ORIGINAL ARTICLE

Epidemiological and clinical characteristics and outcomes of inpatient burn injuries in older adults: Factors associated with mortality

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ABSTRACT

BACKGROUND: There is a lack of epidemiological research on defining the epidemiological profile of burn injuries in older adults in different regions of Turkey. This study was designed to document the prevalent epidemiological pattern of burn injuries and factors that affect mortality in older adults admitted for treatment to the inpatient unit of Adana City Training and Research Hospital (ACTRH).

METHODS: Demographic data, burn mechanism, presentation, percentage of total body surface area (TBSA) burn, abbreviated burn severity index (ABSI) and revised Baux scores, comorbidities, and treatment modalities burn patients aged 60 years and over admitted to our burn center January 1, 2016, and December 31, 2019, were evaluated retrospectively in this study.

RESULTS: The medical records of 1754 inpatient burns over 4 years were retrospectively reviewed. A total of 104 (5.5%) hospitalized adult burn patients aged 60 years old or over and treated more than 24 h were included in the study. There were 38 males and 66 females with a male-to-female ratio of 1.00:2.05 in survivors and 1.25:1.00 in non-survivors. The mean age was 70.5±8.5 (60.0–92.0) for survivors and 72.7±8.4 (62.0–90.0) years for non-survivors. The mean (%) TBSA burned was 11.4±9.9% for survivors and 37.8±30.0% for non-survivors. Most of the burn injuries occurred at indoor locations (81%), caused by hot water scalds, representing more than one-third of all burns, especially in the kitchen and bathroom. Considering the age (p=0.329), the etiology (p=0.984) and place of burns (p=0.071), burned anatomical regions (p=0.817), and the surgical procedure (yes/no) (p=0.798), no statistical difference was observed between survivors and non-survivors.

CONCLUSION: The more extended %TBSA burn, the inhalation injury, and deep burns were found to be significantly the most effective factors in mortality. Revised Baux (R Baux) and ABSI scores had a high value of predicting mortality.

Keywords: Burn; epidemiology; mortality; older adults.

INTRODUCTION

Background

Burn injuries in older adults have significant challenges in burn care management and poorer outcomes than the general population with sustaining burn injuries. More extended hospital stays in this age group, and complications that cause higher mortality (congestive heart failure, pulmonary edema, pneumonia) are usually observed.[1] Lower physiological reserves, diminished senses, impaired mental state, and pre-existing comorbidity in elderly patients affect these challenges.[2,3] Furthermore, lower response and avoidance (slower reaction time) of these patients in the event of harm led to an increased percentage of TBSA burns and increased risk of inhalation injury.[1–3]

Although significant progress has been made in burn management over the past few decades, the incidence of mortality and morbidity has decreased. However, the overall mortality rate of the elderly after burn injury is still higher than that of the children or young adults, and little progress made in improving the outcome of burn damage in older adults over

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the past few decades.[4,5] While the LD50 is 90% TBSA burn in the pediatric population and 70–80% TBSA burn in adults, it is about 30–35% TBSA for the older adults and has remained relatively stable.[2–4]

Although significant progress has been made in burn management over the past few decades, the incidence of mortality and morbidity has decreased. However, the overall mortality rate of the elderly after burn injury is still higher than that of the children or young adults, and little progress is made in improving the outcome of burn damage in older adults during this period.

The increasing rate of older adults' burn population and its vulnerability to the burn injuries reveals the importance of burn prevention programs. A surgical or conservative clinical approach must be planned individually for each patient. Questions about the benefits of early surgical excision in the elderly remain unanswered today. Older patients with deep burns may benefit from early surgical excision by the recent developments in pre-operative, perioperative, and post-operative medical care for patient safety, anesthesia, and surgical technique. Further comparative studies are needed to reveal the results of early surgical excision and differences in burn pathophysiology in older adults from other age groups.

The Aim of the Study

Many published epidemiological studies focused on stratified pediatric age subgroups and precise burn mechanisms (electrical, tandir [a specially designed oven used for baking bread in the eastern and southeastern part of Turkey], and scald burns). There is a lack of epidemiological research on defining the epidemiological profile of burn injuries in older adults in different regions of Turkey. This study was designed to document the prevalent epidemiological pattern of burn injuries and factors that affect mortality in older adults admitted for treatment to the inpatient unit of ACTRH.

MATERIALS AND METHODS

Study Design and Setting

A hospital-based, retrospective, single-center study was conducted over 4 years from January 1, 2016, to December 31, 2019, at the tertiary care referral burn center of ACTRH. Data collection was limited to the population aged 60 and over, representing 5.9% (n=104) of the 1754 hospitalized burn patient admissions during this period.

Data Collection

Demographic data including age, gender, % total body surface area (TBSA) burn, cause and severity of burn injury, comorbidities, monthly variations, and outcomes including length of hospital stay (LOS) and mortality were extracted from the hospital medical information database and were analyzed.

Comorbidity was classified as hypertension (HTN), diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), ischemic heart disease (IHD), epileptic seizures (ES), and others.

The scores of the Abbreviated Burn Severity Index (ABSI)[6] and revised Baux[7] were calculated for each patient.

Data Quality

All data were collected and recorded by MD using the standard electronic medical report form. KG made the necessary inspections for the accuracy, integrity, and clarity of the collected data.

Burn Management

The extent of TBSA burn was calculated by employing the combination of the "rule of nines" and Lund and Browder's chart.[8] The burn depth was estimated clinically. After the initial evaluation, wound cleansing, covered dressings with a topical antimicrobial agent (silver sulfadiazine), was applied to all patients and changed daily. Adequate analgesia and prophylaxis against tetanus were provided. All patients received systematic anticoagulant therapy (low-molecular-weight heparin), anti-ulcer agents, and as needed enteral nutritional support. A central venous catheter was inserted in all patients who needed intravenous fluid resuscitation, performed as per the Parkland formula, and adopted according to urine volume 0.5–1 cc/hour. Appropriate antibiotics were started at the first sign of sepsis. Surgical excisions (tangential and fascial), skin grafts, and patients who needed other surgical interventions such as escharotomy, fasciotomy, and amputations were managed accordingly.

Ethical Clearance

Approval was obtained from the local ethics committee of ACTRH for the study.

Inclusion Criteria

All older adult burn patients aged 60 years old or over admitted in the acute phase of burn injury for treatment to the inpatient unit of the tertiary burn center of ACTRH and treated for more than 24 h were included in the study.

Exclusion Criteria

Outpatient patients with minor burn injuries, patients with toxic epidermal necrolysis, Stevens–Johnson syndrome, and incomplete medical records (missing data never exceeded 1%) were excluded from the study.

Limitations of the Study

This study's limitations were the retrospective design, chart review, single-center, and hospital-based investigation. This data set represents only the inpatient burn admissions to ACTRH.

Data Analysis

Data were entered and analyzed using SPSS 22. Descriptive statistics were applied to all variables. Bivariate analyses using t and Chi-square tests were employed for continuous and categorical variables, respectively. For non-parametric continuous variables, medians were calculated and compared between groups using the Mann-Whitney U test.

Outcome characteristics among survivors and non-survivors of the burn were analyzed using univariate logistic regression analysis. Further stepwise multivariate logistic regression analysis was conducted with statistically significant ($p<0.05$) univariate analysis results to determine the factors predicting mortality in elderly patients with burn injury. Odds ratios were also calculated. Data are presented as mean±standard deviation (minimum–maximum) and median (interquartile range – IQR [25th–75th percentile]). Two-sided $p\leq0.05$ was considered statistically significant.

RESULTS

Monthly Variation of Burn Injury Admissions

Changes in monthly hospital admission patterns of the older adults with burn injury were recorded, and the highest fluctuation was observed in January and March, while the lowest fluctuation in August and November. There was no significant difference in gender distribution of burn incidence between survivors and non-survivors from 2016 to 2019 (p=329) (Fig. 1).

Age-Gender and Incidence Rates

The mean age was 70.9±8.5 (60.0–92.0) years for all patients, 70.5±8.5 (60.0–92.0) for survivors, and 72.7±8.4 (62.0–90.0) years for non-survivors; apart from this, the median age was 69.0 (64.0–77.5) years for all patients, 68.0 (63.0–78.0) years for survivors, and 72.0 (65.0–76.0) years for non-survivors (Table 1). There were 38 males and 66 females in the study group, but the male-to-female ratios differed both in the survivors and non-survivors with 1.00:2.07, and 1.25:1.00, respectively. The age and gender were not found to be efficient variables on mortality in the study (p=0.329 and p=0.226, respectively) (Table 1).

Location of Burn Injury

There was no statistical difference between survivors and non-survivors by the location of burn injury (p=0.071).

The places of patients during the burn injury in older adults are demonstrated in Figure 2a.

Etiology of Burns

Causes of burns were analyzed in five main groups, including scalds, fire flame, electrical, chemical, and contact burns. During the study period, there were any chemical burns observed,

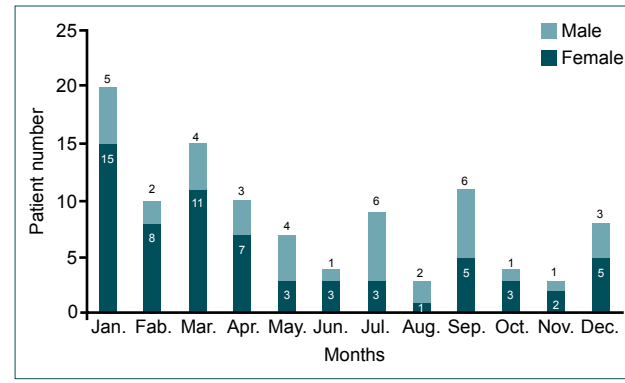

Figure 1. Monthly distribution of hospital admissions of elderly patients by gender, 2016–2019.

whether in survivors or non-survivors. The most frequent causes of burn injuries were scalds (51.2%) in the survivors, followed by fire flame (43.2%), whereas mainly by fire flame (72.3), in the non-survivors followed by scalds (16.7) (p=0.984).

Etiological causes of burns in older adults are demonstrated in Figure 2b.

Burned Anatomical Regions

There was not any statistically significant difference by burned anatomical region between the two groups during the study period (p=0.817; OR=1.01 (95% CI [0.69–1.12]).

The anatomic locations of the burns among the survivors and non-survivors are demonstrated in Table 1.

LOS and Outcomes

In the 4-year study period, 18 of 104 older adult patients died with a mortality rate of 17.3%. About 51.2% of the discharged and 61.1% of deceased patients had at least two pre-existing comorbidities but were found as an ineffective factor on mortality in the study (p=0.733; OR=1.08 (95% CI [0.91–2.21]). Comorbidity details are shown in Figure 3.

The Extent of TBSA Burn

The mean (%) TBSA burned was 16.0±18.2 (1–95)% for all patients, 11.4±9.9 (1–45)% for survivors, and 37.8±30.0 (3–95)% for non-survivors; meanwhile, the median (%) TBSA burned was 10.0 (5.0–17.5)% for all patients, 9.5 (4.0–15.0)% for survivors, and 32.5 (10.0–60.0)% for non-survivors.

The relationship between age and % TBSA burn between survived and non-survived older adult burn patients was detailed in a scatter plot graphic (Fig. 4). It shows that extremes of %TBSA burn injuries occurred mainly between the ages of 60 and 80 and were closely related to mortality (p<0.001; OR=3.21 (95% CI [1.61–5.84]) (Table 1).

Time of the Death

Twelve deaths (66.7%) occurred within 14 days of ad-

Table 1. Comparison of demographic and clinical variables and their relationship with mortality (univariate analysis) between survivors and non-survivors (n=104)

Variables	Survivors	Non-survivors	p-value	Odds ratio	%95 CI
	Mean±SD[a] Median (IQR)[b]	Mean±SD[a] Median (IQR)[b]			
Age (years)	70.5±8.5 (60.0–92.0)	72.7±8.4 (62.0–90.0)	0.329		
	68.0 (63.0–78.0)	72.0 (65.0–76.0)			
TBSA burn (%)	11.4±9.9 (1–45)	37.8±30.0 (3–95)	<0.001		
	9.5 (4.0–15.0)	32.5 (10.0–60.0)			
LOS (days)	23.8±22.7 (2–114)	17.5±18.2 (2–69)	0.226		
	16.0 (8.0–32.0)	9.5 (6.0–23.0)			
Gender, n (%)			0.077	0.39	0.14–1.08
Male	28 (32.5)	10 (55.6)			
Female	58 (67.5)	8 (44.4)			
Cause of burn injury, n (%)			0.984	1.01	0.69–1.12
Scalds	44 (51.2)	3 (16.7)			
Fire-flame	32 (37.2)	13 (72.3)			
Contact	7 (8.1)	1 (5.5)			
Electrical	3 (3.5)	0 (0.0)			
Combined	0 (0.0)	1 (5.5)			
Anatomical region, n (%)			0.817	–	–
Head	8 (3.2)	9 (9.3)			
Neck	5 (2.0)	6 (6.2)			
Anterior trunk	24 (9.6)	11 (11.3)			
Posterior trunk	23 (9.1)	9 (9.3)			
Hand-upper extremities	84 (33.5)	29 (29.9)			
Feet-lower extremities	103 (41.1)	29 (29.9)			
Genital	4 (1.5)	4 (4.1)			
Deep burn, n (%)			0.009	5.75	1.54–21.47
Superficial partial-thickness	37 (43.0)	0 (0.0)			
Deep partial-thickness	22 (25.6)	2 (11.1)			
Full-thickness	27 (31.4)	16 (88.9)			
Surgical procedure, n (%)			0.798	1.06	0.48–1.18
Yes	37 (43.1)	6 (33.3)			
No	49 (56.9)	12 (66.7)			
Inhalation injury, n (%)			<0.001	3.17	1.79–5.86
Yes	0 (0.0)	11 (61.1)			
No	86 (100.0)	7 (38.9)			
Comorbidity, n (%)			0.733	1.08	0.91–2.21
Yes	47 (54.7)	11 (61.1)			
No	39 (45.3)	7 (38.9)			

[a]Mean±standard deviation (Minimum-Maximum); [b]Median (IQR: Interquartile range [25th–75th percentile]); TBSA: Total body surface area; LOS: Length of stay; CI: Confidence interval.

mission. One patient died late (69 days) after developing complications and undergoing six operations. After his last surgical procedure, he developed septicemia. Two patients died after 41 and 44 days; two surgical procedures had been applied for both. They developed pneumonia followed by multiple organ dysfunction syndromes (MODS). Another

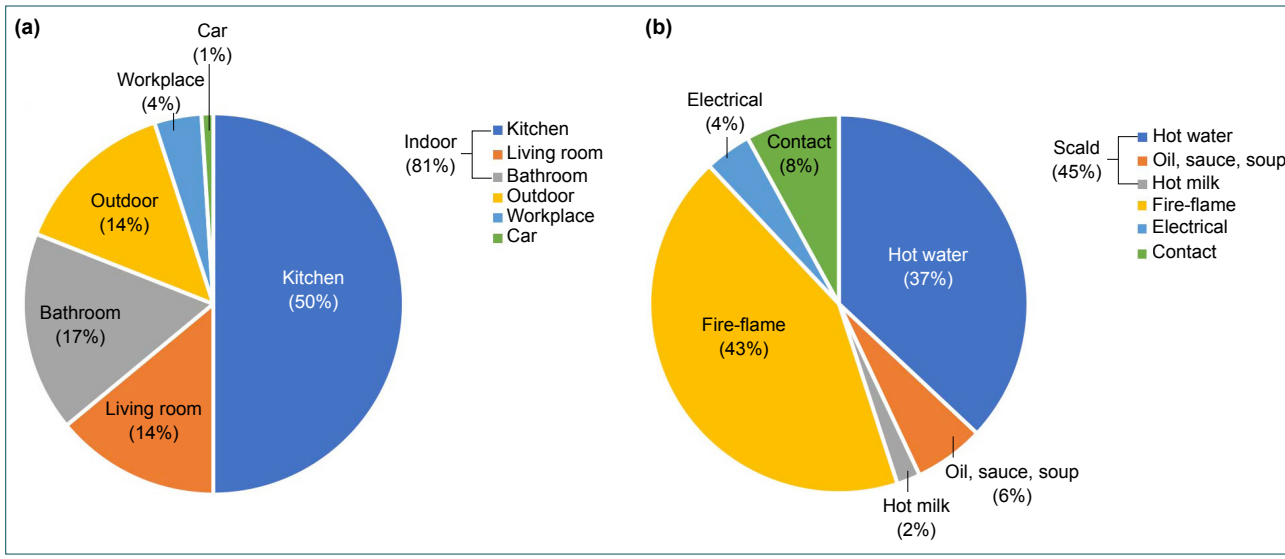

Figure 2. Distribution of the **(a)** place and **(b)** etiology of burn injury between survived and non-survived patients, from 2016 to 2019.

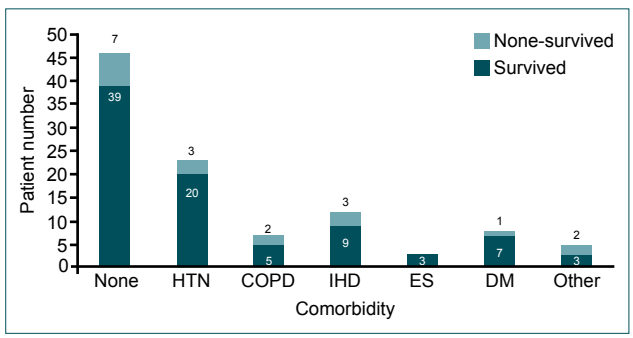

Figure 3. Distribution of the comorbidity between survived and non-survived patients, from 2016 to 2019. HTN: Hypertension; DM: Diabetes mellitus; COPD: Chronic obstructive pulmonary disease; IHD: Ischemic heart disease; ES: Epileptic seizures.

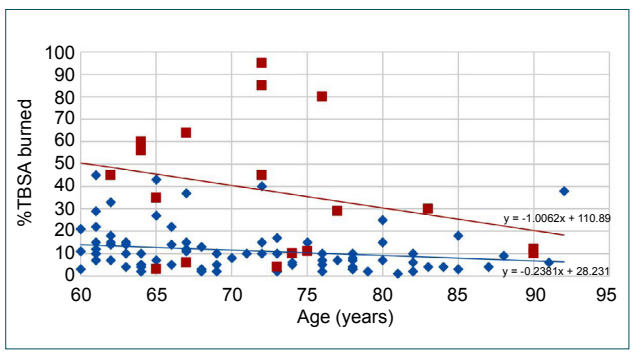

Figure 4. Scatter plot of age against % TBSA burned for burn injuries between survived and non-survived older adults during the study. Blue markers represent survivors, and red markers represent non-survivors. Trendlines are shown in blue for survivors and red for non-survivors. TBSA: Total body surface area.

three patients died on days 15, 22, and 27 due to IHD and MODS.

The distribution of the frequency of death by time in older adult patients with a burn injury is shown in Figure 5.

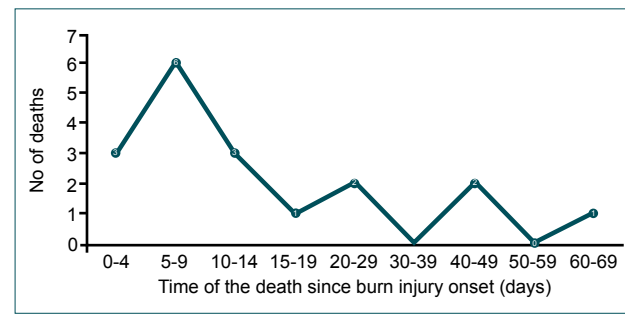

Figure 5. Distribution of the frequency of death by time in elderly patients with burn injury.

The Predictive Value of the r Baux and ABSI Scores

Both two (r Baux and ABSI) scores had significant predictive value, as shown in Table 2a and b ($p<0.001$).

Multivariate Logistic Regression Analysis

As shown in Table 3, TBSA, inhalation injury, and deep burns are significantly associated with mortality.

DISCUSSION

The most effective factors on mortality have been reported in many studies. %TBSA burned, % full-thickness surface area burned, comorbidity number (COPD, DM, heart disease, and sepsis), gender, inhalation injury, need for early intubation, and age are the factors as mentioned above.[9–14] However, also, only age itself is an adverse prognostic factor in burn injuries.[15–18] With the aging population, the percentage of geriatric patients is expected to increase over the next few decades.[19,20] According to the United Nations estimates, the proportion of the world population aged 65 or older is expected to triple to reach 2 billion by 2050.[9,21] Since elderly burn population has a faster growth rate than the rest of the community, prevention of burn injuries in the elderly is a

Table 2a. Mortality relationship with abbreviated severity of burn index (ABSI) score

Score	Total number of patients by score	Mortality by score	
		n	%
≤8	59	3	5.1
9–10	32	5	15.6
11–12	7	4	57.1
≥13	6	6	100.0

Table 2b. Mortality relationship with r Baux score

Score	Total number of patients by score	Mortality by score	
		n	%
≤70	14	1	7.1
70–100	70	4	15.6
≥100	20	13	65.0

Table 3. Multivariable logistic regression analysis of predictors of mortality

Factor	S.E.	p-value	Odds ratio	95% CI
Inhalation	0.11	<0.0001	3.77	2.56–7.14
Deep Burn	0.24	0.0002	11.76	3.69–32.9
%TBSA burned				
<20	0.01	<0.0001	1.08	1.04–1.12
20–39	0.13	0.0093	2.18	1.21–3.92
40–59	0.25	0.0001	8.82	2.89–26.94
>60	0.15	<0.0001	13.94	7.15–28.66

S.E.: Standard error; CI: Confidence interval; TBSA: Total body surface area.

significant public health problem today, and it will be a challenging issue in the next few decades.

Burn injuries may further exacerbate pre-existing comorbidities, resulting in delayed recovery, extended hospital stays, and a worse prognosis.[10,22,23] In this study, the main comorbidities were HTN, DM, IHD, COPD, and epilepsy, and the results were like some previous studies.[10–12]

In many studies, it is reported that the increased extent of TBSA burns and older age generally associated with higher mortality rates.[17,24,25] In their research, Harats et al.[17] shown that patients aged over 70 years had a higher mortality rate of 95% with 40–89% TBSA burn, compared to <80% mortality for those with 30–40% TBSA burn. Similarly, this study found that higher mortality rates were observed with the more extended % TBSA burns.

Adequate resuscitation, early surgical excision, control of infections, and hypermetabolic response regulation are among the primary current burn care modalities. In terms of infection control, which is the main challenge in the treatment approach of burn injuries, early excision of the eschar and covering the wound as early as possible is of great importance. The elimination of non-viable tissue by early surgical resection has critical potentials by reducing the production of chemical intermediates that stimulate the inflammatory cascade and ultimately result in MODS and creating a relatively infection free wound bed. The need for surgical excision depends on the depth of the burn.[26]

A surgical or conservative clinical approach must be planned individually for each patient, and surgery should be performed in clinically stable patients.[15,27] Although early burn excision has been recognized as today's standard surgical burn treatment since Janzekovic first introduced it in the 1970s, questions about the benefits of this approach in the elderly remain unanswered.[28,29] The concept of early excision and grafting opposed delayed surgery (>7 days) is still controversial in the literature.[30–32] In this study, surgical procedures were performed within 7 days of post-injury when the older adult patients' medical conditions were available.

Like Lumenta et al.'s study.,[32] in this study, most of the burn injuries occurred at indoor locations (81%), caused by hot water scalds, which represent more than one-third of all burns, especially in the kitchen and bathroom.

The high mortality rates of inpatient burn injuries in older adults' have been reported in many studies and range from 7.4% to 66%.[1,4,33–35] In this study, the mortality rate in older adult burn patients was 17.3% and was compatible with other published reports. Sepsis, pneumonia, and MODS were the most common causes of death. Eighty-six elderly patients with burn injuries were survived during this period (82.7%). In the study, factors such as comorbidity, age, gender, and the number of surgical procedures were found to be ineffective factors on mortality, considering the examined variables in the univariate analysis.

A study conducted by Mahar et al. in 2008[36] showed that increased % TBSA burn and inhalation injury were among the most effective factors on mortality.

In terms of inhalation injury, as mentioned above, the slower reaction time of older people in the event of harm led to increased inhalation damage.[1–3] Comparable to Macrino et al.'s[20] findings, in the study, patients with inhalation injury had poorer outcomes, and 61.1% (11/18) of non-survivors had inhalation damage. In contrast, no inhalation injury was detected among the survivors.

The existence of inhalation injury, the more extended %TBSA burns, and deeper burns were found to be the most effective factors on mortality in the multivariate analysis.

Conclusion

The increasing rate of the elderly burn population and its vulnerability to the burn injuries reveals the importance of burn prevention programs. A surgical or conservative clinical approach must be planned individually for each patient. In addition to the patients' concomitant diseases, the general health status should be evaluated, and surgery must be delayed until the patient's medical condition stabilizes.

Further comparative studies are needed to reveal the results of early surgical excision and differences in burn pathophysiology in older adults from other age groups.

Ethics Committee Approval: This study was approved by the Adana City Training and Research Hospital Ethics Committee (Date: 22.05.2019, Decision No: 461).

Peer-review: Internally peer-reviewed.

Authorship Contributions: Concept: K.G.; Design: K.G.; Supervision: K.G.; Resource: K.G., M.D.; Materials: K.G., M.D.; Data: K.G., M.D.; Analysis: K.G., M.D.; Literature search: K.G., M.D.; Writing: K.G.; Critical revision: K.G.

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ORİJİNAL ÇALIŞMA - *ÖZET*

Yaşlı yetişkinlerde yatarak tedavi edilen yanık yaralanmalarının epidemiyolojik ve klinik özellikleri ve sonuçları: Mortaliteyle ilişkili faktörler

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AMAÇ: Türkiye'nin farklı bölgelerinde yaşlı erişkinlerdeki yanık yaralanmalarının epidemiyolojik profilini tanımlayan sınırlı sayıda epidemiyolojik araştırma vardır. Bu çalışmada, Adana Şehir Eğitim ve Araştırma Hastanesine yatarak tedavi için başvuran yaşlı erişkinlerde yanık yaralanmalarının yaygın epidemiyolojik verilerini gözden geçirerek tedavi sonuçlarımız ve mortaliteye en fazla etki eden faktörlerin değerlendirilmesi amaçlanmıştır.
GEREÇ VE YÖNTEM: Yanık merkezinde 1 Ocak 2016'dan 31 Aralık 2019 tarihleri arsında yatarak tedavi edilen 60 yaş ve üstündeki hastaların demografik verileri yanık total vücut alanı yüzdesi (TBSA), kısaltılmış yanık şiddeti indeksi (ABSI) ve Revize Baux skorları, ko-morbiditeler, tedavi yaklaşımları, hastanede yatış süresi ve mortalite geriye dönük olarak incelendi.
BULGULAR: Çalışmaya 60 yaş ve üzeri hastanede yatarak 24 saatten fazla tedavi gören toplam 104 (%5.5) erişkin yanık hastası dahil edildi. Hastaların 38'i erkek, 66'sı kadındı. Hayatta kalanlarda erkek/kadın oranı 1.00: 2.05, hayatta kalmayanlarda ise 1.25: 1.00 olarak saptandı. Hayatta kalanlar için ortalama yaş 70.9±8.5 (60.0–92.0), hayatta kalmayanlar için 72.7±8.4 (62.0–90.0) olarak saptandı. Ortalama yanık TBSA yüzdesi hayatta kalanlar için %11.4±9.9 ve hayatta kalmayanlar için %37.8±30.0 idi. Yanık yaralanmalarının büyük çoğunluğun (%81), özellikle mutfak ve banyoda olmak üzere ev ortamında meydana geldiği ve tüm yanıkların üçte birinden daha fazlasının etiyolojisin sıcak suya bağlı (%37) haşlanma yanıklarının oluşturduğu gözlendi. Yaş (p=0.329), etiyoloji (p=0.984) ve yanık yaralanmasının meydana geldiği yer (p=0.071), yanan anatomik bölgeler (p=0.817), cerrahi işlem (evet/hayır) (p=0.798) göz önüne alındığında istatistiksel olarak hayatta kalanlar ve hayatta kalmayanlar arasında anlamlı fark gözlenmedi.
TARTIŞMA: Daha geniş total vücut yanık alanı (TBSA) yüzdesinin, inhalasyon hasarı ve derin yanıkların mortaliteye en fazla etki eden faktörler olduğu bulundu. Revize edilmiş Baux (R Baux) ve kısaltılmış yanık şiddet indeksi (ABSI) skorlarının mortaliteyi tahmin etmede yüksek bir değere sahip olduğu saptandı.
Anahtar sözcükler: Epidemiyoloji; mortalite; yanık; yaşlı erişkin popülasyonu.

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