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Research Article

Ankara Med J, 2025;(3):343-356 // 10.5505/amj.2025.36528

CLINICAL CHARACTERISTICS AND PREDICTORS OF ADVERSE OUTCOMES IN ELECTRICAL INJURIES: A FIVE-YEAR RETROSPECTIVE STUDY IN THE EMERGENCY DEPARTMENT

Melih Çamcı[1], Faruk Büyük[2], Erhan Şimşek[3]

[1]Department of Emergency Medicine, Ankara Bilkent City Hospital, Ankara Yıldırım Beyazıt University, Ankara, Türkiye

[2]Department of Emergency Medicine, Erciş Şehit Rıdvan Çevik State Hospital, Van, Türkiye

[3]Department of Family Medicine, Ankara Yıldırım Beyazıt University, Ankara, Türkiye

Correspondence:
Melih Çamcı (e-mail: drmelih112@gmail.com)

Submitted: 29.07.2025//Accepted: 10.09.2025

Ankara Yıldırım Beyazıt University Faculty of Medicine
Department of Family Medicine

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Abstract

Objectives: Electrical injuries are critical emergencies with outcomes ranging from local damage to systemic complications. Severity depends on the current type, voltage, contact duration, resistance, and current path. Predictive data from initial emergency department (ED) presentations remain limited. This study aims to identify clinical and biochemical markers at ED admission that predict adverse outcomes (intensive care unit [ICU] admission, prolonged hospitalization, complications).

Materials and Methods: This retrospective study analyzed electrical injury cases (ICD-10: T75.4, W86, W87) in a secondary-level ED between January 2020 and January 2025. Demographics, injury details, clinical findings (mental status, burns, electrocardiography [ECG], chest X-ray), and outcomes were collected. Ethical approval was obtained. Statistical methods included chi-square, t-test, Mann–Whitney U, Kruskal–Wallis, Spearman correlation, regression, and receiver operating characteristic (ROC) analysis ($p<0.05$).

Results: Among 142 patients, 65.5% were male, with peak incidence in ≥21 (35.9%) and ≤5 (28.9%) years. Most injuries were domestic (85.9%) from appliances (54.9%) involving alternating current (AC; 95.8%). All non-normal sinus rhythm (non-NSR) ECG patients were admitted to the ICU. Other predictors included outdoor injuries, direct current (DC) exposure, foot/head contact, falls, unconsciousness, and severe burns. Creatine kinase (CK), CK-MB, and lactate levels showed high predictive value. Lactate and hemoglobin were associated with longer hospitalization. Positive chest X-ray findings and elevated lactate were independent predictors, while appliance-related injuries were protective.

Conclusion: Early ECG and laboratory assessments (lactate, hemoglobin, CK, CK-MB), along with event and burn characteristics, help predict outcomes in electrical injuries. Prompt ED risk stratification is essential.

Keywords: Electric injuries, emergency department, risk factors, prognosis, retrospective study.

Introduction

Electrical injuries represent a significant medical emergency that encompasses a broad clinical spectrum ranging from localized tissue damage to severe systemic complications following exposure to electrical current.[1] These injuries are associated with considerable morbidity and mortality worldwide and are often attributable to preventable causes.[2] The severity of injury and extent of damage are primarily determined by factors such as the type of current (alternating current [AC] or direct current [DC]), voltage level, duration of contact, tissue resistance, and the path the current takes through the body.[3]

Globally, electrical injuries result from various etiologies, including occupational and domestic accidents, affecting individuals across all age groups.[4] In the United States, approximately 1,000 deaths and 30,000 emergency department visits annually are attributed to electrical shock injuries.[5,6] Notably, the incidence of electrical injuries in Turkey is reported to be higher compared to other countries, with domestic accidents being more prevalent among children, and occupational accidents being more common among adult patient groups.[7]

Among patients presenting to emergency departments with electrical injuries, the most frequently observed clinical manifestations include burns, cardiac arrhythmias, loss of consciousness, and musculoskeletal injuries.[8,9] Additionally, secondary traumas due to falls from height constitute another major contributor to morbidity and mortality in these cases.[5] Literature indicates that exposure to alternating current (AC) poses a higher risk for fatal arrhythmias such as ventricular fibrillation.[10] Shih et al., in their study evaluating the effects of cardiac dysrhythmias secondary to electrical injury, reported that the majority of cases involved male patients, with the highest incidence in the 20–40-year-old age group.[11] Furthermore, Brandao et al., in their 10-year retrospective analysis of electrical burns, found that while low-voltage domestic incidents were more common, high-voltage industrial accidents were associated with significantly higher mortality rates.[12]

Initial clinical assessment—including electrocardiography (ECG), laboratory parameters (creatine kinase [CK], CK-MB, troponin, lactate), and radiological imaging—plays a critical role in patient evaluation.[13,14] There is strong evidence in the literature supporting the utility of CK and lactate levels in predicting poor clinical outcomes.[15] Early assessment of these parameters can contribute significantly to anticipating hospitalization needs and intensive care unit (ICU) requirements.[16] Current literature emphasizes that factors such as the site of electrical contact, current path through the body, level of consciousness, and percentage of total body surface area (TBSA) burned are important determinants of clinical outcomes.[17,18]

Accurate prognosis and effective patient management in cases of electrical injury necessitate a multidisciplinary approach in the emergency department. Although numerous clinical factors associated with

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outcomes in electrical injuries have been documented, evidence remains limited regarding the predictive value of variables available at the time of initial ED presentation. We hypothesize that specific clinical findings and laboratory parameters obtained upon admission are significantly associated with adverse clinical outcomes (e.g., ICU admission, prolonged hospitalization, or development of complications). Accordingly, this study aims to identify clinical and biochemical markers that may predict poor prognosis in patients presenting with electrical injuries and to highlight their potential utility in guiding early management decisions.

Materials and Methods

Study Design and Setting

This retrospective observational study was conducted in the Emergency Department of Erciş Şehit Rıdvan Çevik State Hospital, a secondary healthcare facility with approximately 450,000 annual patient visits and serving as one of the main healthcare providers in the region. The study covers five years between January 1, 2020, and January 1, 2025. All patients of any age group who presented to the emergency department due to electrical injury and were recorded with ICD-10 diagnostic codes T75.4, W86, and W87 were included in the study. Data were collected retrospectively through the hospital information management system (HIMS).

Participants and Data Collection

All data were independently retrieved by two trained researchers from the hospital information system and electronic medical records. Diagnoses were cross-validated by comparing clinical compatibility. The level of consciousness was assessed using the Glasgow Coma Scale (GCS), while burn percentage and degree were determined using the Rule of Nines. Inclusion criteria required complete documentation on demographic characteristics (age, sex, education level), incident-related variables (location and time of injury, source, and type of electrical current, contact area), clinical findings (presence of fall from height, consciousness status, burn percentage and degree, ECG and chest X-ray findings), and clinical outcomes (discharge status, hospital admission, ICU requirement, length of hospital stay). Additionally, laboratory parameters such as creatine kinase (CK), CK-MB, troponin, and lactate levels were extracted from patient records. Cases with missing data or those not meeting the inclusion criteria were excluded from the study. In addition, a post-hoc power analysis was performed using G*Power (version 3.1.9.4) based on the primary clinical endpoint of hospital stay. For a two-tailed independent samples t-test with an effect size of $d = 2.0445$, $\alpha = 0.05$, and group sample sizes of $n1 = 15$ and $n2 = 10$ ($df = 23$), the achieved power ($1-\beta$) was 0.9977, indicating that the available sample size was sufficient for the analyses.

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Ethical Considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Clinical Research Ethics Committee of the University of Health Sciences Van Training and Research Hospital (Approval No: 60VAEK/2025.04.11, Date of Approval: May 9, 2025). Due to the retrospective nature of the study, the requirement for informed consent was waived by the ethics committee. All patient data were anonymized and handled in accordance with principles of confidentiality and privacy.

Statistical Analysis

Statistical analysis was performed using SPSS version 25.0. Categorical variables were expressed as frequencies and percentages; continuous variables were presented as mean, median, minimum, and maximum values. The normality of distribution was assessed using the Kolmogorov–Smirnov test. Relationships between categorical variables were analyzed using the Chi-square test. For continuous variables, the independent samples t-test was used for normally distributed data, while the Mann–Whitney U test was applied for non-normally distributed data. In analyses involving three or more groups, the Kruskal–Wallis test was used, followed by Dunn's post-hoc test for multiple analyses when significant differences were observed. Correlations between continuous variables were assessed using the Spearman correlation coefficient. Factors affecting the length of hospital stay were analyzed using linear regression, while predictors of poor clinical outcomes were evaluated using logistic regression analysis. Additionally, the predictive power of laboratory parameters for adverse clinical outcomes was assessed using Receiver Operating Characteristic (ROC) curve analysis, and optimal cut-off values were calculated. A p-value of <0.05 was considered statistically significant in all analyses.

Results

The distribution of demographic characteristics, incident details, and clinical presentation features of the included cases is presented in Table 1. Of the 142 patients presenting to the emergency department due to electrical injury, 93 were male (65.5%) and 49 were female (34.5%). Age group analysis showed the highest incidence in individuals aged ≥21 years (n=51, 35.9%), followed by children aged ≤5 years (n=41, 28.9%). The majority of injuries (n=122, 85.9%) occurred in domestic settings, with the most common time of presentation being between 08:00 and 16:00. The most frequent source of electrical injury was household electrical appliances (n=78, 54.9%). In terms of current type, most exposures involved alternating current (AC) (n=136, 95.8%). There were no statistically significant differences in case distribution by year or month (p>0.05).

Table 1. Demographics, Incident Characteristics, and Clinical Findings of Electrical Injury Cases

Variables	Category	n (%)
Gender	Male	93 (65.5)
	Female	49 (34.5)
Age (years)	Min–Max (Median)	1–68 (16)
	Mean ± SD	18.85 ± 16.24
Hospital Stay (days)	Min–Max (Median)	1–17 (5)
	Mean ± SD	6.36 ± 4.87
Age Groups	≤5	41 (28.9)
	6–10	19 (13.4)
	11–15	10 (7.0)
	16–20	21 (14.8)
	≥21	51 (35.9)
Educational Level	Preschool	42 (29.6)
	Primary	61 (43.0)
	Secondary	30 (21.1)
	Higher	9 (6.3)
Incident Location	Indoor	122 (85.9)
	Outdoor	12 (8.5)
	Workplace	8 (5.6)
Time of Incident	08:00–16:00	70 (49.3)
	16:00–00:00	65 (45.8)
	00:00–08:00	7 (4.9)
Source of Electricity	Appliance	78 (54.9)
	Home Wiring	46 (32.4)
	Power Line	13 (9.2)
	Industrial	5 (3.5)
Type of Current	AC	136 (95.8)
	DC	6 (4.2)
Fall from Height	Yes	7 (4.9)
	No	135 (95.1)
Consciousness	Alert	115 (81.0)
	Unconscious	12 (8.5)
	Brief Loss	15 (10.6)
Burn Percentage	<1%	128 (90.1)
	≥1%	14 (9.9)
Burn Degree	1st	129 (90.8)
	2nd	7 (4.9)
	3rd	6 (4.2)
ECG Findings	NSR	129 (90.8)
	Non-NSR	13 (9.2)
Clinical Outcome	Discharged	116 (81.7)
	Ward	10 (7.0)
	ICU	16 (11.3)
Total		142 (100)

Contact site analysis revealed that 123 patients (86.6%) had hand involvement, with the most common entry point being the right hand (n=43, 30.3%). At admission, 115 patients (81.0%) were conscious. Burns involving less than 1% of total body surface area (TBSA) were observed in 128 cases (90.1%), with 129 (90.8%) presenting with first-degree burns.

Electrocardiogram (ECG) findings revealed normal sinus rhythm (NSR) in 129 patients (90.8%) and arrhythmias in 13 patients (9.2%). Among those with arrhythmias, the types identified were sinus tachycardia (n=9), atrial fibrillation (n=2), ventricular extrasystole (n=1), and ventricular tachycardia (n=1).

In terms of clinical outcomes, 116 patients (81.7%) were discharged, 16 (11.3%) were admitted to the intensive care unit (ICU), and 10 (7.0%) were admitted to general wards. Laboratory parameters at the time of ED presentation are summarized in Table 2. Most patients had leukocyte count, hemoglobin, hematocrit, creatinine, AST, ALT, sodium, and potassium levels within reference ranges. However, statistically significant variations were detected. Biomarkers reflecting muscle and cardiac damage showed wide and elevated distributions: the mean creatine kinase (CK) level was 354.43 ± 1235.89 U/L, CK-MB was 30.00 ± 37.16 U/L, and troponin was 9.51 ± 42.73 pg/mL. The mean lactate was 1.87 ± 1.45 mmol/L, which was significantly elevated.

Table 2. Distribution of Laboratory Parameters in Patients Exposed to Electrical Injury

Parameter (Reference	**Min–Max (Median)**	**Mean ± SD**	**P-value**
Leukocyte [4–10 x10^3/μL]	4000–10000 (8000)	7812.68 ±	<0.001
Hemoglobin [11–16 g/dL]	11–16 (14)	13.98 ± 1.30	<0.001
Hematocrit [37–54 %]	37–54 (42)	42.82 ± 3.93	<0.001
Platelet [100–400	113000–400000	294000 ±	=0.035
Urea [17–43 mg/dL]	17–43 (28.50)	28.92 ± 6.64	=0.026
Creatinine [0.6–1.1	0.6–1.1 (0.80)	0.80 ± 0.17	<0.001
AST [0–50 U/L]	11–50 (27)	28.80 ± 9.22	<0.001
ALT [0–50 U/L]	1–50 (18)	20.87 ± 10.69	<0.001
CK [0–145 U/L]	25–13830 (112)	354.43 ± 1235.89	<0.001
CK-MB [0–25 U/L]	2–352 (19)	30.00 ± 37.16	<0.001
Troponin [0–19.8 pg/mL]	0–473 (2.30)	9.51 ± 42.73	<0.001
Potassium [3.5–5.1	3.5–5.1 (4)	4.07 ± 0.33	<0.001
Sodium [136–146	136–146 (138)	138.69 ± 2.05	<0.001
Lactate [0.5–1.6 mmol/L]	0.5–12.0 (1.55)	1.87 ± 1.45	<0.001

*Statistical significance based on Kolmogorov–Smirnov normality test ($p<\alpha=0.05$).

Relationships between clinical outcomes and various clinical, incident-based, and laboratory variables are summarized in Table 3. A significant association was observed between ECG findings and clinical outcome: 89.9% of patients with NSR were discharged, whereas all patients with arrhythmias were admitted to the ICU.

The incident location significantly affected clinical outcomes. Discharge occurred in 89.3% of domestic cases, whereas 66.7% of open-area incidents required ICU care. Similar associations were found with electricity source and current type: all patients exposed to direct current (DC) required ICU admission.

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The anatomical contact site also influenced outcomes. Patients with hand contact had higher discharge rates, while those with contact through the feet or head had increased ICU admission rates. Of patients with a history of falling from height, 71.4% required ICU admission compared to 8.1% in those without such a history.

Consciousness level was strongly associated with outcome: 89.6% of alert patients were discharged, whereas 91.7% of unconscious patients required ICU admission. Burn extent and degree also significantly influenced outcomes—higher TBSA and burn severity were associated with ICU admission. A significant difference in length of hospital stay was observed across age groups, with patients aged ≥21 years having longer stays than other groups.

The diagnostic performance of AST, ALT, CK, CK-MB, troponin, and lactate levels in predicting adverse clinical outcomes is illustrated in Figure 1. CK and CK-MB demonstrated the strongest discriminative power. A CK threshold of >174.00 U/L yielded 92.3% sensitivity and 77.6% specificity; a CK-MB threshold of >27.50 U/L provided 92.3% sensitivity and 80.2% specificity. Lactate also showed high discriminative power, with a threshold of >1.75 mmol/L yielding 76.9% sensitivity and 72.4% specificity. Troponin demonstrated acceptable diagnostic performance (threshold >2.95 pg/mL; sensitivity 69.2%, specificity 68.1%). In contrast, AST and ALT had poor predictive value for adverse outcomes.

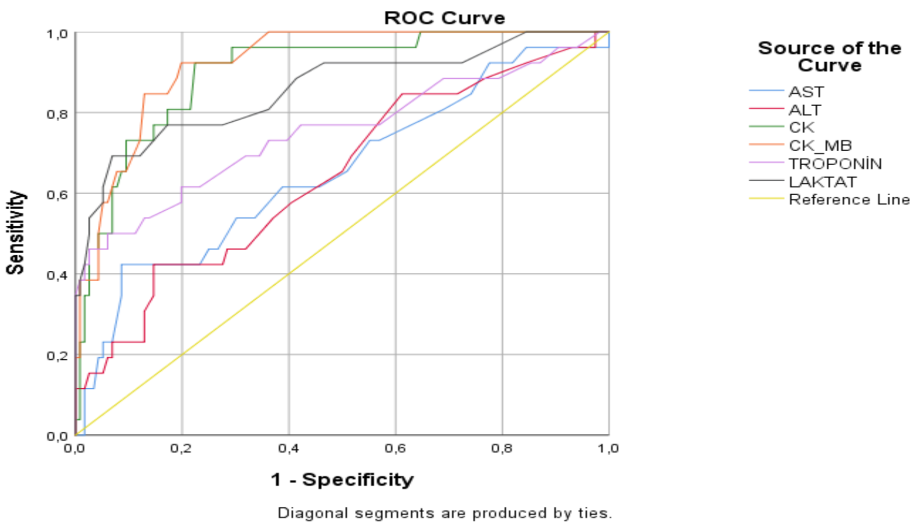

Figure 1: ROC Curves for AST, ALT, CK, CK-MB, Troponin, and Lactate in Predicting Adverse Clinical Outcomes

Correlation analysis revealed a strong positive relationship between age and serum creatinine level. Moderate positive correlations were observed between hemoglobin, hematocrit, urea, and length of hospital stay. Moderate negative correlations were found with platelet count and AST, and a weak negative correlation was noted for CK-MB.

Table 3. Relationship Between Emergency Department Outcomes and Clinical, Incident, and Laboratory Variables

		Clinical Outcome				
		Ward Admission	**ICU Admission**	**Discharged**	**Total**	**Statistical Analysis**
ECG Findings		**n (%)**	**n (%)**	**n (%)**		
	Non-NSR	0 (0.0)	13 (100)	0 (0.0)	13 (100)	χ^2=112.692 p<0.001*
	NSR	10 (7.8)	3 (2.3)	116 (89.9)	129 (100)	
Incident						
	Outdoor	2 (16.7)	8 (66.7)	2 (16.7)	12 (100)	χ^2=52.765 p<0.001*
	Indoor	8 (6.6)	5 (4.1)	109 (89.3)	122 (100)	
	Workplace	0 (0.0)	3 (37.5)	5 (62.5)	8 (100)	
Source of Electricity						
	Home Wiring	6 (60.0)	4 (25.0)	36 (31.0)	46 (32.4)	χ^2=38.759 p<0.001*
	Power Line	2 (20.0)	4 (25.0)	7 (6.0)	13 (9.2)	
	Appliance	2 (20.0)	3 (18.8)	73 (62.9)	78 (54.9)	
	Industrial	0 (0.0)	5 (31.3)	0 (0.0)	5 (3.5)	
Type of Current						
	AC	10 (100)	10 (62.5)	116 (100)	136 (95.8)	χ^2=28.542 p<0.001*
	DC	0 (0.0)	6 (37.5)	0 (0.0)	6 (4.2)	
Contact Site						
	Foot	0 (0.0)	7 (43.8)	5 (4.3)	12(8.5)	χ^2=35.832 p<0.001*
	Head	0 (0.0)	1 (6.3)	1 (0.9)	2 (1.4)	
	Hand	9 (90.0)	5 (31.3)	109 (94.0)	123 (86.6)	
	Arm	1 (10.0)	3 (18.8)	1 (0.9)	5 (3.5)	
Entry Point						
	Right Foot	0 (0.0)	5 (31.3)	2 (1.4)	7 (4.9)	χ^2=37.953 p<0.001*
	Right Hand	6 (60.0)	6 (37.5)	31 (26.7)	43 (30.3)	
	Heat	0 (0.0)	1 (6.3)	1 (0.9)	2 (1.4)	
	Left Foot	0 (0.0)	2 (12.5)	4 (3.4)	6 (4.2)	
	Left Hand	3 (30.0)	0 (0.0)	20 (17.2)	23 (16.2)	
	Absent	1 (10.0)	2 (12.5)	58 (50.0)	61 (43.0)	
Exit Point						
	Right Foot	1 (10.0)	4 (25.0)	0 (0.0)	5 (3.5)	χ^2=37.167 p<0.001*
	Left Foot	0 (0.0)	2 (12.5)	0 (0.0)	2 (1.4)	
	Absent	8 (80.0)	9 (56.3)	115 (99.1)	132 (93.0)	
	Right Hand	0 (0.0)	0 (0.0)	1 (0.9)	1 (0.7)	
	Left Hand	1 (10.0)	1 (6.3)	0 (0.0)	2 (1.4)	
Fall from Height						
	No	8 (5.9)	11 (8.1)	116 (85.9)	135 (100)	χ^2=34.512 p<0.001*
	Yes	2 (28.6)	5 (71.4)	0 (0.0)	7 (100)	
Consciousness						
	Unconscious	0 (0.0)	11 (91.7)	1 (8.3)	12 (100)	χ^2=51.913 p<0.001*
	Alert	8 (7.0)	4 (3.5)	103 (89.6)	115 (100)	
	Brief Loss	2 (13.3)	1 (6.7)	12 (80.0)	15 (100)	
Burn Percentage						
	<1%	9 (7.0)	5 (3.9)	114 (89.1)	128 (100)	χ^2=44.858 p<0.001*
	≥1%	1 (7.1)	11 (78.6)	2 (14.3)	14 (100)	
Burn Degree						
	1	10 (7.8)	4 (3.1)	115 (89.1)	129 (100)	χ^2=58.751 p<0.001*
	2	0 (0.0)	6 (85.7)	1 (14.3)	7 (100)	
	3	0 (0.0)	6 (100)	0 (0.0)	6 (100)	

*Chi-square test p<α=0.05 indicates statistical significance.

Table 4 presents the results of linear regression analysis to identify factors affecting hospital stay. The model explained 50.3% of the variance in hospital stay (R^2=0.503) and was statistically significant (F=11.116, p<0.001). Hemoglobin and lactate levels were found to significantly affect hospital stay. Each 1 g/dL increase in hemoglobin extended hospital stay by 1.753 days, while each 1 mmol/L increase in lactate prolonged stay by 1.057 days. As a result of the analysis, the presence of findings on chest radiography, serum lactate level, and the electrical current source being an electrical appliance was found to have a statistically significant impact on poor clinical outcomes. Patients with positive chest X-ray findings had a 15.013-fold higher likelihood of experiencing a poor clinical outcome (hospital ward or ICU admission) compared to those with negative findings (p < 0.001). Each 1 mmol/L increase in lactate level was associated with a 5.698-fold rise in the risk of a poor outcome (p < 0.001). In contrast, when the source of electrical injury was an electrical appliance, it was found to have a protective effect, reducing the risk of poor clinical outcome by 79% (Odds Ratio: 0.210, p = 0.043).

Table 4. Linear Regression Model Predicting Hospital Stay Duration in Patients Exposed to Electrical Injury

Variables	**B Coefficient**	**Se**	**T Test**	**P-value**	**Confidence Interval**
Constant	-21.351	6.720	-3.177	**0.004***	(-35.286)-
Lactate	1.057	0.395	2.676	**0.014***	0,238-1.876
Hemoglobin	1.753	0.483	3.626	**0.001***	0.750-2.755

Model Significance F=11.116, p<0.001, R^2=50.3. The regression equation is: Hospital stay = -21.351 + 1.057 × Lactate + 1.753 × Hemoglobin. Results of the multivariable logistic regression analysis predicting adverse clinical outcomes are presented in Table 5. The model was statistically significant (χ^2=79.591, p<0.001) with Nagelkerke R^2 = 0.699. Model fit was verified by the Hosmer–Lemeshow test (χ^2=10.270, p=0.247).

Table 5. Logistic Regression Model Predicting Adverse Clinical Outcomes

Variables	**B Coefficient**	**SE**	**Odds Ratio**	**P-value**	**Confidence**
Chest X-ray	2.709	0.777	15.013	<0.001*	3.277–68.778
Lactate	1.740	0.542	5.698	<0.001*	1.971–16.473
Consciousness Status				0.668	
Alert	-0.708	5.443	0.493	0.897	0.0–21181.74
Unconscious / Brief	0.400	5.530	1.492	0.942	0.0–75925.63
Source of Electricity				0.248	
Power Line	-0.879	2.870	0.415	0.759	0.0–115.05
Appliance	-1.560	0.772	0.210	0.043*	0.046–0.954
Industrial	19.446	15235.11	278868614.2	0.999	-
Incident Location				0.698	
Indoor	-0.245	2.851	0.783	0.932	0.003–209.01
Workplace	-1.661	3.026	0.190	0.583	0.001–71.53
Constant	-4.456	6.043	0.012	0.461	

Model significance: χ^2 = 79.591, p < 0.001, Nagelkerke R^2 = 69.9, Hosmer–Lemeshow Goodness of Fit: χ^2 = 10.270, p = 0.247

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Discussion

In this study, we retrospectively evaluated the demographic, clinical, and laboratory characteristics of 142 patients who presented to the emergency department (ED) due to electrical injury, and analyzed factors predicting poor clinical outcomes. Our findings demonstrate that electrical injuries are particularly common among children and young adults, with household electrical appliances being the primary etiological source. These demographic and etiological patterns are largely consistent with previous studies by Aghakhani et al. and Başaran et al.[17,19] Furthermore, the presence of non-sinus rhythm on electrocardiogram (ECG), elevated lactate and hemoglobin levels as predictors of prolonged hospital stay, and a lower risk of adverse outcomes in cases involving exposure to current from 'electrical appliances' emerged as critical findings.

In our study, 65.5% of the patients were male, and 85.9% of incidents occurred in domestic settings. These findings align with literature suggesting that male individuals are more prone to electrical injuries and that domestic accidents, despite being typically low voltage, may have potentially serious consequences.[18] Galet et al. emphasized that over 90% of high-voltage injuries occur in men,[5] while Stockly and colleagues also reported male predominance in electrical shock cases.[6] Additionally, 95.8% of our cases involved alternating current (AC) exposure, a known contributor to fatal arrhythmias such as ventricular fibrillation, as noted by Jensen et al.[10]

One of the most striking findings in terms of clinical outcomes was the strong association between ECG findings and disease progression. All patients with non-sinus rhythm (100%) were admitted to the ICU, highlighting the prognostic value of ECG during the initial ED evaluation. Similarly, impaired consciousness at the time of presentation was significantly associated with poor outcomes. However, our findings differ from those of Pilecky et al., who, in a cohort of 480 patients, reported no significant association between ECG changes and mortality.[20] This discrepancy may stem from differences in study populations, the proportion of high-voltage injuries, or variations in patient management protocols. Notably, Pilecky et al. also reported that impaired consciousness was not a significant predictor of arrhythmia development, [20] whereas, in our study, impaired consciousness was found to be a strong indicator of poor clinical outcomes. This suggests that the consciousness level may reflect overall systemic impact and prognosis, independent of arrhythmia occurrence.

The presence of concomitant traumatic factors, such as falls from height, significantly worsened the clinical course, with 71.4% of these patients requiring ICU admission. Similarly, burn involvement of more than 1% TBSA and the presence of second- or third-degree burns were among the primary determinants of hospitalization. These results are supported by Gökdemir et al., who reported that high-voltage injuries are more likely to be accompanied by traumatic sequelae such as falls from height.[21]

In our study, the prognostic value of laboratory markers was evaluated via ROC analyses. Serum creatine kinase (CK), CK-MB, and lactate levels demonstrated high diagnostic performance. A CK threshold of >174.00 U/L provided a sensitivity of 92.3% and specificity of 77.6%; for CK-MB >27.50 U/L, sensitivity and specificity were 92.3% and 80.2%, respectively. Lactate was also a strong discriminator, with a >1.75 mmol/L cut-off yielding 76.9% sensitivity and 72.4% specificity. These results support previous findings regarding the importance of lactic acidosis as an early marker of cellular hypoperfusion.[1] Ahmed et al. reported that CK elevation was more common in high-voltage injuries compared to low-voltage injuries,[13] and Kopp et al. found significant associations between elevated CK/lactate levels and limb amputation or mortality.[22]

Linear regression analysis revealed that both lactate and hemoglobin levels had a significant effect on hospital stay duration. This underscores the critical importance of these two parameters for both prognostic assessment and ongoing clinical monitoring in electrical injury cases. While the association between elevated lactate and hospital admission is supported by Durdu et al. [23] there is limited literature addressing the impact of hemoglobin levels on the length of hospitalization. This indicates a need for further research into the prognostic significance of hemoglobin in electrical injuries.

Multivariable logistic regression analysis showed that abnormal chest X-ray findings and elevated lactate levels were independent predictors of poor clinical outcomes.[24] Patients with positive chest X-ray findings had a 15.013-fold higher likelihood of poor outcome (p<0.001), and each 1 mmol/L increase in lactate was associated with a 5.698-fold increased risk (p<0.001). Conversely, exposure to household electrical appliances appeared to have a protective effect, reducing the risk of poor outcomes by 79% (Odds Ratio = 0.210, p=0.043). This is likely due to the lower voltage of most household devices, resulting in less severe injuries.

In summary, this study highlights several critical indicators for predicting adverse clinical outcomes in patients presenting to the emergency department following electrical injury. Easily obtainable biomarkers such as ECG rhythm abnormalities, elevated serum lactate, CK, and CK-MB levels are invaluable tools for early risk stratification. Clinical factors, including falls from height, altered consciousness, contact sites, and burn severity, also carry significant prognostic value. These findings equip emergency physicians with the ability to rapidly identify life-threatening cases and initiate timely, aggressive interventions. Our results strongly emphasize the necessity of a multidisciplinary, patient-specific risk assessment approach in managing electrical injury cases. Future prospective multicenter studies are warranted to further elucidate the long-term prognostic implications of these markers.

The retrospective nature of this study and its single-center design pose several important limitations. Retrospective data collection may lead to potential data omissions and recording bias. Moreover, being conducted at a single institution restricts the generalizability of the findings to broader populations and different healthcare settings. The relatively small sample size also limited the statistical power and may have hindered the full evaluation of some variables in the analysis. In light of these limitations, there is a pressing need for prospective, multicenter studies to validate these findings in larger and more diverse patient populations.

This study identified significant clinical and laboratory predictors of adverse outcomes in patients presenting to the emergency department following electrical injury. Abnormal electrocardiographic (ECG) findings at presentation, along with elevated serum lactate, creatine kinase (CK), and CK-MB levels, were noteworthy prognostic indicators. Additionally, clinical factors such as the nature of the incident, anatomical site of contact, burn percentage, and burn severity were found to be essential in guiding the treatment process. A multidisciplinary assessment and early risk stratification in the emergency department play a crucial role in reducing morbidity and mortality in such cases. In addition, strengthening preventive efforts and public awareness through primary care settings may help reduce the occurrence and severity of such injuries.

Ethical Considerations: This study was approved by the Clinical Research Ethics Committee of the University of Health Sciences Van Training and Research Hospital (Approval Date: May 9, 2025; Decision No: 60VAEK/2025.04.11).

Conflict of Interest: The authors declare no conflict of interest.

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