2.75-81.58	0.018	8.68	1,451-51,933
Pediatric trauma score <8	0.998	1.17	1.05-1.31			

CI: Confidence interval

important causes of trauma (23%). In a study on pediatric trauma cases presented to the emergency department, Akay et al.[8] found traffic accidents in 49%, falls in 31%, and other causes in 30%. Based on our results, it was seen that traffic accidents were a significant cause of PICU admission 48%. This may be because our facility is at the route of highways, and it is a center where most severe trauma patients are referred.

A variety of prognostic factors has been described in patients requiring PICU. Our study observed the highest mortality rate in patients admitted to a traffic accident. In their research, Doğan et al.[7] assessed the pediatric cases presented to the emergency department with trauma and found severe head injury in 9 of 10 non-survivors. In our study, there was a head injury in 7 of 8 non-survivors. Our results showed that head injury is the most crucial cause of PICU admissions and mortality. In addition, another remarkable finding in our study was that presence of brain edema and SAH significantly increased mortality.

In pediatric cases with trauma, intra-thoracic organ injuries are the second leading cause of mortality following central nervous system injuries. General mortality was 2-3% in trauma, while the mortality rate reached 20-30 in pediatric cases with chest trauma.[9] In a study on 507 patients with trauma, Gilles reported chest trauma in 30 (49%) of 61 non-survivors. In a study from Turkey, Akay et al.[8] reported chest trauma in 16 (70%) of 22 non-survivors. In our study, chest trauma was detected in 31 cases (32%), and 5 of 31 patients died (16%).

Several trauma scoring systems are developed to ensure the appropriate use of sources and reduce the mortality rate. GCS is a simple scoring system without testing, widely used to assess a patient's neurological status, and rapidly provides detailed information. It was shown that low GCS scores are associated with increased mortality.[10] In a study on 127 adult trauma patients admitted to ICU, Taşdemir et al.[11] suggested that the GCS score was lower among non-survivors. In our series, the results agree with previous studies. When patients were stratified according to GCS score, it was found that mortality was significantly higher while the length of PICU stay was significantly longer in patients with severe TBI in our study.

The PTS is another scoring system used in the follow-up of pediatric trauma patients, which was adapted from adult scoring systems. In a study by Tepas et al.[12], it was shown that there was a significant correlation between PTS and Trauma Severity Score.[13] In particular, it was concluded that PTS<3-4 was strongly associated with mortality.[14] In a study on 1658 patients who presented to the emergency department, Taş M et al. reported that PTS scores were higher in survivors when compared to non-survivors.[15] Similarly, Anıl et al.[16] said that hospitalization rate, need for ICU care, MV, blood transfusion, and mortality were significantly higher in patients with PTS scores ≤8. In our study, the PTS score was considerably lower in non-survivors. In addition, it was found that PTS was significantly correlated to the length of stay and need for intubation.

The Pediatric Risk of Mortality Score III (PRISM III) is a scoring system used to predict mortality in pediatric patients and assess the performance of Intensive care units (ICUs).[17] Gonçalves et al.[17] reported that PRISM III and Pediatric Logistic Organ Dysfunction (PELOD) scores are highly effective in predicting mortality. In a study from Turkey, Tekerek and Akyıldız[18], PRISM III score predicted mortality most effectively among scoring systems including PRISM, PELOD, and Pediatric Mortality index. In our study, the PRISM III score was significantly higher among non-survivors. In addition, our results showed a negative correlation between PTS and PRISM III.

Study Limitations

There are several limitations to this study. Limiting factors include the relatively small number of patients in the study group, and some data, such as time for PICU admission, time to achieve target serum osmolarity, and information about treatments used for patients with a brain injury was unavailable due to the retrospective study design. Another limiting factor includes evaluating all patients admitted for trauma, and creating a heterogeneous group. In particular, including patients without head trauma does not make it possible to consider prognostic factors for all trauma patients.

CONCLUSION

In conclusion, trauma most commonly involves males and occurs during summertime. Motor vehicle accidents are leading causes when assessed according to the type of injury. We want

to underline that the GCS score, PTS score, and presence of SAH and brain edema influence mortality in pediatric trauma patients. The presence of one or more aspects mentioned above can lead to increased mortality; thus, clinicians should be alert for such patients.

Ethics

Ethics Committee Approval: The study was approved by the Ethics Committee on Clinical Research of Erciyes University, Faculty of Medicine (approval#2018/501).

Informed Consent: Informed consent forms were obtained from parents.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.D., S.Ö., B.N.A., Concept: A.D., S.Ö., B.N.A., Design: A.D., S.Ö., B.N.A., Data Collection or Processing: A.D., H.S.D., Analysis or Interpretation: A.D., S.Ö., B.N.A., Literature Search: A.D., H.S.D., S.Ö., Writing: A.D., S.Ö.

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