Cukurova Anestezi ve Cerrahi Bilimler Dergisi

Retrospective Evaluation of Clinical, Demographic, and Prognostic Aspects of Pediatric Trauma Patients Followed in a Tertiary Intensive Care Unit

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Abstract

Objective: This study aimed to evaluate the clinical profile of pediatric trauma patients admitted to a tertiary intensive care unit (ICU) and to determine the prognostic factors. **Materials and Methods:** This retrospective study included 223 patients under 18 years of age who were admitted to the ICU of the Department of Anesthesiology and Reanimation at Kahramanmaraş Sütçü İmam University Faculty of Medicine between 2016 and 2020 due to trauma. Data obtained from medical records included demographic characteristics, mechanisms of injury, injury patterns, and clinical outcomes. Additionally, trauma scoring systems (GCS, PTS, APACHE II) and selected biochemical parameters were recorded to assess their prognostic value. Categorical variables were analyzed using the Chi-square or Fisher's exact test, and continuous variables were compared using Student's t-test or the Mann–Whitney U test, as appropriate. **Results:** Of the patients, 72.1% were male, and the most frequently affected age group was 3–6 years (29.2%). Falls from height (28.7%) and out-of-vehicle traffic accidents (26.5%) were the leading causes of injury. Head trauma was identified in 77.1% of cases. The overall mortality rate was 16.5%. Mortality was associated with the need for mechanical ventilation, lower GCS and PTS scores, higher APACHE II scores, metabolic acidosis (low pH, elevated lactate, negative base excess), and coagulation abnormalities (elevated INR and PTZ). **Conclusion:** This retrospective analysis indicates that established trauma scoring systems, particularly lower GCS and elevated APACHE II scores, are valuable prognostic factors for pediatric trauma patients admitted to the ICU. Furthermore, early physiological derangements—such as elevated lactate levels, metabolic acidosis, and coagulopathy—along with the immediate need for mechanical ventilation, are closely associated with poor clinical outcomes. Integrating these early metabolic and clinical indices may facilitate better risk stratification and help guide resuscitation strategies in severe pediatric trauma cases.

Keywords: Pediatric trauma; intensive care unit; mortality; trauma scores; epidemiology

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1. Introduction

Trauma remains a leading cause of mortality and long-term morbidity in the pediatric population worldwide. While it follows infectious diseases as a cause of mortality in developing nations, trauma ranks as the primary cause of death after the first year of life in developed countries. According to World Health Organization (WHO) and UNICEF reports, pediatric trauma results in hundreds of thousands of fatalities annually, leaving millions with permanent disabilities. National data from the Turkish Statistical Institute (TÜİK) further highlight that accidents and injuries consistently rank among the top causes of death in the 1–14 age group[1-3].

The management of pediatric trauma presents unique clinical challenges, as children possess distinct anatomical, physiological, and psychological characteristics compared to adults. Their proportionately larger heads and higher centers of gravity predispose them to severe head trauma, which is the most common injury type in this demographic. Furthermore, the extreme flexibility of the pediatric rib cage and relatively weak abdominal musculature allow impact energy to be transmitted directly to internal organs. This can result in severe pulmonary contusions or solid organ damage even in the absence of bone fractures[1,4,5]. These developmental differences significantly influence injury patterns, physiological responses to trauma, and overall prognosis.

Because of these unique pediatric vulnerabilities, ensuring survival hinges on rapid and precise ICU assessments. Identifying high-risk patients and predicting mortality cannot be done in isolation; it heavily depends on combining clinical scoring systems—like the Glasgow Coma Scale (GCS) and Pediatric Trauma Score (PTS)—with general severity indices such as APACHE II [6-8]. Furthermore, when clinicians evaluate these scores alongside early biochemical markers of tissue perfusion and coagulopathy, they gain a much more reliable perspective. This combined approach is what ultimately guides effective resuscitation and shapes our early intervention strategies[9,10].

To address this need, this study evaluates data from pediatric trauma patients followed over a 5-year period in the Anesthesiology and Reanimation Intensive Care Unit of Kahramanmaraş Sütçü İmam University Faculty of Medicine. The aim of this study was to retrospectively evaluate the general clinical characteristics and outcomes of pediatric trauma patients admitted to a tertiary intensive care unit (ICU), and to investigate the factors affecting prognosis.

2. Materials and Methods

This research was conducted in a retrospective, descriptive, and cross-sectional design to analyze the epidemiological profile and clinical outcomes of pediatric trauma patients. Ethical approval for this study was obtained from the Medical Research Ethics Committee of Kahramanmaraş Sütçü İmam University (Date: March 29, 2022; Decision No: 04).

2.1.Population and Sample of the Study

The study population consisted of patients under 18 years of age who received inpatient treatment in the Anesthesiology and Reanimation Intensive Care Unit of Kahramanmaraş Sütçü İmam University (KSU) Faculty of Medicine Health Practice and Research Hospital between 2016 and 2020. No sample selection was made; 223 pediatric patients hospitalized with a diagnosis of "trauma" between the specified dates and meeting the inclusion criteria were included in the study.

Inclusion criteria:

• Being in the 0–18 age range.

• Being hospitalized in the intensive care unit due to trauma (traffic accident, fall, assault, gunshot wound, etc.).

• Having accessible and complete medical records and file data.

Exclusion criteria:

• Patients older than 18 years.

• Patients hospitalized for non-trauma reasons (e.g., post-op elective surgery, internal diseases).

• Files with missing datasets.

2.2.Data Collection Method

Data were obtained by retrospectively screening the hospital information management system and patient files in the archive. The following parameters were recorded: demographic data (age, gender); trauma characteristics (mechanism of trauma, injured body regions); clinical scores (GCS, PTS, and APACHE II scores at admission); treatment processes (need for mechanical ventilation, operative status, consultations, intensive care and hospital length of stay); laboratory parameters (hemoglobin, leukocytes, platelets, biochemistry [AST, ALT, urea, creatinine], coagulation tests [INR, PTZ, aPTT], and arterial blood gas values [pH, pCO_2, lactate, base excess]); radiological findings (CT results for brain, thorax, abdomen, bone structures); and outcome (discharge, referral, or death).

2.3.Statistical Analysis

Obtained data were analyzed using SPSS 20.0 software. Descriptive statistics were presented as number (n), percentage (%), mean ± standard deviation, or median and interquartile range (Q1–Q3). Student's t-test was used for comparing normally distributed continuous variables, while the Mann–Whitney U test was used for those not showing normal distribution. ANOVA or Kruskal–Wallis H test was preferred for comparing more than two groups. Chi-square and Fisher's exact tests were applied for comparing categorical data. The statistical significance level was accepted as $p < 0.05$[1].

3. Results

In this section, data from the 223 patients included in the study are detailed under the headings of demographic characteristics, trauma mechanisms, clinical findings, and mortality analyses.

3.1.Demographic Characteristics

Of the 223 patients constituting the study group, 72.2% (n=161) were boys and 27.8% (n=62) were girls. The male/female ratio was approximately 2.6. The most frequent admission was in the 3–6 age group (Table 1).

Table 1. Distribution of Patients by Gender and Age Groups

Demographic Characteristic	Number (n)	Percentage (%)
Gender: Female	62	27.8
Gender: Male	161	72.1
Age 0–2 years	48	21.5
Age 3–6 years	65	29.2
Age 7–11 years	56	25.1
Age 12–17 years	54	24.2

These data indicate that pediatric traumas are concentrated in the preschool (play age) period and in male children.

3.2.Causes of Trauma and Injury Regions

When the trauma etiologies of the patients were examined, falling from height was found to be the most common cause, followed by out-of-vehicle traffic accidents (Table 2).

When looking at injury regions, head trauma ranked first (77.1%), followed by multiple traumas and thoracic traumas (Table 3).

Table 2. Distribution of Trauma Causes

Trauma Cause	Number (n)	Percentage (%)
Fall from Height (>1m)	64	28.7
Out-of-Vehicle Traffic Accident	59	26.5
In-Vehicle Traffic Accident	32	14.3
Fall from Bicycle	15	6.7
Fall from 0–1m Height	11	4.9
Motorcycle Accident	11	4.9
TV Falling	7	3.1
Gunshot Wound (GSW)	10	4.5
Drowning	3	1.3
Other (Electrical, Assault, etc.)	11	4.9
TOTAL	**223**	**100.0**

Table 3. Distribution by Injury Regions

Injury Region	Number (n)	Percentage (%)
Head	172	77.1
Multiple (Multiple Regions)	74	33.2
Thorax	70	31.4
Lower Extremity	33	14.8
Abdomen	32	14.3
Pelvis	24	10.8
Face	20	9.0
Upper Extremity	17	7.6
Vertebra	11	4.9

Since there can be more than one region injured in a patient, the sum of percentages exceeds 100.

3.3.Relationship of Age and Gender with Trauma Mechanism

The distribution of trauma causes according to age groups showed a statistically significant difference (p=0.001). In the 0–2 years group, falls from a height (n=21, 43.7%) and in-vehicle traffic accidents (n=9, 18.7%) were the most common causes. In the 3–6 years group, falls from a height (n=27, 41.5%) and out-of-vehicle traffic accidents (n=20, 30.7%) were predominant. In the 7–11 years group, out-of-vehicle traffic accidents (n=18, 32.1%) and falls from a height (n=11, 19.6%) were leading causes. In the 12–17 years group, out-of-vehicle traffic accidents (n=16, 29.6%), in-vehicle traffic accidents (n=9, 16.6%), and motorcycle accidents (n=9, 16.6%) were the most frequent.

When examined by gender, no statistically significant difference was detected (p>0.05). The most common causes among females were falls from a height (n=25, 40.3%) and out-of-vehicle traffic accidents (n=12, 19.3%), whereas for males, the most frequent causes were out-of-vehicle traffic accidents (n=44, 27.3%) and falls from a height (n=28, 23.6%). Motorcycle accidents and gunshot wounds occurred only among males.

3.4.Mortality Analysis and Risk Factors

Of the 223 patients, 181 (81.2%) were discharged with recovery, 5 (2.2%) were referred to an advanced center, and 37 (16.5%) resulted in exitus (death).

A very strong relationship was found between the need for mechanical ventilation (MV) and mortality. While only 1 (0.8%) of the 132 patients who did not receive MV support was lost, 36 (39.6%) of the 91 patients receiving MV support died (p=0.001). Similarly, 36 (41.4%) of the 87 patients who arrived intubated died, whereas only 1 (0.7%) of the 136 patients arriving with spontaneous respiration was lost (p<0.001).

The success of clinical scoring systems in predicting mortality is summarized in Table 4. The APACHE II scores of deceased patients were significantly high, while GCS and PTS scores were critically low.

Table 4. Comparison of Clinical Scores According to Survival Status (Median Values)

Score	Survivors (Median)	Non-Survivors (Median)	p Value
APACHE II	9.00	23.00	<0.001
GCS	14.00	3.00	<0.001
PTS	9.00	3.00	<0.001

Biochemical and hematological parameters at ICU admission were compared in surviving and deceased patients, and significant differences were found in many parameters (Table 5). Particularly high lactate, metabolic acidosis (low pH, negative BE), and coagulopathy (high INR, PTZ) are the strongest laboratory markers of mortality. Additionally, the death rate in patients receiving blood transfusion in the first 24 hours (41.2%) was significantly higher than in those who did not (9.3%) ($p<0.001$).

Table 5. Relationship of Laboratory Values with Mortality

Parameter	Survivors (Median)	Non-Survivors (Median)	p Value
Hemoglobin (g/dL)	11.5	10.3	0.013
Platelet (/mm^3)	303,500	206,000	<0.001
AST (U/L)	54	157	<0.001
ALT (U/L)	27	56	0.008
pH	7.37	7.30	<0.001
Lactate (mmol/L)	1.8	4.1	<0.001
Base Excess (BE)	-4.6	-8.6	<0.001
INR	1.13	1.50	<0.001
PTZ (sec)	13.3	18.1	<0.001
Creatinine (mg/dL)	0.38	0.61	<0.001

3.5.Radiological Findings and Operations

The most frequently detected pathologies in radiological imaging were: bone fracture in 127 patients (57%), epidural hematoma in 43 patients (19.3%), and subdural hematoma in 36 patients (16.1%) on brain CT; lung contusion in 62 patients (27.8%) and pneumothorax in 28 patients (12.6%) on thorax CT; spleen injury in 17 patients (7.6%) and liver injury in 16 patients (7.2%) on abdominal CT; and pelvic fracture in 24 patients (10.8%) and femur fracture in 23 patients (10.3%) for extremities.

According to operation data, 48 patients were operated on by neurosurgery, 34 by orthopedics, and 7 by pediatric surgery. Fifty percent of fall-from-height cases required surgical intervention ($p=0.039$).

3.6.Brain Death Data

Brain death was diagnosed in 19 (51.4%) of the 37 mortality cases. When the trauma etiologies of those diagnosed with brain death were examined, 9 cases were out-of-vehicle traffic accidents, 5 were in-vehicle traffic accidents, and 2 originated from falling from height.

4. Discussion

In this study, the epidemiological profile, clinical characteristics, and prognostic factors of pediatric trauma patients followed in a tertiary intensive care unit (ICU) were evaluated and compared with the current literature.

4.1.Demographics and Trauma Mechanisms

In our series, the proportion of male patients was significantly high (72.2%), demonstrating strong consistency with both national and international literature regarding the gender-specific distribution of trauma. Similar studies conducted in our country by Sever et al.[11] and Korkmaz et al.[12] reported male rates of 66.3% and 61%, respectively. On a global scale, Wohlgemut et al.[13] reported 61.1% in Scotland, Franzon et al.[14] 68% in a Swedish intensive care series, and Lalwani et al.[15] 71.6% in India.

When the distribution by age groups was examined, the most frequent injury occurred in the 3–6 age group (29.2%). This peak is closely associated with our finding that falls from height constituted the most common trauma mechanism overall (28.7%). While some large-scale studies, such as those by Chabok et al.[6] in Iran (42.2%) and Demir et al.[16] in Ankara (76%), report traffic accidents as the leading cause, our results align more closely with Sala et al.[17], who stated that falls are the most common cause of childhood traumas. We associate this high rate of falls with the architectural structure and climatic habits of our region. The "flat roof" architecture common in our region and the culture of spending time on roofs during summer months create a specific risk environment, a regional epidemiological pattern previously corroborated by Yagmur et al.[18].

Out-of-vehicle traffic accidents (pedestrian accidents) ranked second (26.5%) in our cohort, particularly affecting the 3–6 and 7–11 age groups. This reflects the findings of Serinken and Özen[19], who emphasized that 59.4% of child traffic accident deaths in Turkey are pedestrians. Additionally, the prominent rate of motorcycle accidents (81.8%) within the adolescent group (12–17 years) highlights a critical age-specific risk factor.

4.2.Injury Patterns and Clinical Outcomes

When injury regions were analyzed, head trauma was the most common (77.1%), echoing the cornerstone pediatric trauma data presented by Mayer et al.[7]. When our radiological findings were examined, skull fractures were detected in 57% of patients and epidural hematoma (EDH) in 19.3%. These rates are considerably higher than studies examining general emergency department admissions, such as the 9.7% fracture rate reported by Sönmez et al.[20] and the 14.7% pathological CT rate by Tekgüç[21]. However, our data are in great agreement with specialized intensive care series like Gürbüz and Duyu[22], who found a 49% linear fracture and 42.9% EDH rate. This comparison underscores that our study group consisted of severe trauma patients requiring advanced intensive care.

4.3.Pathophysiological Factors Affecting Mortality

The mortality rate in our study was 16.5%. Since this rate covers only ICU patients, it is consistent with other intensive care-focused series (e.g., 13.8% by Mayer et al.[7] and 10.3% by Lalwani et al.[15]).

In the non-survivor group, admission lactate levels (median 4.1 vs. 1.8 mmol/L) and base excess (−8.6 vs. −4.6) were significantly worse than in survivors ($p<0.001$). This confirms the determinant role of tissue hypoperfusion in mortality and is consistent with the predictive power of base deficit highlighted in the "BIG Score" validation by Mısırlıoğlu et al.[23]. Similarly, Çeleğen et al.[9] reported that high lactate at admission is the earliest harbinger of poor prognosis.

Trauma-induced coagulopathy was profound in our deceased patients, evidenced by significantly elevated INR values (median 1.50 vs. 1.13) compared to survivors. Strumwasser et al.[10] reported that if coagulopathy develops in pediatric patients, it increases mortality approximately 28 times. The high requirement for blood transfusion within the first 24 hours in our high mortality group (41.2%) and concurrent thrombocytopenia (median 206,000 vs. 303,500, $p<0.001$) clinically reflect this physiological deterioration.

Admission clinical scores accurately discriminated non-survivors from survivors. The median GCS of 3 and PTS of 3 in our exitus group confirms the findings of Chabok et al.[6] regarding the strong prognostic value of these scores. Furthermore, the significantly higher APACHE II median in our non-survivor group (23 vs. 9, p<0.001) proves its utility in demonstrating physiological exhaustion in children, closely mirroring the conclusions of Chhangani et al.[8], who reported mean scores of 26.11 for deceased and 16.60 for surviving PICU patients.

4.4.Limitations of the Study

Our study has certain limitations. The primary limitation is its retrospective and single-center design, which restricts the generalizability of the findings to broader populations. Additionally, due to the reliance on medical records, some pre-hospital data and long-term functional outcomes could not be fully evaluated. Despite these limitations, our study provides valuable and comprehensive data on severe pediatric traumas requiring intensive care and highlights critical early prognostic indicators.

5. Conclusion

In conclusion, our findings suggest that early physiological derangements and initial clinical scores are closely associated with the prognosis of pediatric trauma patients in the intensive care unit. Specifically, metabolic acidosis, elevated lactate levels, and impaired coagulation profiles were observed as significant early indicators of mortality in our cohort. Additionally, lower GCS and higher APACHE II scores, along with an immediate need for mechanical ventilation or early blood transfusions, appear to correlate with poorer clinical outcomes. These results imply that combining established trauma scoring systems with acute metabolic parameters might offer a more comprehensive approach to early risk stratification, rather than relying primarily on trauma mechanisms or demographics. Future prospective studies will be helpful to further evaluate how these physiological parameters might be integrated into standardized resuscitation protocols.

genAI: No artificial intelligence-based tools or generative AI technologies were used in this study. The entire content of the manuscript was originally prepared, reviewed, and approved by all authors.

Statement of Ethics: Ethical approval was obtained from the Medical Research Ethics Committee of Kahramanmaraş Sütçü İmam University (Date: March 29, 2022; Decision No: 04). As this was a retrospective study based on medical records, informed consent was waived.

Data Availability: The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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