ORIGINAL ARTICLE

Predictive factors of mortality in patients with abdominal trauma

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ABSTRACT

BACKGROUND: Traumatic injuries, particularly abdominal trauma, are a major cause of mortality worldwide. This study aimed to evaluate predictive factors for mortality and morbidity in abdominal trauma patients using simple, rapid, and accessible clinical and laboratory parameters, with a focus on developing scoring systems for emergency department decision-making.

METHODS: A retrospective cohort study was conducted in a Level 1 Trauma Center between October 2022 and March 2024. Patients aged 18 and older with abdominal trauma or multi-trauma were included, while cases with incomplete records, known chronic diseases, or a recent trauma history were excluded. Data on demographics, vital signs, laboratory results, imaging findings, clinical scores, and outcomes were collected. Logistic regression and receiver operating characteristic (ROC) analyses were performed to identify independent mortality predictors and their cut-off values.

RESULTS: Out of 693 patients, the mortality rate was 3.6%. The most common mechanisms of trauma were road traffic accidents (59.3%) and falls (23.4%). Independent predictors of mortality included age ≥54 years, Glasgow Coma Scale (GCS) ≤14, Injury Severity Score (ISS) ≥24, and Shock Index ≥1.08. ROC analysis revealed that GCS had the highest predictive value for mortality (area under the curve [AUC]: 0.828), followed by ISS, age, and Shock Index. Elevated levels of alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate, and creatinine were associated with worse outcomes, aligning with findings in the literature.

CONCLUSION: Age, GCS, ISS, and Shock Index are strong predictors of mortality in abdominal trauma patients. Integrating these parameters into clinical decision-making can enhance risk stratification and improve patient management. Prospective multicenter studies and national trauma registries are necessary to refine trauma care and reduce mortality rates.

Keywords: Abdominal trauma; emergency department; Glasgow Coma Scale; Injury Severity Score; mortality predictors.

Cite this article as: Turan ÖF, Çankaya Gökdere D, Genç M, Bulut B, Akkanöz M, Mutlu H, et al. Predictive factors of mortality in patients with abdominal trauma. Ulus Travma Acil Cerrahi Derg 2025;31:276-282.

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Ulus Travma Acil Cerrahi Derg 2025;31(3):276-282 DOI: 10.14744/tjtes.2025.64644

Submitted: 14.01.2025 Revised: 22.01.2025 Accepted: 25.01.2025 Published: 03.03.2025

INTRODUCTION

Traumatic injury remains the leading cause of death in individuals under 45 years of age.[1] Since the effects of trauma on the body are unpredictable and can impact various organs and systems, a comprehensive patient assessment is essential.[1-3] Patients with multiple trauma require rapid and accurate diagnosis, with a focus on identifying potentially life-threatening conditions.[1]

Up to 75% of abdominal injuries result from road traffic accidents or falls.[2] Intra-abdominal injuries often arise from different pathophysiological mechanisms, such as crush, compression, and deceleration, which frequently occur in combination.[1-4] Abdominal trauma is diagnosed in up to 20% of major trauma patients and is associated with a high mortality rate of approximately 20%.[3,4] The management of abdominal trauma requires an interprofessional and multidisciplinary approach, beginning in the prehospital setting and extending through to the intensive care unit (ICU).[3]

There is strong evidence that trauma scores can enhance outcome prediction, guide triage and urgency of trauma interventions, and improve the overall quality of trauma management.[5]

Despite advances in imaging techniques, such as computed tomography (CT) and ultrasound, and the development of various clinical decision tools to predict mortality in trauma patients, the search for reliable, feasible, and effective mortality markers continues in high-level trauma centers.[6-8]

The aim of this study is to predict mortality and morbidity using predictive values derived from simple, rapid, inexpensive, and easily accessible blood parameters, clinical findings, and scores obtained from abdominal trauma patients. Additionally, the study seeks to develop scoring parameters that will assist clinicians in decision-making amidst the chaos of the emergency department.

MATERIALS AND METHODS

Study Design and Participants

This retrospective cohort study was conducted at Ankara Hospital Emergency Department between October 1, 2022 and March 31, 2024. Ankara Etlik City Hospital Scientific Research Evaluation and Ethics Board's approval was obtained before the study (Approval No: 2022-16/138, Date: 08.05.2024). The hospital where the study was conducted is a Level 1 Trauma Center, with an average of 40,000 multi-trauma admissions per year. Patients with abdominal trauma who presented to the trauma center with multi-trauma due to causes such as road traffic accidents, falls, penetrating injuries, and industrial accidents were included in the study. Multi-trauma was defined as trauma affecting at least two different organs or systems. The exclusion criteria were as follows:

- Patients whose complete medical records were unavailable,
- Patients younger than 18 years of age,
- Pregnant or breastfeeding patients,
- Patients without routine blood samples,
- Trauma patients without multi-trauma,
- Patients without abdominal trauma,
- Patients with known chronic diseases, and
- Patients with a recent history of trauma (within the last six months).

Patients were divided into two groups: survivors and deceased. The study was conducted in accordance with the tenets of the Declaration of Helsinki. Due to the retrospective design, patient or family consent was not required.

Study Protocol and Data Collection

Patient data were obtained from the hospital electronic data system and medical records. Demographic data, including age, sex, and time of accident, were recorded. The following parameters were collected: Vital signs, demographic characteristics, mechanism of injury, Glasgow Coma Scale (GCS), hemodynamic stability, physical examination findings, injury sites; complete blood count, creatinine, urea, aspartate aminotransferase (AST), alanine aminotransferase (ALT), lactate dehydrogenase (LDH), creatine kinase (CK), sodium, potassium, calcium, amylase, lipase, blood gas results; body radiographs, whole abdominal ultrasound, hepatobiliary ultrasound, urinary system ultrasound, superficial ultrasound, focused assessment with sonography in trauma (FAST), upper abdominal CT, lower abdominal CT, and pelvic CT, and various parameters such as surgical intervention and mortality status. Additionally, defined pathologies, the Injury Severity Score (ISS) calculated based on these pathologies, and data on patients discharge from the emergency department (ED) were recorded.

Statistical Analysis

Data analysis was performed using IBM SPSS 27.0 (Armonk, NY: IBM Corp.). Descriptive statistical methods (frequency, percentage, mean, standard deviation, median, min-max, interquartile range [IQR]) and chi-square test (χ^2) were used to compare qualitative data. The Kolmogorov-Smirnov test, skewness and kurtosis values, and graphical methods (histogram, Q-Q plot, stem-and-leaf plot, boxplot) were used to assess the normality of data distribution. The Mann-Whitney U test was used to compare non-normally distributed data between groups. The receiver operating characteristic (ROC) curve method was used to assess the discriminatory ability of variables, and binary logistic regression was performed to determine risk ratios. The level of statistical significance was set at p=0.05.

RESULTS

Out of 35,400 trauma patients presenting to the emergency department, 693 patients who met the study criteria were

Table 1. Comparison of demographic characteristics, clinical findings, laboratory parameters, and mortality-associated factors in patients with abdominal trauma

	General (n=693)	Alive (n=668)	Deceased (n=25)	p value*
Sex				
Female	196 (28.3%)	189 (28.3%)	7 (28.0%)	0.974[a]
Male	497 (71.7%)	479 (71.7%)	18 (72.0%)	
Age (years)	41.1±18.0	40.4±17.5	59.8±22.5	<0.001[b]
Vital Signs				
SBP (mmHg)	122 (110-135)	127.0 (114.0-143.8)	99.0 (94.0-106.0)	<0.001[c]
Pulse (bpm)	84 (76-93)	74.0 (66.5-83.5)	93.5 (81.3-105.3)	<0.001[c]
Shock Index	0.66 (0.58-0.82)	0.60 (0.5-0.8)	0.78 (0.65-0.97)	<0.001[c]
ISS	8.0 (0.0-75.0)	6.0 (2-17)	66 (25-75)	< 0.001[c]
Mechanism of Trauma				
Traffic Accident	411 (59.3%)	400 (59.9%)	11 (44.0%)	<0.001[a]
Fall from Height	162 (23.4%)	151 (22.6%)	11 (44.0%)	
Assault	67 (9.7%)	67 (10.0%)	0 (0.0%)	
Self-inflicted Injury	29 (4.2%)	28 (4.2%)	1 (4.0%)	
Other	24 (3.5%)	22 (3.3%)	2 (8.0%)	
Injury to End Organs				
Liver	75 (10.8%)	54 (8.1%)	21 (84.0%)	0.046[a]
Spleen	58 (8.4%)	42 (6.3%)	16 (64.0%)	0.032[a]
Kidney	15 (2.2%)	13 (1.9%)	2 (8.0%)	0.098[a]
Stomach &				
Small Bowel	27 (3.9%)	22 (3.3%)	5 (20.0%)	<0.001[a]
Colon & Rectum	20 (2.9%)	17 (2.5%)	3 (12.0%)	<0.001[a]
GCS	15 (3-15)	15 (15-15)	11 (3-15)	<0.001[c]
Outcome from ED				
Discharged	412 (59.5%)	409 (61.2%)	3 (12%)	<0.001[a]
Hospitalized	271 (39.1%)	249 (37.2%)	22 (88%)	<0.001[b]
NLR	2.6 (0.3-44.1)	2.5 (1.6-5.0)	5 (2.2-11.1)	0.028[c]
WBC (103/µL)	9.9 (3.0-41.9)	9.8 (7.7-12.6)	16.0 (11.0-19.6)	<0.001[c]
HGB (g/dL)	14.7 (4.8-19.4)	14.8 (13.3-15.8)	12.8 (10.2-13.8)	<0.001[c]
BUN (mg/dL)	28.1 (10.2-169.0)	27.8 (22.8-34.2)	40.9 (26.8-58.7)	<0.001[c]
Creatinine (mg/dL)	0.9 (0.1-4.1)	0.9 (0.7-1.0)	1.0 (0.7-1.5)	0.007[c]
Lactate (mmol/L)	1.8 (0.5-17.4)	1.8 (1.4-2.5)	3.3 (2.3-5.7)	<0.001[c]
ALT (IU/L)	22.0 (4.0-1,058.0)	22.0 (15.0-33.0)	36.0 (18.0-70.5)	0.006[c]
AST (IU/L)	25.0 (4.9-994.0)	24.0 (19.0-35.0)	61.0 (29.5-93.0)	<0.001[c]
pH	7.4 (6.9-7.6)	7.4 (7.4-7.4)	7.3 (7.3-7.4)	<0.001[c]
Base Deficit	-1.3 (-27.3-20.6)	-1.2 (-2.8-0.5)	-6.8 (-9.5--2.1)	<0.001[c]

SBP: Systolic Blood Pressure; GCS: Glasgow Coma Scale; ISS: Injury Severity Score; ALT: Alanine Aminotransferase; AST: Aspartate Aminotransferase; WBC: White Blood Cell Count; BUN: Blood Urea Nitrogen; NLR: Neutrophil-to-Lymphocyte Ratio. *p-value<0.05; a: Chi-Square Test (n/%), b: Independent Samples t-Test (Mean±SD), c: Mann-Whitney U Test (Median (IQR)).

included. The study design is shown in Figure 1. The mean age of the included patients was 41.1±18.0 years, and 196 (28.3%) were female. The most common causes of multi-trauma were road traffic accidents, affecting 411 (59.3%) patients, and falls from height, affecting 162 (23.4%) patients. Among the study participants, 412 patients (59.5%) were discharged, 271

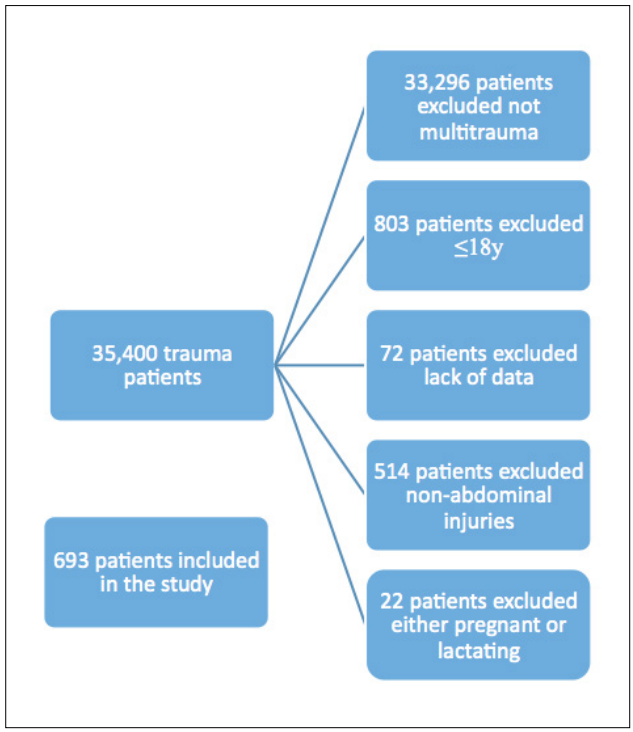

Figure 1. Study diagram.

patients (39.1%) were hospitalized, and 25 patients (3.6%) died. The demographic and clinical characteristics of the patients are presented in Table 1. When comparing mortality cases, the following variables were found to be statistically significant ($p<0.05$): age, Shock Index, Injury Severity Scale, mechanism of trauma, gastric and small bowel injury, GCS on admission, neutrophil-to-lymphocyte ratio (NLR), white blood cell count (WBC), creatinine, urea, ALT, AST, amylase, LDH, calcium, lactate, pH, bicarbonate, and base deficit. A comparison of demographic and clinical characteristics and laboratory parameters is shown in Table 1.

Variables that were considered clinically significant and not highly correlated among the statistically significant mortality predictors in abdominal trauma included: age, Shock Index, ISS, mechanism of trauma, gastric and small bowel injury, GCS, NLR, WBC, hematocrit (HCT), creatinine, urea, ALT, AST, lactate, and bicarbonate. These variables were initially evaluated using univariate logistic regression analysis followed by multivariate logistic regression test analysis for significant variables. In the multivariate logistic regression analysis, the following were identified as independent predictors of mortality: age, GCS on admission, ISS, Shock Index, and stomach and small bowel injury (Table 2).

Table 2. Univariate and multivariate analysis of predictive factors for mortality in abdominal trauma

	Univariate Logistic Regression Analysis					Multivariate Logistic Regression Analysis				
Risk Factors	**B**	**SE**	**Odds Ratio**	**95% CI**	**P***	**B**	**SE**	**Odds Ratio**	**95% CI**	**P***
Age (years)	0.079	0.022	1.08	1.04-1.13	<0.001	0.07	0.016	1.07	1.04-1.11	<0.001
GCS on Admission	-0.304	0.098	0.74	0.61-0.89	0.002	-0.332	0.062	0.72	0.64-0.81	<0.001
ISS	0.048	0.015	1.05	1.02-1.08	0.001	0.061	0.011	1.06	1.04-1.09	<0.001
Shock Index	0.747	0.297	2.11	1.18-3.78	0.012	0.979	0.367	2.66	1.30-5.46	0.008
Stomach & Small Bowel Injury	1.534	0.733	4.64	1.10-19.50	0.036	2.314	0.881	6.12	1.080-26.92	0.009

GCS: Glasgow Coma Scale; ISS: Injury Severity Score; CI: Confidence Interval. *Binary Logistic Regression Test was used (only variables remaining in the model). Nagelkerke R^2=0.582, Hosmer and Lemeshow Test = 0.907. $p<0.05$ is considered statistically significant.

Table 3. Area under the receiver operating characteristic (ROC) curve analysis for mortality in abdominal trauma

	AUC	**95% CI**	**Cut-off**	**Sensitivity**	**Specificity**	**Youden Index**	**+PV**	**-PV**	**p value***
Age (years)	0.745	0.711-0.777	>54	68.1	77.8	0.458	10.3	98.5	<0.001
GCS on Admission	0.828	0.798-0.855	≤14	68.3	97.1	0.650	45.9	98.8	<0.001
ISS	0.823	0.793-0.851	>24	80.4	81.5	0.610	13.6	99.1	<0.001
Shock Index	0.538	0.500-0.576	≤1.08	84.5	28.1	0.121	4.2	97.9	0.488

GCS: Glasgow Coma Scale; ISS: Injury Severity Score; AUC: Area Under the Curve; PV: Predictive Value.

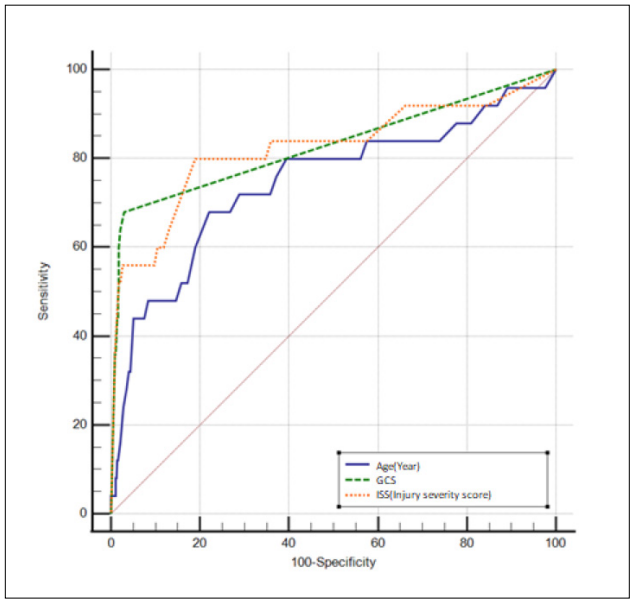

Figure 2. Receiver operating characteristic curves of age, Glasgow Coma Scale (GCS), and Injury Severity Score (ISS) for mortality.

We performed ROC analysis to determine the predictive power of age, GCS on admission, ISS, and Shock Index for mortality (Fig. 2). The cut-off values for predicting mortality in abdominal trauma patients were determined as follows: age: 54 (68.1% sensitivity, 77.8% specificity), GCS: 14 (68.3% sensitivity, 77.8% specificity), ISS: 24 (80.4% sensitivity, 81.5% specificity), and Shock Index: 1.08 (84.5% sensitivity, 28.1% specificity). The area under the curve (AUC) for GCS was 0.828, indicating a higher predictive power for mortality compared to ISS alone (AUC: 0.823), age alone (AUC: 0.745), and Shock Index alone (AUC: 0.538) (Table 3).

DISCUSSION

This retrospective study evaluated the clinical outcomes and prognostic factors in multi-trauma patients with abdominal injuries. In our study, the mortality rate among abdominal trauma patients was 3.6%, and we identified the following as poor prognostic factors: age over 54 years, GCS below 14, ISS above 24, and Shock Index over 1.08.

Multi-trauma patients are a complex and high-risk group requiring rapid and accurate decision-making.[9] The prioritization of diagnostic modalities in these patients can vary significantly, as each diagnostic tool has its own advantages and limitations. Although abdominal CT is the most effective method for detecting intra-abdominal injuries, its use is limited to certain patients due to its high cost, time-consuming nature, and high radiation exposure.[1,10] However, in cases where abdominal CT cannot be utilized, examination findings, clinical scoring systems, and biochemical tests may serve as an important predictive tools.[9-12] The difficulty of risk stratification in the follow-up of solid organ or visceral injuries that cannot be diagnosed in the early stages is a major concern. At this point, clinical scoring systems and biochemical parameters can help clinicians identify high-risk patients,[4,12] as more severe abdominal trauma is expected to result in greater alterations in biochemical and radiological measures. In 2015, Zhao et al.[13] found that age and a high ISS accurately predicted in-hospital mortality in trauma patients older than 65 years. De Simone et al.[14] highlighted that mortality is higher in elderly patients compared to younger individuals in the 2024 World Society of Emergency Surgery (WSES) trauma management guideline for elderly patients. Aging is associated with physiological changes across multiple systems and is correlated with frailty, which is a risk factor for mortality in elderly trauma patients.[13,14] As frequently emphasized in the literature, our study also found a statistically significant relationship between age, ISS, and mortality.

Damulira et al.[15] showed that trauma patients with a systolic blood pressure (SBP) range of 90-109 mmHg had worse outcomes than those with an SBP above 109 mmHg in a study examining trauma scores. Additionally, Vang et al.,[16] in a meta-analysis of 1,350 articles, reported that in-hospital mortality was significantly higher in adult trauma patients with a Shock Index ≥1 compared to those with a Shock Index <1. Consistent with the literature, our study also found that SBP was lower in patients with a fatal outcome, and a Shock Index ≥1.08 predicted mortality with a sensitivity of 84.5% and a specificity of 28.1%.

In a retrospective study of 199 patients with abdominal trauma over a seven-year period, Demirpolat et al.[17] concluded that NLR, platelet-to-lymphocyte ratio (PLR), and ISS may be useful in predicting the need for surgical intervention in the clinical follow-up of patients whose physical examination findings were unclear, making an immediate decision for emergency surgery difficult. Similar studies have reported that laboratory values, including NLR, PLR, lactate, and base deficit, are associated with mortality in trauma patients.[16-21] Lee et al.[19] suggested that in 289 patients who underwent abdominal CT for blunt abdominal trauma, an elevated white blood cell count, along with elevated serum ALT and AST levels, provided valid justification for additional screening methods to investigate liver injury. In a study of 174 patients with blunt liver and spleen trauma, Kumar et al.[20] highlighted the association between increased intra-abdominal pressure monitoring and renal injury in non-operative patients, linking it to elevated creatinine levels. The findings in our study regarding the relationship between elevated creatinine, urea, NLR, WBC, ALT, AST levels, and intra-abdominal injury are consistent with the literature.

Soni et al.[22] examined the impact of intubation performed within the first hour on in-hospital mortality in their cohort study of 3,476 trauma patients with a GCS score ≤8. They emphasized the association between low GCS scores, the need for intubation, and increased mortality.[22] In our study, we found that GCS <14 predicted mortality with 68.3% sensitivity and 77.8% specificity in patients with abdominal trauma (AUC: 0.823).

The strengths of our study include the large patient cohort and detailed mortality analyses. However, the study has certain limitations. First, it was conducted using single-center data, which may limit the generalizability of the results to the broader population. Second, the retrospective study design prevented a detailed analysis of clinical data. Finally, long-term complications could not be evaluated due to the lack of long-term follow-up data.

CONCLUSION

In conclusion, our study demonstrated that ISS, age, and GCS are strong predictors of mortality, as shown in ROC analyses. While clinical scores and laboratory parameters play a significant role in the diagnosis of intra-abdominal injuries, vital signs and blood tests alone are not sufficiently sensitive. However, future multicenter prospective studies and the development of national trauma registries will help improve the management of abdominal trauma and reduce mortality rates.

Ethics Committee Approval: This study was approved by the Ankara Etlik City Hospital Scientific Research Ethics Committee (Date: 08.05.2024, Decision No: 2022-16/138).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: Ö.F.T., M.G., R.Y.; Design: D.Ç.G., M.A.Ö.; Supervision: Ö.F.T., B.B., H.M., R.Y.; Resource: B.B., M.A.Ö.; Materials: Ö.F.T., M.A.Ö.; Data Collection and/or Processing: Ö.F.T., M.A.Ö.; Analysis and/or Interpretation: D.Ç.G., B.B., H.M.; Literature Review: M.G., M.A.Ö., R.Y.; Writing: D.Ç.G., B.B.; Critical Review: M.G., B.B., H.M., R.Y.

Conflict of Interest: None declared.

Financial Disclosure: The author declared that this study has received no financial support.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Acil servisteki abdominal travma vakalarında mortaliteyi öngören faktörler

AMAÇ: Travmatik yaralanmalar, özellikle de abdominal travmalar, dünya çapında önemli bir mortalite nedenidir. Bu çalışmanın amacı, basit, hızlı ve erişilebilir klinik ve laboratuvar parametreleri kullanarak abdominal travma hastalarında mortalite ve morbidite için prediktif faktörleri değerlendirmek ve acil serviste karar verme için skorlama sistemlerinin geliştirilmesine odaklanmaktır.

GEREÇ VE YÖNTEM: Ekim 2022 ve Mart 2024 tarihleri arasında bir 1. Seviye Travma Merkezinde retrospektif bir kohort çalışması yapılmıştır. Abdominal travma ve multitravma geçiren 18 yaş ve üzeri hastalar çalışmaya dahil edilirken, eksik kayıtları, bilinen kronik hastalıkları veya yakın zamanda travma öyküsü olan vakalar çalışma dışı bırakılmıştır. Demografik veriler, vital bulgular, laboratuvar sonuçları, görüntüleme bulguları, klinik skorlar ve sonuçlara ilişkin veriler toplanmıştır. Bağımsız mortalite prediktörlerini ve bunların cut-off değerlerini belirlemek için lojistik regresyon ve ROC analizleri yapılmıştır.

BULGULAR: Çalışmaya dahil edilen 693 hastada mortalite oranı %3.6'dır. En yaygın travma mekanizmaları trafik kazaları (%59.3) ve düşmeler (%23.4) olmuştur. Mortalitenin bağımsız belirleyicileri arasında yaş ≥54, GKS (Glasgow Koma Skalası) ≤14, ISS (Yaralanma Şiddeti Skoru) ≥24 ve şok indeksi ≥1.08 yer almıştır. ROC analizi, GKS'nin mortalite için en yüksek prediktif değere sahip olduğunu (AUC: 0.828), bunu ISS, yaş ve şok indeksinin izlediğini ortaya koymuştur. Yüksek ALT, AST, laktat ve kreatinin düzeyleri literatür bulgularıyla uyumlu olarak daha kötü sonuçlarla ilişkilendirilmiştir.

SONUÇ: Yaş, GKS, ISS ve şok indeksi, abdominal travma hastalarında mortalitenin güçlü belirleyicileridir. Bu parametrelerin klinik karar verme sürecine entegre edilmesi, risk sınıflandırmasını geliştirebilir ve hasta yönetimini iyileştirebilir. Travma bakımını iyileştirmek ve mortalite oranlarını azaltmak için prospektif çok merkezli çalışmalar ve ulusal travma kayıtları gereklidir.

Anahtar sözcükler: Abdominal travma; Glasgow koma skalası, yaralanma şiddet skoru; mortalite öngörücüleri; acil servis.

Ulus Travma Acil Cerrahi Derg 2025;31(3):00-00 DOI: 10.14744/tjtes.2025.64644