Retrospective Analysis of Trauma Patients in the Intensive Care Unit

Yoğun Bakım Ünitesindeki Travma Hastalarının Retrospektif Analizi

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ABSTRACT

Objective: About 5.8 million people die each year as a result of injuries. Since trauma is an important problem that increases mortality and morbidity, these patients are usually followed up in intensive care units. In this study, we aimed to investigate the demographic characteristics, the effectiveness of trauma scoring systems, mortality rates, and factors affecting mortality in patients with trauma who were followed up and treated in our Intensive Care Unit (ICU).
Methods: The files of the patients who were followed up and treated in the Anesthesiology and Reanimation ICUs of our hospital between January 2017 and August 2019 were retrospectively reviewed. In addition to demographic data such as age, sex, trauma region, comorbidities, duration of hospitalization, Glasgow Coma Scale (GCS), Revised Trauma Score (RTS), and Acute Physiological and Chronic Health Assessment II (APACHE II), surgical history, hospital and ICU length of stay, the duration of invasive mechanical ventilation, ICU mortality, admission lactate, Procalcitonin (pct), ratio of neutrophil/lymphocyte values were recorded from the files of the patients.
Results : A total of 115 had complete data available for the analysis. The median age of the patients was 57.0 (44.0) years and 58.3% of the patients were male. ICU length of stay 6.0 (10.0) days, invasive mechanical ventilation (IMV) duration 5.0 (12.0) days, mortality rate 23.5% was found. The mean GCS, RTS scores were lower and APACHE II scores, duration of IMV, admission lactate levels, pct, ICU length of stay were higher in the non-survivors group than survivors (p<0.05).
Conclusion: It is important to know the characteristics of trauma patients who are among the main causes of death. We believe that knowing factors that negatively affect prognosis in patients with trauma may contribute positively to trauma management. High APACHE II, GCS, lactate levels, and low RTS increase mortality during admission to ICU for trauma patients.

Keywords: Trauma, APACHE-II, Revised trauma score, Mortality

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ÖZET

Amaç: Her yıl yaklaşık 5.8 milyon insan yaralanma sonucu hayatını kaybediyor. Travma mortalite ve morbiditeyi artıran önemli bir problem olduğundan, bu hastalar genellikle yoğun bakım ünite (YBÜ)'lerinde takip edilir. Bu çalışmada YBÜ'mizde izlenen ve tedavi edilen travma hastalarında demografik özellikleri, travma skorlama sistemlerinin etkinliğini, mortalite oranlarını ve mortaliteyi etkileyen faktörleri araştırmayı amaçladık.
Yöntemler: Ocak 2017 - Ağustos 2019 tarihleri arasında hastanemizin Anesteziyoloji ve Reanimasyon YBÜ'de izlenen ve tedavi edilen hastaların dosyaları retrospektif olarak incelendi. Yaş, cinsiyet, travma bölgesi, komorbiditeler, hastanede yatış süresi, Glosgow Koma Skala (GKS), Revize Travma Skoru (RTS) ve Akut Fizyolojik ve Kronik Sağlık Değerlendirmesi II (APACHE II), cerrahi geçmiş gibi demografik verilere ek olarak, hastane ve YBÜ kalış süresi, invaziv mekanik ventilasyon (İMV) süresi, YBÜ mortalitesi, laktat kabulü, prokalsitonin (pct), nötrofil/lenfosit değerlerinin oranı hastaların dosyalarından kaydedildi.
Bulgular: Analiz için 115 veriye ulaşıldı. Hastaların ortanca yaşı 57.0 (44.0) ve % 58.3'ü erkek cinsiyetten oluşmaktaydı. Yoğun bakımda kalış süresi 6.0 (10.0) gün, İMV süresi 5.0 (12.0) gün, mortalite oranı % 23.5 olarak bulundu. Ortalama GKS, RTS skorları daha düşük ve APACHE II skorları, İMV süresi, başvuru laktat düzeyleri, pct, YBÜ kalış süresi hayatta kalan hastalarda kalmayanlara kıyasla daha uzundu (p <0.05).
Sonuç: Travma başlıca ölüm nedenleri arasındadır. Travma hastalarının özelliklerini bilmek önemlidir. Travma hastalarında prognozu olumsuz etkileyen faktörlerin bilinmesinin travma yönetimine olumlu katkı sağlayabileceğine inanıyoruz. Yüksek APACHE II, GKS, laktat seviyeleri ve düşük RTS, travma hastalarında YBÜ'ne kabul sırasında mortaliteyi arttırır.

Anahtar Sözcükler: Travma, APACHE-II, Revize travma skoru, Mortalite

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INTRODUCTION

In the industrialized world, with socioeconomic and technological developments, trauma is the leading cause of death and disability in patients aged less than 45 years. Globally, 9-10% of all deaths are caused by traumatic injuries (1). In the United States, trauma is the fifth leading cause of death, regardless of type and age of persons, and it is the leading cause of death among individuals aged under 44 years (2). In 2011, The World Health Organization (WHO) reported that nearly 1.3 million people die and up to 50 million more are injured each year as the result of trauma secondary to road traffic accidents (RTAs) (3). The majority of patients with traumatic injuries are admitted to the intensive care unit (ICU) with a preliminary diagnosis of severe or multiple trauma and constitute a significant proportion of critical patients.

The ICU is the place where the resuscitation and restoration of physiology is optimal after detecting the damage following trauma and performing surgical or medical initial interventions (4). The presence of a well-equipped ICU offering a multidisciplinary approach is important in centers that accept patients with trauma. In the United States, more than 50 million patients receive medical care due to trauma per year, and trauma accounts for approximately 30 percent of all ICU admissions (5). In addition to monitoring and current treatment approaches in the ICU, scoring systems are used to evaluate the patient's condition objectively, and provide predictions for survival expectations (6).

In this retrospective study, we aimed to investigate the demographic characteristics, effectiveness of trauma scoring systems, mortality rates, and factors affecting mortality in patients with trauma who were followed up and treated in our ICU.

MATERIALS and METHODS

This study was conducted in a 21-bed teaching hospital with a trauma center in Diskapi Yildirim Beyazit Training and Research Hospital, Turkey. The hospital is a level 3 trauma center. After the approval of the local ethics committee (Ethical Committee 05.08.2019 No: 69/01), the records of 900 patients who were followed up in the Anesthesiology and Reanimation ICU in our hospital between January 2017 and August 2019 were evaluated retrospectively. A total trauma patients of 115 had complete data available for the analysis.

Demographic data, type of trauma, trauma area, presence of multiple trauma, initial referring unit, additional diseases, ICU and hospital length of stay, duration of invasive mechanical ventilation (IMV), Glasgow Coma Scale (GCS), Revised Trauma Score (RTS), Acute Physiological and Chronic Health Assessment II (APACHE II), surgical requirement, level of albumin on admission, level of procalcitonin (pct) on admission, level of lactate on admission, ratio of neutrophil/lymphocyte on admission (NLR) at the time of admission, need for renal replacement therapy, history of erythrocyte suspension (ES) in the ICU, fresh frozen plasma (FFP), albumin transfusion requirement, and ICU mortality rate (survivor/nonsurvivor) were evaluated and recorded.

APACHE II uses a point score based upon initial values of 12 routine physiologic measurements, age, and previous health status to provide a general measure of disease severity (7). The GCS is a scoring system that predicts the severity of neurologic dysfunction and predicts early mortality after injury (8). The RTS is a scoring based on the clinical and physiologic data of the bedside and is calculated using the formula RTS = (0.9368 x GCS) + (0.7326 x Systolic blood pressure) + (0.2908 x Respiratory rate) (9).

Statistical Analysis

The suitability of continuous variables obtained from 115 volunteers to normal distribution was examined using the Shapiro-Wilk test and graphical methods. Continuous variables were summarized using median (inter-quartile range, IQR) statistics because the variable in the study did not meet the assumption of normal distribution. Number (percentage) [n (%)] statistics were used to summarize the categorical variables. The Chi-square (χ^2) test was used to compare categorical variables according to mortality rates (survivor/nonsurvivor) and İMV requirement, and the most suitable likelihood ratio, continuity correction, and Pearson's Chi-square test results were reported. The nonparametric equivalent t-test of the Mann-Whitney U test was used because the necessary assumptions were not provided in the analysis of continuous variables according to mortality and mechanical ventilation. A multiple logistic regression equation was established to determine the relationship between the outcome variable and the variables of development, infection, RTS, APACHE II, level of lactate on admission, and ICU length of stay (ICU LOS). The goodness-of-fit of the model was examined using Hosmer-Lameshow statistics, outlier value evaluations using Cook's and Mahalonobis distance, and multiple connection problems using the variance inflation factor. -2 Log likelihood and Nagelkerke R2 values are reported for model descriptors, and odds ratios are given in 95% confidence intervals (CI).

The level of statistical significance was determined as $p<0.05$. Statistical analyses and calculations were performed using the IBM SPSS Statistics 25.0 software (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) and MS-Excel 2016.

RESULTS

Between January 2017 and August 2019, 900 patients were followed up in the Anesthesiology and Reanimation ICU. Of the 128 patients with a diagnosis of trauma, 115 had complete data available for the analysis. The median age, sex, additional comorbidities, initial referring unit, ICU LOS, hospital LOS, IMV duration, requirement of hemodialysis, and ICU mortality (survivor/nonsurvivor) are shown in Table 1. Mechanisms of trauma, trauma area, level of lactate on admission, level of pct on admission, NLR, type of infection, and enteral nutrition are given in Table 2.

Table 1. Baseline characteristics.

Variable	Median (IQR)
Age (years)	57.0 (44.0)
ICU LOS (days)	6.0 (10.0)
Hospital LOS (days)	12.0 (22.0)
IMV duration (days)	5.0 (12.0)
Variable	**n (%)**
Gender	
Female	48 (41.7)
Male	67 (58.3)
ICU mortality	
Exitus	27 (23.5)
Discharge	88 (76.5)
Initial referring unit	
Operating room	51 (44.3)
Outside center	7 (6.1)
Emergency	34 (31.3)
Service	21 (18.3)
Severe chronic illness	
Chronic respiratuar disease	22 (19.1)
Chronic cardiovascular	25 (21.7)
Chronic renal disease	28 (24.3)
DM	25 (21.7)
Others	15 (13.0)
Hemodialysis requirement	23 (20.0)

ICU= Intensive Care Unit, LOS= Length of Stay,
IMV= Invasive Mechanical Ventilation, DM: Diabetes Mellitus,

Table 2. Trauma and ICU admission characteristics

Variable	Median (IQR)
Admission lactate	1.8 (2.0)
Admission pct	0.8 (3.0)
Admission NLR	5.8 (5.0)
Variable	**n (%)**
Mechanisms of trauma	
Road traffic accidents	44 (38.3)
Pedestrian accidents	27 (23.5)
Falling from high	24 (20.9)
Work accident	6 (5.2)
Assault	8 (7.0)
Other	6 (5.2)
Trauma Location	
Head and neck	51 (44.3)
Thoracic	18 (15.7)
Abdominal	12 (10.4)
Pelvis, Vertebrae	14 (12.2)
Extremity	20 (17.4)
Type of Infection	
Blood	5 (13.5)
Tracheal	8 (21.6)
Uriner	1 (2.7)
Catheter	1 (2.7)
Multiple	22 (59.5)
Enteral nutrition start in the first 48 hours	68 (59.1)

NLR= neutrophil-to-lymphocyte ratio,

When the patients were classified according to their exit status from the ICU (survivor and nonsurvivor), the median age, NLR, haemodialysis requirement and surgical histories of patients in both groups were similar ($p > 0.05$) (Table 3, Table 4).

RTS, GCS, APACHE II score, level of lactate on admission, level of pct on admission, the presence of infection, IMV duration, ICU LOS, ES, FFP and albumin requirements were found to be different between survivor and nonsurvivor patients ($p < 0.05$) (Table 3, Table 4).

Table 3. Evaluation of mortality according to ICU outcomes

Variable	Nonsurvivors [n=27]	Survivors [n=88]	Test Z	P Value
Age (years)	63.0 (34.0)	55.0 (49.8)	1.270	0.204
GCS	8.0 (5.0)	12.0 (3.0)	5.900	<0.001
RTS	5.2 (3.3)	6.9 (1.2)	4.172	<0.001
APACHE II	29.0 (4.0)	19.0 (5.0)	7.146	<0.001
IMV duration (days)	13.0 (25.0)	4.0 (8.0)	2.130	0.033
ICU LOS (days)	14.0 (28.0)	5.0 (6.0)	2.257	0.024
NLR	7.0 (6.4)	5.5 (4.5)	1.963	0.050
Admission pct (ng/mL)	3.0 (13.2)	0.7 (1.2)	3.236	0.001
Admission lactate (mmol/L^{-1})	4.2 (6.4)	1.4 (1.4)	4.613	<0.001

Values are presented as median (IQR). GCS: Glasgow Coma Scale, RTS: Revised Trauma Score, APACHE: Acute Physiology and Chronic Health Assessment, IMV: Invasive Mechanical Ventilation.

Table 4. Evaluation of mortality according to ICU admission and intervention

Variable	Nonsurvivors [n=27]	Survivors [n=88]	Test χ^2	P Value
Mechanisms of trauma			5.650	0.227*
Head and neck	11 (40.7)	40 (45.5)		
Thoracic	4 (14.8)	14 (15.9)		
Abdominal	6 (22.2)	6 (6.8)		
Pelvis, Vertebrae	3 (11.1)	11 (12.5)		
Extremity	3 (11.1)	17 (19.3)		
Intervention during ICU				
Surgery	11 (40.7)	66 (75.0)	9.467	0.002#
Haemodialysis requirement	9 (39.1)	14 (60.9)	1.087	0.297
ES replacement	21 (77.8)	46 (52.3)	4.528	0.033#
TDP replacement	17 (63.0)	31 (35.2)	5.445	0.020#
Albumin replacement	16 (59.3)	18 (20.5)	13.135	<0.001#
Presence of infection	15 (55.6)	24 (27.3)	6.166	0.013#

Values are presented as n (%). *= Likelihood ratio, #= Continuity correction is the result of the chi-square test. ES=Erythrocyte suspension, TDP= Fresh frozen plasma.

In the study, mortality ($p<0.001$) was significantly higher in patients with lactate >2 mmol/L^{-1}. However, hemodialysis requirement was significantly lower in patients with lactate <2 mmol/L^{-1} ($p<0.001$). The duration of mechanical ventilation was significantly longer in patients with lactate >2 mmol/L^{-1} ($p=0.018$), whereas the duration of ICU stay was not affected ($p=0.079$).

In order to determine the factors affecting mortality, a logistic regression model was established with the presence of infection, RTS, APACHE II, admission lactate, and ICU LOS variables. When the multiple logistic regression results were analyzed, it was found that APACHE II and lactate admission values were significant in the equation ($p<0.05$). A one unit increase in APACHE II was found to increase mortality by 2.092 times (95% CI: 1.439-3.040), and a one unit increase in level of lactate on admission increased mortality by 1.531 times (95% CI: 1.151-2.036) (Table 5).

Table 5. Multiple logistic regression analysis of factors related to mortality of patients

Variable	B ± Std Error	P Value	Odds Ratio	%95 C.I. Lower Bound	%95 C.I. Upper Bound
Presence of infection	0.210 ± 1.073	0.845	1.233	0.151	10.095
RTS	0.578 ± 0.319	0.070	1.782	0.954	3.328
Apache II	0.738 ± 0.191	0.000	2.092	1.439	3.040
Admission lactate (mmol/L^{-1})	0.426 ± 0.145	0.003	1.531	1.151	2.036
ICU LOS (days)	0.009 ± 0.018	0.617	1.009	0.974	1.045
Constant	-17.919 ± 5.252	0.001	0.000		

-2 log likelihood: 31.077; Nagelkerke R^2=0.843
RTS: Revised Trauma Score, APACHE: Acute Physiology and Chronic Health Assessment, ICU= Intensive Care Unit, LOS= Length of Stay,

Patients who did not receive mechanical ventilation were retrospectivley compared, and there was a significant difference in baseline GCS, RTS, APACHE II scores, admission lactate, pct, NLR values, presence of infection, hospital LOS, and ICU LOS (p<0.05) (Table 6). However, there was no statistical difference in terms of additional comorbidities (chronic cardiovascular, chronic respiratuar disease, chronic renal disease, diabetes mellitus, others) (p=0.987) (Table 6).

Table 6. Comparison of data according to mechanical ventilator requirement

Variable	IMV applied [n=68]	IMV not applied [n=47]	Test Z	P Value
GCS	10.0 (4.0)	13.0 (2.0)	5.700	<0.001
RTS	6.0 (2.8)	7.1 (0.7)	4.739	<0.001
APACHE II	24.0 (9.0)	17.0 (6.0)	5.685	<0.001
Admission lactate (mmol/L^{-1})	2.3 (3.1)	1.3 (1.2)	2.915	0.004
Hospital LOS (days)	21.0 (36.5)	7.0 (6.0)	4.903	<0.001
ICU LOS (days)	10.0 (17.8)	2.0 (3.0)	6.245	<0.001
Admission pct (ng/mL)	1.7 (6.6)	0.4 (0.8)	3.905	<0.001
Presence of infection (n)	36 (52.9)	3 (6.4)	24.842	<0.001[#]

Values are presented as median (IQR).

[#]: Continuity correction. ICU= intensive care unit, LOS= length of stay, DM: diabetes mellitus, GCS: Glasgow Coma Scale, RTS: Revised Trauma Score APACHE: Acute Physiology and Chronic Health Assessment IMV: Invasive Mechanical Ventilation.

DISCUSSION

This study showed that scoring systems, admission lactate, pct, NLR values, ICU LOS, and IMV duration were associated with mortality in patients with trauma admitted to the ICU in a major trauma center. However, it was determined that patient age and trauma body site did not affect the mortality rate. It is evident that the level of lactate on admission and APACHE II score are helpful indicators in predicting prognosis for patients with trauma.

Trauma is an important cause of morbidity and mortality especially in young patients (10). Yazar et al. (11) showed that mortality rates increased as the mean age increased. However, it was observed that the age variable was not associated with direct mortality in centers following more specific age groups in ICUs (4, 12, 13). In the current study, we found that patient age was not a factor affecting mortality. This result is attributed to the fact that we are frequently following geriatric patients in our ICU and there was no age distribution to make a difference between the patients.

Traffic accidents are the most common trauma factor in studies conducted in our country and in the world (4, 14, 15). In our study, according to the etiology of trauma, road traffic accidents were the most common cause of trauma with a rate of 38.3%. Thousands of people are killed every year in traffic accidents and reported by the media. In order to prevent accidents, traffic rule violations are being punished more strictly. We believe that the measures taken will significantly reduce the mortality caused by traffic accidents in the coming years.

The trauma body site affects mortality (11, 16, 17). The head and neck region is the most commonly affected area in trauma (16, 18). In our study, head and neck traumas were observed most frequently. However, in our study, the mortality rate was independent of the trauma body site. We believe that this is due to improved imaging methods, high adherence to organ-sparing strategies (lung-protective ventilation, prevention of ventilator-associated pneumonia, strategies to reduce intracranial pressure), and easy access to relevant surgical clinics.

Prolonged ICU stay may increase infection, pre- and post-operative complications, and mortality rates in patients who require complex treatment involving many organ systems such as those with trauma. Karip et al. (19) reported that the mean LOS in the ICU was 13 days and the mortality rate was 34.6%. Dur et al. (20), in their study in multiple trauma patients, the mean length of stay in the ICU was 4 days, the mean length of hospital stay was 12 days, and the mortality rate was 26.8%. In our study, the duration of ICU stay was 6 days, hospital stay was 12 days, and the mortality rate was 23.5%. Despite the length of stay in ICU hospitalizations, the mortality rate was partially lower. This is attributed to the fact that most patients (44.3%) were transported to the ICU for close follow-up after trauma and emergency surgical intervention.

It is known that there is a two-way relationship between the duration of ICU stay and the risk of infection (21). Kara et al. (22) reported that prolonged ICU stay increased mortality.

By contrast, Adıyaman et al. (23) concluded that LOS in the ICU was not a risk factor for mortality and long hospital stay would not change mortality with appropriate follow-up and treatment. In the current study, it was found that the duration of ICU stay was longer in patients who died compared with survivors. In addition, the rate of infection in non-surviving patients was higher than in those who survived. This suggests that the risk of infection increases due to prolonged stay in the ICU and mortality rates rise with increasing infection rates.

One of the factors affecting mortality in patients with trauma is the prolongation of IMV time (23). Use of IMV creates a tendency to complications such as secondary pulmonary infection, pulmonary embolism, atelectasis, and barotrauma. The presence of a pathology requiring IMV and all complications may increase the tendency to mortality. As in similar studies, the duration of IMV was longer in the non-surviving group compared with the survivors.

Yazar et al. (11) found that the presence of surgical procedures did not affect mortality. However, the surgical rate of patients in our study was significantly higher in survivors. We consideration that trauma patients with impaired organ function or hemodynamics may be due to corrected of existing pathology by surgical intervention. Blood and blood product transfusion and albumin infusion increase mortality in patients with trauma (24, 25). In our study, transfusion of blood and blood products and albumin infusion increased mortality and the need for IMV.

Lactate value is a parameter related to mortality in patients with trauma (23, 26). Ouellet et al. (26) evaluated the relationship between mortality and lactate levels in arterial blood gas during admission to a level-3 ICU of 3000 patients with trauma. They found that lactate levels were higher in non-surviving patients than in survivors. In this study, lactate values were found to be higher in the group that needed mechanical ventilation compared with the group that did not, and in the non-surviving group compared with the surviving group. In multiple logistic regression analysis among factors affecting mortality, we found that one unit increase in lactate from normal levels on admission increased mortality 1.5 times. Hemodialysis requirement was also increased in patients with lactate >2 mmol/L^{-1}. This showed that high lactate levels in patients with trauma is an important parameter to be considered during the treatment process because it is a sign of perfusion disorder in tissues.

In the literature, data on the relationship between NLR and mortality in patients with trauma are conflicted (27-30). In our study, we considered that the relationship between mortality and elevation of NLR could not be shown because this parameter is affected by many inflammatory conditions and is not selective due to an increase in all patients with trauma.

Procalcitonin is a useful parameter in the diagnosis of sepsis; however, blood levels may increase for many reasons other than sepsis (31-33). Procalcitonin has been shown to be a better marker than C-reactive protein in the early diagnosis of septic complications in patients with trauma (34). In addition, increased pct levels were associated with mortality in patients with trauma (35). As expected, high pct levels were associated with increased mortality and the need for mechanical ventilators in our study.

In intensive care patients, scoring systems are frequently used to determine the severity of disease, response to treatment, expected mortality rates, and intensive care performance (19). Scoring systems are also used to determine the severity of trauma (10, 13, 22, 36). The APACHE II score is a prognostic scoring system calculated by 12 physiologic parameters, age, and previous health status (37). High APACHE II scores were associated with increased mortality, increased IMV requirement, and prolonged IMV duration (22, 38, 39). In our study, a statistically significant relationship was found between APACHE II scores and mechanical ventilation requirement, duration of mechanical ventilation, and the mortality rate. At the same time, multiple logistic regression analysis among the factors affecting mortality showed that high APACHE II scores increased mortality by approximately twice and was an important parameter in predicting mortality.

Low GCS scores are known to be associated with increased mortality (40). In our study, the mean GCS was 8 in nonsurvivors, whereas it was 12 in survivors. In addition, the mean GCS was 10 in the group that needed IMV and 13 in the group without IMV. The rate of IMV administration is considered to be higher in this patient group because of concerns about airway safety in patients with low GCS scores.

The GCS assesses only the severity of head trauma in patients with trauma. Therefore, the RTS was established by adding respiratory rate and systolic blood pressure to the GCS. At low RTS values, mortality, need for mechanical ventilation, and duration of mechanical ventilation are prolonged (4, 13, 41). In our study, similar to the literature, the RTS was found to be lower in the nonsurvivor group compared with the survivor group. The RTS was found to be lower in patients who needed mechanical ventilation compared with those without need. Therefore, we recommend that APACHE II, GCS, and RTS scoring should be used to predict mortality risk and

CONCLUSION

Trauma is one of the major causes of death at the present time. ICU mortality estimation systems may contribute to the determination of mortality in affected patients. In our study, APACHE-II, GCS, and the RTS scoring systems were shown to be effective in determining the mortality and IMV requirment of patients with trauma. In addition, high lactate and pct values were found to increase mortality during admission to the ICU. We believe that knowing and considering factors that negatively affect prognosis in patients with trauma may contribute positively to trauma management.

Conflict of interest
No conflict of interest was declared by the authors.

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