ORIGINAL ARTICLE

Factors affecting the mortality at patients with burns: Single centre results

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ABSTRACT

BACKGROUND: Burns are a primary cause of mortality along with the severe physical and psychological morbidities in patients and their families. Such kinds of injuries bring about considerable financial burdens due to the treatment processes and sequels. The present study aims to investigate the factors that affect the mortality of burns.

METHODS: The archives files of the patients admitted because of burn injuries in our burn centre between September 2008 and December 2016 were examined in this study. Some of the lab values, such as age, sex, percentage of total burn surface area (TBSA), referral status, burning site, degree of burns, time of admission to hospital, aetiology of burning, blood and blood products collection, complete blood count, routine biochemistry, coagulation parameters, C-reactive protein (CRP), sedimentation rate, neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR), were examined while evaluating the patients' mortalities.

RESULTS: A total of 133 patients were included in this study. The patient's age (p=0.001), the degree of burns (p<0.001), surface area of burns (p<0.001), the time of hospital admission (p<0.001), burning aetiology (p=0.006), erythrocyte suspension, fresh frozen plasma, along with the administration of albumin transfusion (p<0.001), mean platelet volume (MPV) (p=0.028), NLR (p<0.001) and PLR (p<0.030) values were found to be associated with mortality in patients with burns.

CONCLUSION: In this study, age, burn grade, TBSA, hospital admission time, burn aetiology, erythrocyte, fresh frozen plasma and albumin transfusion, MPV, NLR and PLR values were found to be associated with mortality in patients with burns. With this study, it is possible to produce the treatment guidelines to reduce mortality by taking these parameters into consideration, which were determined to be associated with mortality while evaluating the patients with burns.

Keywords: Burn; mean platelet volume; neutrophil-to-lymphocyte ratio; platelet-to-lymphocyte ratio.

INTRODUCTION

Burns are the fourth most common type of trauma worldwide, followed by traffic accidents, falls and interpersonal violence and are a major public health problem among all injuries.[1–3] Burns are a major cause of mortality along with severe physical and psychological morbidities in patients and their families. In addition, such kinds of injuries impose considerable financial burdens due to treatment processes and sequels.[4,5] Every year, approximately 200,000 people around the world die of burn injuries.[3] Various fires, scalding agents, chemicals, electricity and radiation are seen as the causes of burning and all these agents cause burns of varying severity, thereby resulting in severe morbidity and mortality.[6] In general, the mortality risk factors for patients with burns are gender, age, total burn surface area (TBSA), presence of in-

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halation damage, co-morbid disease and other concomitant trauma.[7,8] With advances in intensive care and burn care, the survival outcomes of patients with severe burn injuries over the past ten years have improved significantly.[9]

MATERIALS AND METHODS

This study received approval from the Ataturk University Faculty of Medicine clinical research Ethics committee (dated 13/03/2019 and numbered 02–01). Of the 301 patients with BSA of 15% and over who were referred to Erzurum Regional Training and Research Hospital Burn Center between September 2008 and December 2016 from other centres, 133 patients (whose full information could be obtained) were included in this study.

The files of these patients were retrieved from the electronic archives and their data were retrospectively examined. The patients were divided into two groups as follows: survivors and the deceased patients. Some of the lab values, such as age, sex, percentage of TBSA, referral status, burning site, degree of burn, time to admission to hospital, aetiology of burning, blood and blood products collection, complete blood count, routine biochemistry, coagulation parameters, C-reactive protein (CRP), sedimentation rate, neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR), were examined while evaluating the patients' mortalities.

Statistical Analysis

Statistical analyses were performed by employing SPSS 15.0 software (SPSS Inc., Chicago, IL, USA). The distribution of data was determined using the Kolmogorov–Smirnov test. Continuous variables were expressed as mean ± std. deviation, whereas categorical variables as frequency and percentage. Continuous variables were compared with the independent sample t-test or Mann–Whitney U test and categorical variables were compared using Pearson's Chi-square test for two groups. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Of the admitted patients, 69 (52.7%) were males, and 64 (47.3%) were females. Of the deceased patients, eight (6.1%) patients were males and 16 (12.2%) patients were females. There was no statistically significant difference between the two groups (p=0.070). The mean ages of surviving patients and deceased patients were 15.17±18.23 and 33.04±26.64, respectively. There was a statistically significant difference between the two groups (p=0.001). According to the degree of burns, two of the surviving patients had first-degree burns, 66 patients had superficial second-degree burns, 12 patients had deep second-degree burns, 29 patients had third degree burns, whereas in the deceased patients, one patient had superficial second-degree burnseight patients had deep second-degree burns and 15 patients had third-degree burns. There was a statistically significant difference between the two groups (p<0.001).

The percentages of TBSA in surviving patients and deceased patients were 22.92±9.11 and 52.04±23.52, respectively. There was a statistically significant difference between the two groups (p=0.001). A total of five of the 96 patients with a TBSA ratio of 16%–30% were deceased patients, whereas 19 of the 37 patients with a TBSA ratio higher than 30% were deceased patients. Again, there was a statistically significant difference between the two groups (<0.001).

Of the 114 patients admitted directly, six were deceased patients, whereas 18 of the 19 patients referred from another centre were deceased patients. There was a significant difference between the two groups (<0.001).

According to the burn site, among the surviving patients, 91 patients were burned at home, two patients at work and 16 patients in an open area, whereas among the deceased patients, 19 patients were burned at home, one patient at work and four patients in an open area. There was no statistically significant difference between the two groups (p=0.752).

Patients were divided into two groups as early and late arrivals according to the admission hours. Accordingly, patients who were admitted in the first four hours of the event were defined as early applicants; whereas, patients who were admitted four hours after the event were defined as late applicants. In total, four of 80 patients who applied early were deceased patients, whereas 20 of the 53 patients who were admitted late were deceased patients. There was a statistically significant difference between the two groups (p<0.001). The demographic characteristics of the patients are presented in Table 1.

According to the aetiology of burning, the largest group of patients discharged with healing were 57 patients with hot water burns, 22 patients with flame burns, 12 patients with tandoori burns, nine patients with home electrical burns, four patients with milk burns, three patients with hot water burns, one patient with a lightning strike and one patient with sand contact burns. Concerning deceased patients, eight patients had hot water burns, 14 patients had flame burns and two patients had tandoori burns. There was a statistically significant difference between the two groups concerning aetiology of burn (p=0.006) (Table 2).

Of the 76 patients receiving erythrocyte suspension, five patients were deceased patients, whereas 19 of 57 patients without erythrocyte suspension were deceased patients. There was a statistically significant difference between these two groups (p<0.001). Of the 65 patients receiving fresh frozen plasma, one patient was a deceased patient, whereas 23 out of the 68 patients were deceased patients. There was a statistically significant difference between these two groups

Table 1. Comparison of the groups according to general demographic data

	Alive (n=109)	Deceased (n=24)	p
Age	15.17±18.23	33.04±26.64	0.001
Gender			0.070
Male	61	8	
Female	48	16	
Burn percentage	22.92±9.11	52.04±23.52	<0.001
Burn percentage group			<0.001
≤15%	0	0	
16–30%	91	5	
≥31%	18	19	
Referral status			<0.001
Direct admission	108	6	
Referred	1	18	
Burn location			0.752
Home	91	19	
Workplace	2	1	
Open area	16	4	
Burn grade			<0.001
Superficial 1st degree	2	0	
Superficial 2nd degree	66	1	
Deep	12	8	
Deep+superficial 2nd degree	29	15	
Time elapsed for admission			<0.001
≤4 hours	76	4	
2–4 hours	33	20	

Table 2. Comparison of the groups according to the aetiology of burning

	Alive (n=109)	Deceased (n=24)	p
Burning by hot water	57	8	0.006
Flame burn	22	14	
Tandoori burn	12	2	
House electricity burn	9	0	
Milk burn	4	0	
Tea water burn	3	0	
Lightning strike	1	0	
Sand contact burn	1	0	

(p<0.001). Of the 99 patients who underwent albumin transfusion, seven patients were deceased patients, whereas 17 out of the 34 patients without transfusion were deceased patients. There was a statistically significant difference between these two groups (p<0.001) (Table 3).

Table 3. Comparison of the groups according to blood and blood products transfusion status

	Alive (n=109)	Deceased (n=24)	p
Erythrocyte suspension transfusion			
Yes	71	5	<0.001
No	38	19	
Fresh frozen plasma transfusion			
Yes	64	1	<0.001
No	45	23	
Albumin transfusion			
Yes	92	7	<0.001
No	17	17	

Table 4. Comparison of the groups according to laboratory findings

	Alive (n=109)	Deceased (n=24)	p
Haemoglobin	13.56±2.92	14.52±3.50	0.635
WBC	18.66±10.27	22.50±11.20	0.116
Eosinophils	0.66±0.99	0.14±0.26	0.025
Platelet	402.95±181.80	344.20±171.65	0.169
MPV	7.63±2.36	8.07±1.24	0.028
Glucose	147.92±70.21	184.12±117.35	0.234
BUN	29.60±12.71	30.84±17.98	0.956
Creatinine	0.59±0.77	1.47±3.35	0.001
Sodium	135.50±13.52	138.46±6.35	0.254
Potassium	4.46±0.67	4.29±0.77	0.041
Calcium	8.95±1.01	7.42±1.20	<0.001
AST	59.30±83.86	58.16±29.75	0.081
ALT	33.12±41.27	30.04±24.01	0.146
Albumin	3.80±0.73	2.56±0.70	<0.001
INR	1.09±0.19	1.22±0.25	0.010
Sedimentation	15.04±22.51	8.62±17.60	0.001
CRP	24.76±49.81	39.35±56.73	0.173
NLR	6.34±12.13	12.96±9.70	<0.001
PLR	52.77±94.30	46.56±31.34	0.030

WBC: White blood cell; BUN: Blood urea nitrogen; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; INR: International normalized ratio; CRP: C-reactive protein; NLR: Neutrophil-to-lymphocyte ratio; PLR: Platelet-to-lymphocyte ratio.

When patients were evaluated according to laboratory values, there was a statistically significant difference between eosinophils, MPV, creatinine, potassium (K), calcium (Ca), albumin, international normalized ratio (İNR), sedimentation, NLR, PLR values between the survivors and deceased survivors or burns, whereas among the haemoglobin (Hg), white blood cell (WBC), platelets (PLT), glucose, blood urea nitrogen (BUN), sodium (Na), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and CRP values, there was no statistically significant difference between the two groups (Table 4).

DISCUSSION

Skin is one of the most important organs of the body and the largest organ that covers our body. Heat regulation, the role of sensation, protection from the external environment and having immunologic functions increase the importance of the skin even more. As a result of burning injury, in addition to the loss of functions, a life-threatening situation may also arise.[8] Every year, millions of people in the world are affected by burns. Half of them consist of children, and one-fourth of these cases are of severe burns. Therefore, patients with burns should be treated as serious trauma patient.[10] Advanced age, large TBSA and the presence of inhalation injury are the factors affecting the mortality rate of patients with burns.[11–13] In addition, other factors, such as the presence of shock, the presence of sepsis and thrombocytopenia, have been reported to affect mortality rates during the admission.[14–17]

In our study, the relationship between mortality in patients with burns and gender, age, degree of burn, burn percentage, aetiology, receiving erythrocyte suspension, receiving fresh frozen plasma, albumin, haemogram and biochemical values were evaluated.

Gender and Age

The majority of the studies have reported that the female gender is a risk factor for mortality.[18–20] Zarei et al.[21] reported that the mortality rate was higher in men. In a study conducted by Brusselaers,[22] no statistically significant difference was reported between males and females concerning mortality. In our study, similar to Brusselaers' study, no statistically significant difference was found between males and females concerning gender. In the burns literature, it has been reported that age plays a key role in the relationship with mortality, especially in children and elderly people.[23–25] Other studies examining the relationship between age and mortality have shown a marked increase in mortality in children younger than two years old as compared with those older than two years of age.[25] Another study reported that the mortality rate was highest in children.[26] A study conducted by Tiryaki et al.[27] on patients with electrical burns reported that elderly people were a large number of deceased ones in such cases. In our study, when we compared the survivors and deceased patients, we concluded that the deceased survivors of burns constitute the older group and this was consistent within the literature. In our study, increased mortality was found with increased age.

Burn Degree

Albayrak et al. reported that tandoori burns caused deeper burns as compared to other types of burns. Therefore, morbidity and mortality rates are reported to be higher in the cases of tandoori burns.[28] Zarei et al.[21] revealed that second- and third-degree burns were a risk factor in mortality rates. A study conducted by Kaya et al.[29] regarding the electrical burns reported that there was a significant increase in mortality in the third-degree burns group as compared to the first- and second-degree burns groups. Lip et al.[30] reported that the mortality rates in patients with full-thickness burns were higher than those in the patients with partial-thickness burns. In our study, we also concluded that the increase in mortality was parallel with the increase in the degree of burns.

Burn Percentage

Some studies have reported that BSA is an independent risk factor in determining mortality.[24,31–33] In some studies, the BSA of the 70%–79%, 80%–89% and more than 90% of the burns were reported to have a mortality rate of 51.1%, 70.6% and 82.6%, respectively.[31,33,34] A study reported that a burn area of more than 20% was an important predictor factor in determining the mortality rate.[30] In a study, the mortality rate was found to be two-thirds higher in a burn patient group with TBSA between 21 and 30% than the burns patient group with TBSA between 11 and 20%.[35] Also, in our study, five of the 96 patients with burn percentage of 15 and 30% were deceased patients, whereas 19 of the 37 patients with burn percentage higher than 30% were deceased patients. Our results, too, were consistent with the literature.

Admission Time

A study, which included 235 paediatric patients in our paediatric patient group, reported that two people were deceased, and two of these deceased patients were brought to hospital 24 hours after the incident of burning.[36] In this study, we found that mortality was significantly higher in the patient group who applied to our clinic after the four hours following the occurrence of the event. The late admission of patients with burns to the hospital causes a delay in both emergency fluid resuscitation and burn wound care treatment.[37,38] In addition, patients who do not apply to health institutions after burns generally use traditional treatment methods, and burn wound infections occur as a result of these incorrect treatments.[39,40] All of these are the causes of mortality in the patients admitted late to the hospital after the incident of burning.

Burning Aetiology

Previously conducted studies reported that the most common cause of death in patients with burns was flame burns.[4,21,41–43]

The pathogenesis of electrical burns has certain differences concerning the other types of burns (6). A study conducted on 964 patients in Iran by Aghazadeh et al.[44] reported that death arose from scalding with flame, chemicals and hot liquid, respectively. Al et al.[26] in reported that a total of 624 patients (76.5%) were scalded, of them, 192 patients (23.5%) had flame-induced burns, 18 patients (9.4%) had burns due to flames, 32 patients (5.1%) died due to scald burns and the effects of flame burns on mortality were statistically significant. In our study, the highest mortality rate arose from flame burns and, then, by the scald burns, which was consistent with the literature. It can be concluded that the most common cause of mortality in flame burns may be because flame burns lead to a larger BSA and cause deeper burns.

Administration of Erythrocyte

Koljonen et al. found that the mortality of the patients with burns undergoing transfusion was five times higher than the mortality of the patients without transfusion.[45] Although some studies in the literature have reported a high mortality rate in patients undergoing transfusion, this relationship could not be found in most of the studies on this matter.[46–50] In our study, we also concluded that the administration of erythrocyte suspension reduces mortality.

Administration of Fresh Frozen Plasma

Lu et al.[49] reported that plasma transfusion is associated with mortality. Previous research works have claimed that transfusions can facilitate the formation of serious infections by suppressing the immune system, thereby increasing the mortality rate.[51,52] Fresh frozen plasma should be used in the event of severe bleeding or coagulopathy; however, it is recommended that early and aggressive plasma transfusion should be performed if burn wound excisions are performed in patients with severe coagulopathy.[53–55] In our study, it was found that mortality was higher in the group without FFP administration.

Administration of the Albumin

Melinyshyn et al. compared the two groups with and without routine albumin. In this study, some parameters, such as length of hospital stay, wound healing time and mortality, were compared and no difference was found between the two groups. It was also reported that the treatment costs were higher in the albumin-treated group. The results of this study concluded that the administration of albumin in patients with burns increased the cost of treatment and had no benefits.[56] A different study reported that albumin resuscitation might reduce fluid leakage and the negative effects of excessive fluid administration.[57] A sub-group evaluation performed in the Cochrane meta-analysis reported that the administration of albumin increased the mortality in patients with burns, whereas the results of Wilkes meta-analysis did not increase the mortality and had a neutral effect.[58,59] Another meta-analysis study reported that albumin was not beneficial.[60] Our study concluded that the use of albumin reduces mortality. Although our results were consistent with a small portion of the literature, it was found to be incompatible with most of the research works in literature.

MPV

MPV is used as an inflammatory marker in some diseases, such as sepsis, thrombosis, acute appendicitis and respiratory distress syndrome.[61,62] To date, we have not found a study examining MPV mortality in patients with burns. Our study showed that MPV levels were significantly higher in deceased patients than in survivors.

NLR

NLR indicates the ratio of neutrophils and lymphocytes. NLR is shown as one of the new markers of systemic inflammation.[63] Fuss et al.[64] reported that NLR is significantly higher in patients with burns along with sepsis. In our study, we evaluated burn patients with sepsis, along with all the burn trauma patients. In conclusion, we found a higher rate of NLR in patients with the mortal course.

PLR

Recently, PLR has been shown to be an important new marker of systemic inflammation, such as NLR.[65] To our knowledge, there was no study on PLR regarding the patients with burns. Our study is in contrast with many other studies on other pathologies in the literature; however, it is in parallel with the small number of studies, i.e., PLR was found to be lower in the group with deceased patients.

Our study was conducted on 133 burn patients, and the factors, such as age, degree of burn, admission time, aetiology of burning, erythrocyte, FFP and albumin transfusion, MPV, NLR and PLR values of the patients were found to be associated with mortality in patients with burns. This study was limited to one centre's experience. Even within one healthcare system, it remains difficult to match and carefully compare data, mostly because of different treatment approaches and selection of outcome parameters. Future studies can determine the factors that affect the mortality of burns and may ensure the development of treatment guidelines that will decrease the mortality of the patients with burns.

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ORİJİNAL ÇALIŞMA - *ÖZET*

Yanıklı hastalarda mortaliteyi etkileyen faktörler: Tek merkez sonuçları

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AMAÇ: Yanıklar, hasta ve ailelerine ciddi fiziksel ve psikolojik morbidite meydana getirmeleri yanında önemli bir mortalite nedenidir. Ayrıca bu tür yaralanmalar, tedavi süreçleri ve bıraktığı sekeller nedeniyle önemli mali yükler de getirmektedir. Bu çalışmada amaç, yanık mortalitesini etkileyen faktörleri belirlemektir.

GEREÇ VE YÖNTEM: Yanık merkezimize Eylül 2008–Aralık 2016 yılları arasında yanık nedeni ile başvuran hastaların kayıtları incelendi. Hastaların mortaliteleri değerlendirilirken yaş, cinsiyet, yanık yüzey alanı yüzdesi, sevk durumu, yanma yeri, yanık derecesi, hastaneye başvuru için geçen süre, yanma etyolojisi, kan ve kan ürünleri alıp almaması, tam kan sayımı, rutin biyokimya, kuagülasyon parametreleri, C-reaktif protein (CRP), sedimentasyon hızı, nötrofil lenfosit oranı (NLR) ve trombosit-lenfosit oranı (PLR) gibi bazı laboratuvar değerleri incelendi.

BULGULAR: Toplam 133 hasta çalışmaya dahil edildi. Hastanın yaşı (p=0.001), yanık derecesi (p<0.001), yanık yüzey alanı (p<0.001), hastaneye başvuru süresi (p<0.001), yanma etiyolojisi (p<0.001), eritrosit süspansiyonu, Taze Donmuş Plazma ve albümin transfüzyonu verilmesi (p<0.001), MPV (p<0.001), NLR (p<0.001) ve PLR (p<0.001) değerlerinin yanık hastalarında mortalite ile ilişkili olduğu tespit edildi.

TARTIŞMA: Bu çalışmada, hastanın yaşı, yanık derecesi, yanık yüzey alanı, hastaneye başvuru süresi, yanma etiyolojisi, eritrosit, TDP ve albümin transfüzyonu, MPV, NLR ve PLR değerlerinin yanık hastalarında mortalite ile ilişkili olduğu tespit edildi. Yaptığımız bu çalışma ile yanık hastaları değerlendirilirken mortalite ile ilişkili tespit edilen bu parametreler göz önünde bulundurularak hastaların mortalitesini azaltacak tedavi rehberlerinin oluşturulması sağlanabilir.

Anahtar sözcükler: Nötrofil lenfosit oranı; ortalama trombosit hacmi; trombosit-lenfosit oranı; yanık.

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