ORIGINAL ARTICLE

Prehospital and emergency data analysis in burn patients: Mortality predictors and response times over five years

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ABSTRACT

BACKGROUND: This study aimed to retrospectively examine the prehospital and emergency department processes of burn cases to evaluate process effectiveness, establish regional data, and identify factors affecting mortality in burn patients.

METHODS: The study included 784 burn cases treated by Ankara 112 Emergency Health Services and transferred to Ankara Bilkent City Hospital Emergency Department between January 1, 2019 and December 31, 2023. Demographic data, burn characteristics, response times of 112 emergency health services, and patient outcomes were retrospectively analyzed.

RESULTS: The mean age of the patients included in the study was 23.4±20.7 years, with 36.7% being female. The most common type of burn was hot liquid burns (49.9%) and 73.7% of cases involved second-degree burns. The overall mortality rate was 5%. Logistic regression analysis identified advanced age (odds ratio [OR]: 1.02), presence of inhalation burns (OR: 3.33), and burn percentage as independent risk factors for mortality. Receiver operating characteristic (ROC) analysis showed that age >44 years (38.5% sensitivity, 83.8% specificity) and burn surface >16% (89.7% sensitivity, 77.5% specificity) were predictive thresholds for mortality.

CONCLUSION: Advanced age, extensive burn surface area, residence in rural areas, and inhalation injuries are key predictors of mortality in burn patients. Enhancing prehospital emergency services, implementing community education programs, and adopting a multidisciplinary approach are critical for preventing and effectively managing burn injuries.

Keywords: Burn; mortality; prehospital care; emergency department; risk factors.

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INTRODUCTION

Burns are among the types of trauma that can cause significant damage to the skin and other tissues, forming a major category of preventable injuries worldwide.[1] Burn injuries are recognized as a serious public health issue, affecting populations across all geographical regions and demographic groups.[1,2] According to the World Health Organization (WHO), burns are the fourth most common cause of injury globally, with an estimated 180,000 deaths annually.[3] Burns can result from various causes, including dry, wet, or chemical agents, with the type and severity of these agents determining the extent of tissue damage.[4,5] Burn-related injuries can range from mild tissue damage to life-threatening conditions, posing a significant health burden in terms of both mortality and morbidity. Despite recent advancements that have improved survival rates, high mortality persists among patients with severe burns.[6] Therefore, it is crucial that such cases are transported to the appropriate health service as quickly as possible.[3-5] Prehospital management of burns, particularly factors such as the reaction time of the 112 command and control center, ambulance departure times, and arrival times, has a significant impact on patient outcomes. Studies on burns often focus on specific age groups (e.g., pediatric patients), burn mechanisms (e.g., electrical, chemical, etc.), or hospital data, such as burn percentages. However, there is a lack of research addressing the prehospital data of burn patients. In this study, we aimed to retrospectively examine the prehospital and hospital emergency department processes of burn cases, evaluate the effectiveness of these processes, generate regional data, and identify the factors affecting mortality in burn patients. Additionally, we aim to provide recommendations to reduce morbidity and mortality by improving healthcare for burn patients.

MATERIALS AND METHODS

Study Design and Participants

This study was conducted between January 1, 2019 and December 31, 2023 within Ankara 112 Emergency Health Services, which handles an average of 35,000 cases per month, and the Ankara Bilkent City Hospital Emergency Department, which serves approximately 45,000 patients per month. The study included approximately 976 burn cases registered in the Ankara 112 Emergency Health Services System (ASOS) and transferred to the Ankara Bilkent City Hospital Emergency Department. Ethics committee approval was obtained prior to the study from the Scientific and Ethical Review Board for Medical Research (TABED) of Ankara Bilkent City Hospital No. 2 (ethics committee approval number: TABED 2-24-303). Prehospital data collected included demographic information, time of occurrence, reaction time of the 112 command and control center, ambulance departure and arrival times, vital interventions applied during the first contact with emergency health services, and the time of arrival at the hospital. Hospital data included parameters such as diagnosis, burn site, burn type, burn percentage, burn degree, presence of associated injuries, whether the patient required a ward or intensive care admission, duration of hospitalization, and patient outcomes. All data were recorded in the hospital system and examined retrospectively. Burn cases from all age groups were included in the study. Cases with incomplete transport forms or missing any of the investigated parameters were excluded. Informed consent was obtained from all participants prior to their inclusion in the study, in accordance with ethical guidelines. The study adhered to the principles outlined in the Declaration of Helsinki.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics 27.0 (Armonk, NY: IBM Corp.). Descriptive statistical methods, including frequency, percentage, mean, standard deviation, median, and interquartile range (IQR), were used to summarize the data. Qualitative data were compared using the Chi-Square (X^2) test. Bonferroni correction was applied when differences were observed in multiple comparisons. The conformity of the data to a normal distribution was assessed using the Kolmogorov-Smirnov test, skewness-kurtosis measures, and graphical methods such as histograms, Q-Q plots, stem-and-leaf plots, and boxplots. The Independent Samples t-test and one-way analysis of variance (ANOVA) test were used to compare quantitative data with a normal distribution between groups, while the Mann-Whitney U test was used to compare data without a normal distribution between groups. Relationships between variables were evaluated using Spearman's rho correlation test. A statistical significance level of $p=0.05$ was considered significant.

RESULTS

Of the 976 patients who received ambulance services for burns, 114 patients with incomplete transport forms and 78 patients with insufficient hospital records were excluded, leaving 784 patients for inclusion in the study. The mean age of the included patients was 23.4±20.7 years, and 36.7% (288) of them were female. The mean command reaction time was 575.9±885.8 seconds, and the mean station reaction time was 75.9±273.5 seconds. The demographic and clinical characteristics of the cases are presented in Table 1.

A total of 26.4% (207) of the burns occurred during the winter season. Although there was little variation across years, the highest number of burns was recorded in 2020, accounting for 25.5% (200) of the cases. The distribution of burns by years is shown in Figure 1.

While second-degree burns were the most common type of burns among rural patients (68.3%), the rate of third-degree burns (24.4%) was found to be significantly higher in patients living in urban areas ($p<0.05$). A comparison of burns between urban and rural areas is presented in Table 2.

Table 1. Characteristics of the participants

	Mean±SD	Median (IQR)
Age (years)	23.4±20.7	20.0 (3.0-36.8)
Command Center Reaction Time (s)	575.9±885.8	219.0 (105.0-597.8)
Station Reaction Time (s)	75.9±273.5	36.0 (16.0-55.0)
Burn Percentage (%)	12.6±14.9	8.0 (3.0-17.0)
Duration of Ward Hospitalization (days)	11.3±13.7	7.0 (2.0-15.0)
Duration of Intensive Care Unit Hospitalization (days)	17.7±23.8	10.0 (4.0-20.0)
Duration of Hospital Stay (days)	9.2±18.6	1.0 (0.1-11.5)
	n	**%**
Sex		
Female	288	36.7
Male	496	63.3
Patient Nationality		
Republic of Türkiye	712	90.8
Other	72	9.2
Urban/Rural		
Urban	743	94.8
Rural	41	5.2
Reason for Call		
Medical	344	43.9
Soft Tissue Trauma	218	27.8
Fire	129	16.5
Transport	55	7.0
Work Accident	38	4.8
Hospital Diagnosis		
Hot Liquid Burn	391	49.9
Flame Burn	244	31.1
Electric Burn	41	5.2
Heat Burn	40	5.1
Chemical Burn	39	5.0
Steam Burn	29	3.7
Burn Location		
Multiple Zones	533	68.0
Lower Extremity	90	11.5
Head, Neck, and Face	71	9.1
Upper Extremity	58	7.4
Body Front	19	2.4
Genital Area	7	0.9
Body Rear	6	0.8
Degree of Burn (Highest Degree)		
First-Degree	98	12.5
Second-Degree	578	73.7
Third-Degree	108	13.8
Related Injury		
No	732	93.4
Yes	52	6.6
Inhalation Burn		
No	736	93.9
Yes	48	6.1
Patient Outcome		
Hospitalization	364	46.4
Discharged	381	48.6
Death	39	5.0

SD: Standard Deviation; IQR: Interquartile Range (25th-75th percentiles); s: Seconds.

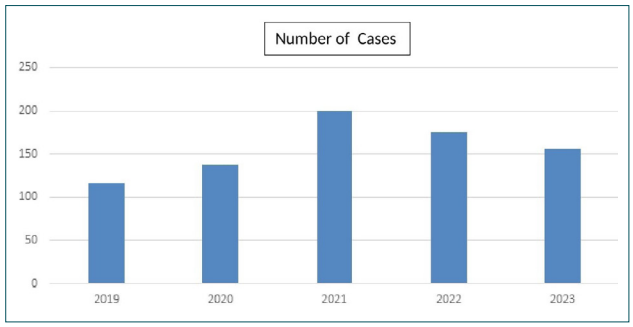

Figure 1. Distribution of the number of cases by years.

When burn types were analyzed by age groups, hot liquid burns (64.8%) were the most common in patients aged <18 years, while flame burns (38.1%) were the most common type in patients aged ≥18 years. Additionally, it was found that the rates of hot liquid burns and steam burns were higher among women, while the rates of flame burns, electrical burns, and chemical burns were lower. A statistically significant difference ($p<0.05$) was observed between age groups and gender in terms of burn types (Table 3).

In the comparisons made according to mortality, statistically significant differences ($p<0.05$) were observed for the following variables: age, urban/rural residence, call reason, burn type, burn location, burn degree, associated injury, inhalation burns, command reaction time, station reaction time, and burn percentage (Table 4).

Statistically significant parameters for mortality were included in the regression model. The analysis revealed statistically significant relationships between age, inhalation burns, and burn percentage ($p<0.05$). In burn cases, individuals with older age were approximately 1.02 times more likely to die for each additional year of age, and those living in rural areas were approximately 3.14 times more likely to die compared to those living in urban areas (Table 5).

We performed receiver operating characteristic (ROC) analysis to evaluate the strength of the effects of burn percentage and age on mortality (Figs. 2 and 3). The analysis showed that an age >44 years predicted mortality with 38.5% sensitivity and 83.8% specificity. Similarly, a burn percentage >16 predicted mortality with 89.7% sensitivity and 77.5% specificity (Table 6).

DISCUSSION

Burn injuries represent a significant public health problem that can result in life-threatening complications and permanent disabilities. This issue is particularly prevalent in low- and middle-income countries.[5,7] Most burn injuries occur in homes and workplaces, and a majority of them are preventable.[3,7] Globally, a 6% decrease in burn-related mortality has

Table 2. Urban/rural comparison by burn degree

	Urban/Rural		p*
	Urban (n=743)	Rural (n=41)	
Degree of Burn (Highest Degree)			
First-Degree	95 (12.8%)	3 (7.3%)	0.042
Second-Degree	550 (74.0%)	28 (68.3%)	
Third-Degree	98 (13.2%)	10 (24.4%)	

*Mann-Whitney U Test.

Table 3. Comparison of burn type by gender and age groups

	Age Group		p*	Sex		p*
Type of Burn	<18 (n=349)	≥18 (n=435)		Female (n=288)	Male (n=496)	
Hot Liquid Burn	226 (64.8%)	164 (37.7%)	<0.001	198 (68.8%)	193 (38.9%)	<0.001
Flame Burn	79 (22.6%)	166 (38.1%)		43 (14.9%)	201 (40.5%)	
Electric Burn	16 (4.6%)	25 (5.7%)		5 (1.7%)	36 (7.3%)	
Heat Burn	9 (2.6%)	31 (7.1%)		11 (3.8%)	29 (5.8%)	
Chemical Burn	12 (3.4%)	27 (6.2%)		8 (2.8%)	31 (6.3%)	
Steam Burn	7 (2.0%)	22 (5.1%)		23 (8.0%)	6 (1.2%)	

*Chi-Square Test (n/%).

Table 4. Comparisons by mortality

		Mortality		p
	General (n=784)	Dead (n=39)	Alive (n=745)	
Sex				
Female	288 (36.7%)	16 (41.0%)	272 (36.5%)	0.689[a]
Male	496 (63.3%)	23 (59.0%)	473 (63.5%)	
Age	23.3±20.7	34.6±26.2	22.8±20.2	0.008[b]
Nationality				
Republic of Türkiye	712 (90.8%)	37 (94.9%)	675 (90.6%)	0.569[a]
Other	72 (9.2%)	2 (5.1%)	70 (9.4%)	
Urban/Rural				
Urban	743 (94.8%)	33 (84.6%)	710 (95.3%)	0.013[a]
Rural	41 (5.2%)	6 (15.4%)	35 (4.7%)	
Reason for Call				
Medical	344 (43.9%)	20 (51.3%)	324 (43.5%)	0.010[a]
Soft Tissue Trauma	218 (27.8%)	2 (5.1%)	216 (29.0%)	
Fire	129 (16.5%)	9 (23.1%)	120 (16.1%)	
Transport	55 (7.0%)	6 (15.4%)	49 (6.6%)	
Work Accident	38 (4.8%)	2 (5.1%)	36 (4.8%)	
Type of Burn				
Hot Liquid Burn	391 (49.9%)	5 (12.8%)	386 (51.8%)	<0.001[a]
Flame Burn	244 (31.1%)	27 (69.2%)	217 (29.1%)	
Electric Burn	41 (5.2%)	5 (12.8%)	36 (4.8%)	
Heat Burn	40 (5.1%)	1 (2.6%)	39 (5.2%)	
Chemical Burn	39 (5.0%)	1 (2.6%)	38 (5.1%)	
Steam Burn	29 (3.7%)	--	29 (3.9%)	
Degree of Burn (Highest Degree)				
First-Degree	98 (12.5%)	0 (0.0%)	98 (13.2%)	<0.001[a]
Second-Degree	578 (73.7%)	11 (28.2%)	567 (76.1%)	
Third-Degree	108 (13.8%)	28 (71.8%)	80 (10.7%)	
Related Injury				
No	732 (93.4%)	28 (71.8%)	704 (94.5%)	<0.001[a]
Yes	52 (6.6%)	11 (28.2%)	41 (5.5%)	
Inhalation Burn				
No	736 (93.9%)	25 (64.1%)	711 (95.4%)	<0.001[a]
Yes	48 (6.1%)	14 (35.9%)	34 (4.6%)	
Command Center Reaction Time (s)	575.9±885.8	1,199.8±1,516.2	543.2±828.8	0.011[b]
Station Reaction Time (s)	75.9±273.5	328.2±699.3	62.7±224.2	0.023[b]
Burn Percentage (%)	12.6±14.9	45.9±25.4	10.9±11.8	<0.001[b]

a: Chi-Square Test (n/%); b: Independent Samples t-Test (Mean±SD).

been recorded in recent years.[7] This study comprehensively analyzed the prehospital and emergency department management processes of burn cases. The findings highlight the critical impact of prehospital interventions on patient outcomes in burn cases, particularly the importance of rapid response times by 112 emergency health services. Prolonged reaction times in prehospital services are a significant factor affecting patient survival. Watterson et al. reported that dif-

Table 5. Logistic regression analysis of predictive factors for mortality in burn patients

Risk Factor	B	SE	Wald	Odds Ratio	95% CI	p*
Age (Per One Year)	0.042	0.010	18.713	1.04	1.02-1.06	0.000
Urban/Rural (Rural)	0.516	0.656	0.618	1.68	0.46-6.06	0.432
Associated Injury (Yes)	0.663	0.547	1.468	1.94	0.66-5.67	0.226
Inhalation Burn (Yes)	1.202	0.511	5.531	3.33	1.22-9.07	0.019
Burn Percentage (%)	0.086	0.011	62.798	1.09	1.07-1.11	0.000

*Binary Logistic Regression Test (only variables remaining in the model are presented). Nagelkerke R2 = 0.508; Hosmer and Lemeshow Test = 0.226.

Table 6. Area under the receiver operating characteristic (ROC) curve analysis for mortality in burn patients

	AUC	95% CI	Cut-Off	Sensitivity	Specificity	Youden Index	+PV	-PV	p*
Age	0.631	0.596-0.665	>44	38.5	83.8	0.222	11.0	96.3	0.007
Burn Percentage (%)	0.916	0.894-0.934	>16	89.7	77.5	0.672	17.2	99.3	<0.001

*ROC Curve Analysis.

ficulties in accessing emergency health services in rural areas increased mortality rates.[1] Similarly, our study observed longer response times in rural areas, which corresponded to a higher mortality rate in these regions. The literature also highlights that rapid intervention in burn cases reduces both mortality and morbidity.[1,7] Therefore, improving emergency health infrastructure in rural areas and enhancing prehospital emergency services are critical for the optimal management of burn cases.

In our study, 24.4% of burn patients in rural areas had third-degree burns, compared to 13.2% in urban areas. This disparity may be attributed to the difficulties in accessing healthcare services and the limited opportunities for timely initial interventions in rural settings.[8,9]

Similar to many studies in the literature, our study found that scald and steam burns were more common in females, while flame, electrical, and chemical burns were more prevalent in males.[7-11] When burn types were analyzed by age groups, scald

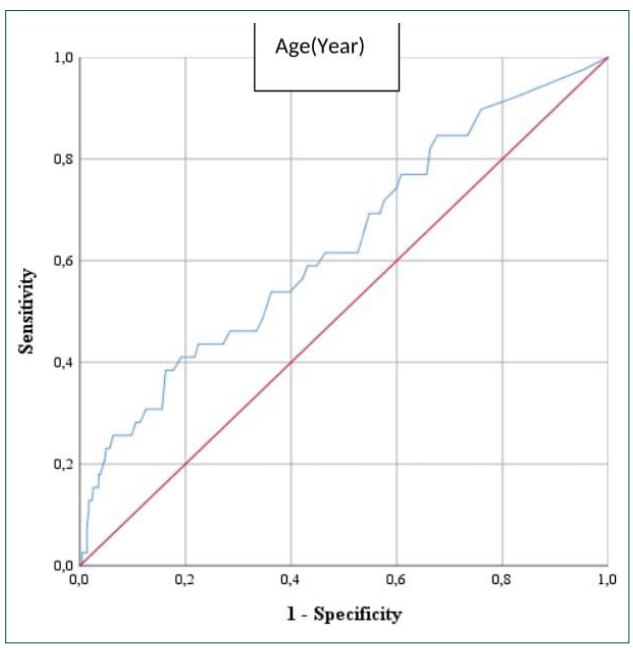

Figure 2. ROC Curve analysis of the association between age and mortality.

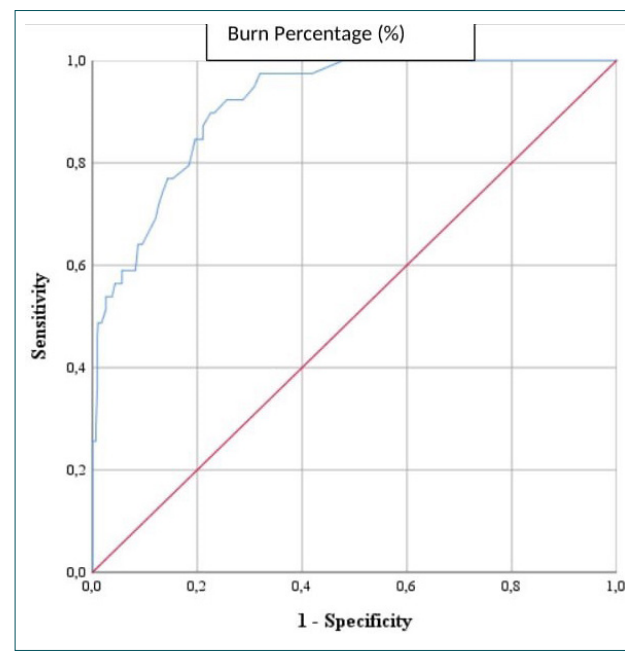

Figure 3. ROC Curve analysis of the relationship between burn percentage and mortality.

burns (64.8%) were the predominant type in individuals under 18 years of age, whereas flame burns (38.1%) were the most common type in those aged 18 years and older, consistent with previous studies.[9-11] Age was also identified as an indicator of mortality in our study. The logistic regression model revealed that mortality increased approximately 1.02-fold for each additional year of age. The age threshold for mortality was found to be >44 years, which predicted mortality with a sensitivity of 38.5% and a specificity of 83.8%. Comorbid chronic diseases and decreased physiologic reserve likely play a critical role in increasing mortality among burn patients.[1,7,12]

Inhalation burns are reported to occur in 0.3% to 43% of burn cases[7,13] and our study observed a similar rate of 6.1%. Inhalation burns have been reported to negatively impact the prognosis in burn cases, particularly due to increased need for prolonged respiratory support and intensive care treatment.[8,9] In our study, patients with inhalation burns had longer durations of intensive care unit hospitalization, and this was identified as an indicator of mortality. The logistic regression model revealed that the presence of inhalation burns increased the risk of mortality by 3.33-fold. This indicates that patients with inhalation burns require more meticulous management during both prehospital and in-hospital treatment processes.

Our data align with the literature regarding burn localization. Burns to the upper and lower extremities are the most common across all age groups. This can be attributed to the fact that these areas are more frequently exposed, particularly in occupational and domestic accidents.[13,14] A positive correlation has been reported between the percentage of burns and the duration of hospitalization.[12-16] The literature also indicates that as the extent of the burn area increases, healing time is prolonged, and the risk of infection and complication rises.[1,17] A high burn percentage increases the complexity of the treatment process and prolongs hospital stays.[15-17] In our study, we found a positive correlation between the percentage of burns and the duration of hospitalization, with the percentage of burns emerging as a key prognostic factor for mortality. In our study, mortality was low for burn areas below 10%; however, it increased significantly as the percentage of burns rose. According to our data, a burn area of 16% or more predicted mortality with 89.7% sensitivity and 77.5% specificity. This finding aligns with studies conducted in comprehensive burn centers.[18-20]

The strengths of our study include the integrated analysis of both prehospital and emergency department data, the large patient cohort, and the detailed mortality analyses. However, the study has some limitations. First, it relied on single-center data, which may limit the generalizability of the findings to broader populations. Additionally, certain data were missing, such as the potential subjectivity in assessing burn depth, which can be attributed to the retrospective design of the study. Finally, recurrent infections and long-term complications could not be evaluated due to the lack of long-term follow-up data.

CONCLUSION

Burn injuries remain a significant public health issue. Older age, large burn surface area, living in rural areas, and inhalation injury are the primary determinants of mortality. Improving prehospital emergency services, enhancing community education, providing continuous training for healthcare personnel, and adopting a multidisciplinary approach are essential for the prevention and effective treatment of burn injuries. Future multicenter, prospective studies and the establishment of national burn registry systems will contribute to a better understanding and management of this critical health concern.

Ethics Committee Approval: This study was approved by the Scientific and Ethical Review Board for Medical Research (TABED) of Ankara Bilkent City Hospital No. 2 (date: 12-06-2024, decision no: TABED 2-24-303.

Peer-review: Internally peer-reviewed.

Authorship Contributions: Concept: B.B., M.G., H.M., İ.B.; Design: B.B., M.A.K., K.K., Ö.F.T.; Supervision: M.B., M.A.Ö., E.T.S., F.A.K.; Resource: M.G., R.Y., H.M., F.A.K.; Materials: B.B., M.A.Ö., E.T.S., A.S.A.; Data collection and/or processing: M.A.Ö., R.Y., K.K., F.A.K.; Analysis and/or interpretation: B.B., R.Y., H.M., Ö.F.T.; Literature review: B.B., M.A.Ö., E.T.S., F.A.K., A.S.A.; Writing: M.G., R.Y., K.K., İ.B.; Critical review: B.B., M.G., H.M., E.T.S., Ö.F.T., A.S.A.

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ORİJİNAL ÇALIŞMA - ÖZ

Yanık hastalarında hastane öncesi ve acil servis verilerinin analizi: Beş yıllık dönemde mortalite belirteçleri ve yanıt süreleri

AMAÇ: Bu çalışma, yanık vakalarının hastane öncesi ve acil servis süreçlerini retrospektif olarak inceleyerek sürecin etkinliğini değerlendirmeyi, bölgesel veriler oluşturmayı ve yanık hastalarında mortaliteyi etkileyen faktörleri belirlemeyi amaçlamıştır.
GEREÇ VE YÖNTEM: Çalışma, 1 Ocak 2019 - 31 Aralık 2023 tarihleri arasında Ankara 112 Acil Sağlık Hizmetleri'ne başvuran ve Ankara Bilkent Şehir Hastanesi Acil Servisi'ne nakledilen 784 yanık vakasını kapsamaktadır. Hastaların demografik verileri, yanık özellikleri, 112 acil sağlık hizmetlerinin müdahale süreleri ve hasta sonlanımları retrospektif olarak incelenmiştir.
BULGULAR: Çalışmaya dahil edilen vakaların yaş ortalaması 23.4±20.7 yıl olup %36.7'si kadındı. En sık görülen yanık türü sıcak sıvı yanığı (%49.9) olup, vakaların %73.7'sinde 2. derece yanık mevcuttu. Mortalite oranı %5 olarak saptandı. Lojistik regresyon analizinde; ileri yaş (OR: 1.02), inhalasyon yanığı varlığı (OR: 3.33) ve yanık yüzdesi mortalite için bağımsız risk faktörleri olarak belirlendi. ROC analizinde >44 yaş (%38.5 sensitivite, %83.8 spesifisite) ve >%16 yanık yüzeyi (%89.7 sensitivite, %77.5 spesifisite) mortalite için öngördürücü eşik değerler olarak saptandı.
SONUÇ: Yanık yaralanmalarında ileri yaş, geniş yanık yüzeyi, kırsal bölgelerde yaşama ve inhalasyon yaralanması başlıca mortalite belirleyicileridir. Yanık yaralanmalarının önlenmesi ve etkin tedavisi için hastane öncesi acil hizmetlerin geliştirilmesi, toplum eğitimi ve multidisipliner yaklaşım temel unsurlardır.

Anahtar sözcükler: Yanık; mortalite; hastane öncesi bakım; acil servis; risk faktörleri.

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