ORIGINAL ARTICLE

Can ionized calcium levels and platelet counts used for estimating the prognosis of pediatric trauma patients admitted to the emergency surgery intensive care?

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ABSTRACT

BACKGROUND: Injury is the leading cause of death for pediatric population older than 1 year of age and 95% of those deaths are from the low- and middle-income countries. Most of those injured pediatric patients are treated in general hospitals. In designated trauma centers, the outcomes of severely injured patients are better. Scoring systems used frequently in intensive care units (ICUs) to make triage easier and to estimate prognosis. However, some of the scores may require additional expensive and sometimes time consuming tests. The purpose of the present study was to compare the usefulness of several scoring systems with initial ionized calcium levels and platelet counts to predict prognosis of pediatric trauma patients admitted to the emergency surgery department.

METHODS: This retrospective study was performed at a tertiary university hospital. The patients' ages, genders, trauma etiologies, types of trauma, time of trauma, transport place (primary or secondary), duration of stay in the ICU and in the hospital, mortality rates, initial ionized calcium levels (Ca^{+2}), initial platelet counts, and data of several trauma scores (GCS, RTS, ISS, TRISS, and PTS) were analyzed.

RESULTS: One hundred and fourteen pediatric trauma patients were admitted to the ICU. The mean age was 77.8±54 months. Most of them were male, falls were the primary mechanism of injury, and head trauma was the most common pattern of injury. The mortality rate was 15.8%, and the admission values for Ca^{+2}, platelet counts, GCS, RTS, TRISS, and PTS had been found higher for patients who survived, while ISS scores were higher for those who had died.

CONCLUSION: It was found that pediatric patients admitted to the ICU were younger than 10 years, of whom most of them were male. Falls were the most common mechanism of injury, and head trauma was present in most of the pediatric patients admitted to the ICU. Initial Ca^{+2} levels and platelet counts can be used along with the trauma scoring systems in predicting mortality and overall survey regarding pediatric trauma patients.

Keywords: Ca^{+2} levels; intensive care unit; pediatric trauma; platelet counts; trauma scores.

INTRODUCTION

Injury is the leading cause of death considering pediatric population older than 1 year of age including most parts of the world.[1] Each year more than 6,26,000 patients younger than 15 years of age die due to injury related problems and 95% of these deaths are among the citizens of the low- and middle-income countries (LMICs).[1] Most of these injured pediatric patients are treated in general state hospitals not in special pediatric hospitals.[2] In designated trauma centers, the outcomes of severely injured patients are better compared to non-trauma centers.[3] In most of the LMICs, pediatric trauma centers are few or not present at all.

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Meanwhile, scoring systems used frequently in intensive care units (ICUs) to make triage easier and to estimate clinical outcome of the patients. Glasgow Coma Score (GCS), Revised Trauma Score (RTS), and Pediatric Trauma Score (PTS) are used for triage in pediatric patients having trauma, while Injury Severity Score (ISS) and Trauma and Injury Severity Score (TRISS) are used as prognostic comparative scoring systems.

The purpose of this study was to identify the usefulness of several scoring systems and simple laboratory parameters such Ca^{+2} and platelet counts to predict mortality risks of pediatric trauma patients admitted to the emergency surgery department which works as a Level I trauma center in a tertiary university hospital in Istanbul, Turkey. Istanbul is the biggest city in Turkey with an estimated population of 14,657,000 in 2015 (official data) and in 2015, gross domestic product per capita for Turkey was 10,915 US dollars.

MATERIALS AND METHODS

This retrospective study was performed at the emergency surgery ICU of a tertiary university hospital. After the approval of the Local Research Ethics Board (2015/1929), medical archives of the emergency surgery department were evaluated retrospectively for patients <18 years of age with trauma admissions.

The patients' ages, gender distribution, trauma etiologies, types of trauma, time of trauma, transport time (primary or secondary) duration of stay in the ICU and in the hospital, mortality rates and trauma scores (GCS, RTS, ISS, TRISS, and PTS) initial Ca^{+2} levels, and platelet counts were analyzed.

The patients were defined as polytrauma, if they had injuries including two or more organs in different cavities or damage of internal organs and the musculoskeletal system including the face and the pelvis. Injuries of two organs in a single cavity without any other injury of other body parts are were accepted as isolated trauma.

GCS is used to assess level of consciousness and to predict the severity and early period mortality due to neurological function disorders and is scored between 3 and 15 based on visual, verbal, and motor responses given to various types stimuli. A score of <9 is suggestive of moderate-to-severe head trauma.[4]

For RTS, the GCS, systemic blood pressure (SBP), and the respiratory rate (RR) are used. These parameters are coded from 0 to 4 based on the magnitude of physiological derangement. It is calculated using the formula: (0.9368 × GCS) + (0.7326 × SBP) + (0.2908 × RR). The RTS is calculated between 0 and 7.8408, where 0 represents death and 7.8408 is counted as normal. A threshold coded as RTS<4 has been proposed to identify those patients who should be treated in a trauma center.[5]

In ISS, which is an anatomical scoring system developed to assess mostly blunt traumas. Scores between 1 and 6 are given for each body part that has been injured most, and the sum of squares of the three highest (worst) values are calculated. They are scored between 3 and 75. A score of ≥15 indicates that the patient has severe trauma.[6,7]

TRISS is calculated by combining RTS and ISS and adding age factor (A score of 1 for >54, 0 for ≤54) and it is scored between 0 and 100.[7,8]

PTS is a scoring system using six parameters (weight, airway patency, level of consciousness, systolic blood pressure, existence of open wound injury, and existence of skeletal trauma) with a score of +12 to −6, and a score ≤8 indicates a significant mortality risk.[9–11]

Calcium is a cation that is found intracellularly and extracellularly, and it exists in free, unbound, and physiologically active state as well as an inert state. Nearly 55% of total calcium is bound to proteins such as calcium and citrate, while only the remaining 45% is biologically active. Variations of the levels of such serum proteins can decrease the level of ionized calcium as in the case of massive transfusion. Serum calcium is assessed measuring the ionized calcium levels and its normal concentration is 1.1 mmol/L to1.3 mmol/L and can be easily measured in ABG analysis.

Platelets are key elements in achieving adequate hemostasis, and their loss and/or dysfunction can contribute to trauma induced coagulopathy.

Statistical Analysis

All quantitative data were normally disturbed that were assessed by skewness and kurtosis tests. Quantitative data are presented as mean±standard deviation. Quantitative data were compared using unpaired Student's t-test. Qualitative data are presented as frequencies and percentages and were compared using the Chi-squared test. All statistical analyses were performed using IBM SPSS for Windows, Version 20.0 (IBM Corp., Armonk, NY). P<0.05 was considered statistically significant.

RESULTS

During the study period, it was found that 114 pediatric trauma patients were admitted to the ICU of emergency surgery department of a tertiary university hospital. Table 1 shows the age, gender, time of admission (in working hours or during on call hours), place of admission (primary or secondary (from another hospital)), length of stay in the ICU and in the hospital, and mortality rates of patients. In subgroup analysis, mortality rates of working hours admissions (6/43, 13.95%) and on call hours admissions had been found similar (12/71, 16.9%). Furthermore, mortality rates of primary ad-

Table 1. Cases demographic and general data

Variables	
Age (months)	77.8±54
Gender (M/F, no and %)	68 (59.65%)/46 (40.35%)
Time of admission (working hours/ on call hours)	43/71
Place of admission (primary/secondary)	73/41
ICU length of stay (days)	9±15.9
Hospital length of stay (days)	12.9±17.8
Mortality (no and %)	18 (15.8%)

M: Male; F: Female; ICU: Intensive care unit.

Table 2. Trauma mechanisms and no and percentage patients

Falls from height	53/46.5%
MVA (P)	32/28.1%
MVA (VO)	14/12.3%
Assaults	9/7.9%
Home accidents (TV falls)	6/5.26%

MVA: Motor vehicle accident; P: Pedesterian; VO: Vehicle occupant.

missions (10/73, 13.7%) and secondary admissions had been found approximate as well (8/41, 19.5%).

In Table 2, the trauma mechanisms and number of patients whom were affected with these mechanisms were summarized. Sixty-seven of the 76 (58.77%) patients had polytrauma, while 47 patients (41.22%) had isolated trauma. The number of deceased patients having polytrauma was 15 (83.3% of all deaths and 22.38% of polytrauma patients) and the number of deaths regarding isolated trauma was 3 (16.6% of all deaths and 6.38% of isolated trauma patients), and the mortality rate of polytrauma patients was significantly higher compared to isolated trauma patients (p<0.05).

Forty-five (39.47%) patients had isolated head trauma of whom 3 (6.6%) of them had lost their lives, four patients (3.5%) had isolated thoracic trauma, and 10 (8.77%) had isolated abdominal trauma and there were no mortality recorded in both groups. Fourteen patients (12.28%) had a combination of head and thoracic trauma of whom 7 (50%) of them had died; four patients had a combination of head and abdominal trauma of whom 1 (25%) had died, while nine patients (7.9%) had a combination of thoracic and abdominal trauma of whom 2 (22.2%) had been deceased. Fifteen patients (13.15%) had a combination of head, thoracic and abdominal trauma of whom 3 (20%) died, while 2 (40%) of the five patients (4.4%) who had pelvis trauma died. None of the four patients having facial trauma or vertebra trauma as a part of their polytrauma lost their lives (Table 3).

Table 3. Traumatized body parts

Body part/Parts	Patients no	No of deaths
Head	45	3
Thorax	4	0
Abdomen	10	0
Head + Thorax	14	7
Head + Abdomen	4	1
Thorax + Abdomen	9	2
Head + Thorax + Abdomen	15	3
Pelvis (not isolated)	5	2
Face (not isolated)	4	0
Vertebra (not isolated)	4	0

Table 4. Admission GCS, RTS, ISS, TRISS, and PTS Scores

	Surviving patients	Deceased patients
GCS*	12.48±3.22	5.27±3.12
RTS*	6.99±1.34	3.35±1.9
ISS*	14.78±8.15	26.95±8.83
TRISS*	94.16±14.68	49.76±28.72
PTS*	7.83±2.96	1.33±2.35

*P<0.0001. GCS: Glasgow Coma Score; RTS: Revised Trauma Score; ISS: Injury Severity Score; TRISS: Trauma and Injury Severity Score; PTS: Pediatric Trauma Score.

Scoring system scores calculated for all of the patients are presented in Table 4. Statistically significant differences were found between the GCS, RTS, ISS, TRISS, and PTS values of the surviving patients and the deceased patients at the time of admission to the ICU (p<0.0001, p<0.0001, p<0.0001, p<0.0001, and p<0.0001, respectively). According to these results, it was found that the admission values GCS, RTS, TRISS, and PTS were higher in the patients who survived, while ISS scores of the deceased patients were higher than the surviving patients.

Calcium levels, platelet counts on admission, first measured PT, and aPTT values after admission are given in Table 5. Unfortunately, there were too many unrecorded INR values, so no statistical analysis was made for INR. Number of patients with an initial Ca^{+2} level ≤1 mmol/l was 22 of whom 50% died, while only seven of the 54 patients (12.6%) with an initial Ca^{+2} level >1 mmol/l passed away and in the remaining 38 patients who survived; no record of initial Ca^{+2} level was present. The number of patients with initial hypocalcemia was 28.9%.

The number of platelets of the surviving patients was 328.100±117.800/mm^3 (median value was 314.000/mm^3, range: 99.000–575.000/mm^3) on the other hand, it was

Table 5. Admission Ca^{+2}, platelet, PT, and aPTT values

	Surviving patients	Deceased patients
Ca^{+2*}	1.13±0.13	0.96±0.16
PLT*	328.1±117.8	238.6±133.2
PT**	13.9±1.57	19.6±7.05
aPTT**	32.6±10.32	47.1±17.73

*P<0.01. **P<0.01 (as SD were different a nonparametric test was used). Ca^{+2}: Calcium levels; PLT: Platelets; PT: Prothrombin time; aPTT: Partial prothrombine time.

283.600±132.200/mm^3 (median value was 190.000/mm^3, range: 66.000–471.000/mm^3) p<0.01.

DISCUSSION

The main findings of the present study were such as; most of the pediatric patients admitted to the ICU were younger than 10 years, most of them were male, falls were the primary mechanism of injury, most of the events occurred in day times and on weekdays, head was the most injured part of the body, trauma scores were helpful in estimation of mortality, and the combination of head and thoracic trauma was the most lethal combination of injury.

In a study using data coming from by Kids' Inpatient Database, Densmore et al.[2] found that the median age of pediatric trauma inpatients was 12.2±6.2 years which is older than ours, when subgroup analysis was made using ISS >15, the median age of the pediatric patients population decreases to 3.9±5.0 years making the results more similar to the results of the present study. In a retrospective study using the data coming from a level I trauma center, Voth et al.[12] found that the median age of the pediatric patients was 8 years which is quite similar to the results of the present study.

In this study, 59.65% of the patients were male, while in Voth's study, 59% of all pediatric patients were male, and in a retrospective study of 10 years period evaluating 6,380 patients, 65% of the patients were male which makes our results comparable with these studies.[12,13]

The mechanism of injury can be different in high income countries and low- or middle-income countries. For example, in the USA, motor vehicle crashes had been found as the most common mechanism of injury in injury-related deaths among individuals aged 1–20 years, while in a study done in South Africa and covering a 10 years period, Herbert et al.[14] found that falls were among the most frequent mechanism type of injury compromising 39.8% of all injuries which are quite similar to the results of the present study.[15]

In-hospital mortality rate of trauma patients in Europe ranges between 15% and 17% and this is very similar to the results of the present study.[16] According to the data of the German Trauma Annual Registry Report System (DGU) that included all the patients older than 6 years of age, the mean duration of stay in the ICU after severe trauma was 11.5±12 days, although being in the younger group (6–15 years) reduced length of stay to 1.2 days and the results of the present study are 12.9±17.8 which is higher; but in their study, Böhmer et al.[17] found that central nervous system failure increased length of stay for about 2.1 days while an initial GCS ≤8 led to 3.0 additional days in the ICU, and in our study that includes younger patients 45 of all patients who had isolated head trauma, as well as 33 patients had head trauma as one component of their polytrauma; and these differences in age and traumatized body parts can explain the differences of the studies.

In the present study, the GCS of the deceased patients was significantly lower than the surviving patients. In most of the deceased patients (14/18, 77.7%), head trauma was present so GCS was more accurate for these patients. This finding is consistent with the results of a study made by Gill et al.[18] which proved that GCS is helpful in prediction of morbidity and mortality due to head trauma. In a study comparing different scoring systems in predicting mortality in pediatric patients, El-Gamasy et al.[19] found a highly significant difference of the GCS values of survivors and non-survivors.

In the present study, the PTS of the deceased patients was significantly lower than the surviving patients. There are conflicting reports about the effectiveness of the PTS on prognosis estimation and as a triage tool for transfer to a pediatric trauma center. El-Gamasy et al.[19] found that the PTS showed a moderate specificity and sensitivity at a cutoff value of ≤3.5, while Narci et al.[20] who studied the prognostic value of the PTS in pediatric trauma patients found it to be an independent predictor of morbidity. On the other hand, Kaufmann et al.[21] reported that the PTS has no advantage in children, even in children younger than 14 years of age. We are not able to explain the reasons of these differences of PTS, but it is clear that a refinement will increase the value and effectiveness of the PTS in specific patient populations.

In the present study, the ISS of the deceased patients was significantly higher when compared to surviving patients. In a study comparing ISS with the New Injury Severity Scale (NISS), Sullivan et al.[22] found that ISS was effective in predicting mortality in patients having lower injury severity score (ISS<25), but NISS had been found more accurate in predicting mortality with higher injury severity score, but El-Gamasy et al.[19] underlined that NISS is not intended to reflect patient outcomes and does not take physiologic derangements or chronic health into account. Although initially developed for the adult trauma population, both the ISS and the RTS have been validated in the pediatric trauma population. Perhaps even outperforming specialized pediatric trauma scoring systems, and our results are compatible with these findings.[23]

The number of patients with initial hypocalcemia was 28.9% which was lower than the numbers given for adult trauma patients the reason of this difference which can be explained, at least partially, with the ages of the victims, mechanism of trauma, and trauma severity differences of the present study with those studies which enrolled adult patients.[24,25]

The initial platelet counts of the surviving patients were higher than the platelet counts of the deceased patients; in adult trauma patient populations as the number of the platelet increased mortality decreased or patients who did have lower platelet counts had higher mortality.[26,27]

The present study has multiple limitations such as retrospective nature of data analysis. Furthermore, this is not an epidemiological study, since only patients having injuries whom were treated in the ICU were included in the study. Children treated in the emergency department or those treated in the ward or in other ICUs of our hospital had not been included in the study.

Another limitation is that the functional outcomes were not evaluated which may be important especially following head trauma.

As we could not measure the function of platelets, we cannot make any comment whether the number or platelet dysfunction has more important impact on mortality.

Last but not the least, this study was on a level I trauma center which is a referral clinic for all traumatic pediatric injuries, including severely injured pediatric patients suffering from head and visceral injuries, and we are not sure that the results can be representable for other hospitals in our country. These findings should be validated in a multicenter study and the data obtained from that trial would then help to develop different and better treatment opportunities and scoring systems for the treatment of pediatric patients.

Conclusion

In the present study, it was found that pediatric patients admitted to emergency surgery ICU were younger than 10 years of age of whom most of them were male. The primary mechanism of trauma was "fall," and head trauma was present in most of the pediatric patients who had been admitted to the ICU. Trauma scoring systems may be efficient and predictive assessment scales regarding management of pediatric trauma patients thus may work in favor of clinical outcome when used appropriately. It was found that trauma scores are useful in predicting mortality.

Ethics Committee Approval: This study was approved by the Istanbul University Istanbul Faculty of Medicine Clinical Research Ethics Committee (Date: 27.11.2015, Decision No: 2015/1929).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Acil cerrahi yoğun bakıma kabul edilen pediyatrik travma hastalarının prognozunun tahmininde iyonize kalsiyum düzeyleri ve trombosit sayıları kullanılabilir mi?

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AMAÇ: Yaralanma, bir yaşından büyük pediyatrik popülasyon için önde gelen ölüm nedenidir ve bu ölümlerin %95'i düşük ve orta gelirli ülkelerden gelmektedir. Yaralanan pediyatrik hastaların çoğu 1. basamak hastanelerde tedavi edilmektedir. Belli travma merkezlerinde, ağır yaralı hastaların sonuçları daha iyidir. Yoğun bakım ünitelerinde (YBÜ) puanlama sistemleri triyaj işlemini kolaylaştırmak ve prognozu tahmin etmek amacıyla sıklıkla kullanılmaktadır. Ancak bazı puanlama sistemleri ek, pahalı ve zaman alıcı testler gerektirebilmektedir. Bu çalışmanın amacı, acil cerrahi servisine başvuran pediyatrik travma hastalarının prognozunu öngörmek için başlangıçtaki iyonize kalsiyum seviyeleri ve trombosit sayıları ile bazı skorlama sistemlerini karşılaştırmaktı.
GEREÇ VE YÖNTEM: Bu geriye dönük çalışma, üçüncü basamak bir üniversite hastanesinde yapıldı. Hastaların yaş, cinsiyet, travma etiyolojileri, travma tipleri, travma zamanı, nakil yeri (birincil veya ikincil), yoğun bakımda ve hastanede kalış süreleri, ölüm oranları, başlangıçtaki iyonize kalsiyum düzeyleri (Ca^{+2}), başlangıç trombosit sayıları ve çeşitli travma skorlarının (GCS, RTS, ISS, TRISS ve PTS) verileri analiz edildi.
BULGULAR: Yüz on dört pediyatrik travma hastası yoğun bakım ünitesine yatırıldı. Ortalama yaş 77.8±54 aydı. Hastaların çoğunluğu erkekti, düşme birincil yaralanma etiyolojisiydi ve kafa travması en yaygın yaralanma şekliydi. Mortalite oranı %15.8 olup, Ca^{+2}, trombosit sayıları, GCS, RTS, TRISS ve PTS değerleri hayatta kalanlarda daha yüksek bulunurken, ISS skorları ölenlerde daha yüksek bulundu.
TARTIŞMA: Yoğun bakıma alınan çocuk hastaların çoğunun 10 yaşından küçük olduğu ve erkek olduğu belirlendi. Düşme en yaygın yaralanma etiyolojisiydi ve yoğun bakım ünitesine kabul edilen pediyatrik hastaların çoğunda kafa travması mevcuttu. Pediyatrik travma hastalarına ilişkin mortalite ve prognozun belirlenmesinde travma skorlama sistemleri ile birlikte başlangıç Ca^{+2} seviyeleri ve trombosit sayıları kullanılabilir.
Anahtar sözcükler: Ca^{+2} seviyeleri; pediatrik travma; travma skorları; trombosit sayısı; yoğun bakım ünitesi.

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