Comparison of ABSI and Full-Thickness Burns Indexes in the Prediction of Hospital Mortality in Burn Patients

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Abstract- The aim of this study was to evaluate the abbreviated burn severity index (ABSI) score and the percentage of full-thickness burn in the prediction of hospital mortality in burn patients admitted to Sina Hospital in Tabriz. A total of 250 burn patients admitted to burn, and ICU wards during December 2016-Sep 2018 entered the present cross-sectional descriptive study. The collected data included age, gender, burn percentage, anatomical location of the burn, cause of the burn, severity of the burn, mucosal or inhalation injury, underlying disease, length of stay (day), and the hospital outcome of the patient. There was a significant difference between the two genders in terms of the cause of burns (P<0.0001). The most common cause of burn-in women and men was hot liquids and fire, respectively. 40% TBSA with 92% sensitivity and 94% specificity and 20% full-thickness burns with 98% sensitivity and 88% specificity was obtained in predicting mortality of patients. ABSI score of 9 with 85% sensitivity and 95% specificity was obtained in predicting mortality in patients. By increasing one unit in the ABSI score, the odds ratio increases by 17.5 times in terms of mortality probability. The present study showed a significant difference between the two genders in terms of the cause of the burn, and it is evidently affected by the culture and lifestyle of our country. On the other hand, an investigation of the cause of death in patients with ABSI>9 and taking appropriate measures to reduce their mortality is recommended. Also, it is recommended to use more simple criteria such as burn percentage or full-thickness burns to predict mortality rate in case of burning injury patients.

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Keywords: Burns; Mortality; Outcome

Introduction

Burns and associated injuries are one of the most common causes of mortality and morbidity in the world (1-3), and in Iran are also considered as one of the most important causes of mortality and morbidity (4,5). In the first phase, the long-term outcome of burns depends on the extent of the burn and the age of the patient (6). Although extensive burns can lead to death, new treatments have significantly reduced burn-related death, especially in children and adolescents (7-9).

Available systems for determining prognosis in burn patients include Abbreviated Burn Severity Index (ABSI), Belgian Outcome in Burn Injury (BOBI), the Ryan model, Baux and FLAMES, and Roi Index (8,10-14). Today, we can estimate the risk level of burn patients using ABSI. This index is simple and is derived from logistic regression. By increasing the numerical value of this score, the mortality rate increases. Survival rates at the following scores were estimated as: 2-3 (very low)≥ 99%, 4-5 (moderate)=98%, 6-7 (moderately severe)=80-90%, 8-9 (serious)=50-70%, 10-11 (severe)=20-40% so that the survival rate calculated in score 12 and above is less than 10% (11,13-15).

Horbord *et al*., showed that the percentage of burned body surface and age were mostly associated with poor prognosis in patients (16). Lionelli *et al*., also showed that the percentage of full-thickness burns is mostly associated with mortality (17). Salehi *et al*., concluded that the ABSI was the best index for predicting mortality

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among burn patients (12). The role of age and percentage of burns and their impact on patient mortality is mentioned in other studies (18-20).

Considering the impact of the geographic area on the severity and type of burns, as well as the survival rate of patients on the one hand, and the lack of comprehensive study in this regard in the country, and since care, treatment and necessity of comprehensive studies on burn patients has been emphasized as a very important healthcare priority, Therefore, the main objective of the present study was to better and more accurately determine the risk of mortality in burn patients by using two ABSI and full-thickness skin burns indexes.

Materials and Methods

Setting

The present study was a descriptive cross-sectional study conducted in a research and training center affiliated to the University of Medical Sciences between Dec 2016-Sep 2018 period.

Study design and participants

Inclusion criteria was all burn patients over the age of 18 years admitted to the burn and ICU wards. Exclusion criteria also were 1. Patients under 18 years, 2. Being discharged with personal consent, 3. Hospitalization in other words, 4. Unwilling to participate in the study. Sample size was calculated according to previous studies (11) and considering α=0.05, and power=80%, 79% sensitivity, 100% specificity for ABSI score to predict of mortality, 10-unit difference with reported sensitivity level and 95% confidence interval and 250 patients were enrolled in the study. Sampling was carried out using convenience method until completion of the sample size.

Ethical consideration

This study was approved by the Ethics Committee of the University of Medical Sciences on 08/10/2016 with the number IR.TBZMED.REC.1395.717.

Data gathering

Burn patients were evaluated upon the admission to the emergency room and if required to be admitted to the burn center, the patient was enrolled in the study and according to the current guideline (1). Then, the variables required for the study including age, gender, burn percentage, anatomical zones of burn, cause of burn, severity of burn, mucosal or inhalation injury, and underlying disease were recorded after obtaining the consent of the patient or his/her family member, and the patient was admitted and followed up until discharge. Length of stay (day) and hospital outcome of patient were collected.

Based on the collected data, the ABSI and FTSA indexes were calculated and recorded in the checklist. The ABSI score calculation method includes gender (male=0, female=1), age=1 score for every 20 years, mucosal injury=1 score, full-thickness burns=1 score, and 1 score per 10% burn (11). The full-thickness burns included the total percentage of third and fourth-grade burns in patients.

Statistical analysis

Data were entered into SPSS 17.0. The Kolmogorov-Smirnov test was used to determine the normal distribution of data. To describe quantitative and qualitative data, mean±standard deviation, and frequency (percentage) were used. Median (first and third quartiles) was used to describe the quantitative data with non-normal distribution. The *chi*-square test was used to compare qualitative data and Independent Sample's T-test to compare quantitative data with the normal distribution. U Mann Whitney test was used to compare the quantitative data with non-normal distribution. To determine the predictive value of ABSI and FTSA indices in the admission outcome of patients, the ROC curve was used. The area under the curve (AUC), sensitivity, and specificity of the variables were then calculated. In all cases, $P<0.05$ was considered as the significance level.

Results

A total of 250 patients admitted to burn and ICU wards with a mean age of 38.49±15.09 (18-93-year-old) were enrolled in the present study. Of the subjects, 146 (58.4%) were male, and 104 (41.6%) were female. The upper limb was the most common site of burn-in patients with a frequency of 203 patients (81.2%). The fire was the most common cause of burns with a frequency of 162 patients (64.8%), and grade 3 burns were also the most common burn grade with an incidence of 205 patients (82%). Of the total patients, 57 (22.8%) patients suffered from inhalation injury, and 74 patients (29.6%) were admitted to the ICU. A total of 53 patients died during the admission period (21.2%). Table 1 shows the demographic features of patients.

Table 2 shows the comparison of the causes and severity of burns in the two groups of males and females. As shown in table 2, the prevalence of burns with hot fluids is higher among females, and burns with flames are more prevalent in males, which was statistically

significant (P<0.0001); however, there was no significant difference between the two genders in terms of the burn severity (P=0.691).

Table 3 shows the comparison of age, percentage of burn, total thickness burns, duration of hospitalization in hospital and ICU in patients who died and survived. This table shows a significant difference between the two groups of patients in terms of burn percentage, full-thickness burns, duration of hospital admission, duration of admission in ICU, Baux index, and ABSI score (P<0.0001).

Table 1. Demographic features of patients

Variables	First Quartile	Median	Third Quartile
Age (year)	27	36	49.25
Burn size (percent)	8	13	33
Full-thickness burn size (percent)	4.75	9	25
Admission duration (day)	5	9	15
ICU Admission duration (day)	3.75	6	11.25
Baux index	42	58.5	80
ABSI	5	6	8

Table 2. Comparison of burn injury causes and depth between males and females

Variables/Gender		Male (146)	Female (104)	*P*
Burn injury causes	• **Hot liquids**	22 (15.1%)	50 (48.1%)	<0.001
	• **Acid/alkali**	8 (5.5%)	1 (1%)	
	• **Hot metals**	2 (1.4%)	0 (0%)	
	• **Electrical injury**	5 (3.4%)	0 (0%)	
	Fire	109 (74.7%)	53 (51%)	
Burn injury depth	• **Partial thickness (second degree)**	16 (11%)	14 (13.5%)	0.691
	• **Full thickness (third degree)**	120 (82.3%)	85 (81.7%)	
	Forth degree	10 (6.8%)	5 (4.8%)	

Table 3. Comparison of the age and physical exam findings between patients with and without mortality

Variables	With mortality (53)	Without mortality (197)	*P*
Age (year) • **Median (IQR 25-75%)**	36 (25-45.5)	37 (27.5-50.5)	0.807
Burn size (percent) • **Median (IQR 25-75%)**	55 (42-80)	10 (7-18)	<0.001
Full-thickness burn size (percent) • **Median (IQR 25-75%)**	50 (40-75)	5 (3-10)	<0.001
Inhalation Injury • **Yes**	44 (83%)	13 (6.6%)	<0.001
• **No**	9 (17%)	184 (93.4%)	
Admission duration (day) • **Median (IQR 25-75%)**	6 (3-10)	10 (6-17)	<0.001
ICU Admission duration (day) • **Median (IQR 25-75%)**	5 (3-9)	10 (5-16)	0.009
Baux index • **Median (IQR 25-75%)**	98 (81-110)	49 (40-65)	<0.001
ABSI score • **Median (IQR 25-75%)**	11 (9-13)	5 (5-6)	<0.001

Table 4 shows the comparison of survival rates based on the ABSI score classification with the results of the previous study (15). As can be observed, the survival rate is almost equal to the previous cases reported, or even higher in cases of scores below 10, but the survival rate in our study is lower than that the rate reported in the previous study in the case of scores >10 (15).

The ROC curve was used in order to determine the percentage of burn, the percentage of full-thickness burns, ABSI, and the Baux index to predict the mortality of patients (Figure 1). The results of this Figure are presented in Table 4. As can be observed from Fig. 1 and Table 5, all indexes have a high value for predicting mortality in patients considering AUC and can be used to

predict the mortality of burn patients upon admission. Figure 2 shows the value of burn percentage, percentage of full-thickness burns, ABSI, and Baux index of patients in determining the need for ICU admission. The results of this figure are presented in Table 5. As shown in Fig. 2 and Table 4, the percentage of burn and ABSI, according to the AUC, are of high value for predicting the need for ICU admission.

Logistic regression was used to investigate the effect of burn percentage, percentage of full-thickness burns, ABSI, and Baux in predicting mortality and the need for ICU admission in burn patients. The odds ratio of each of the variables is shown in Table 6. Investigation of variations in odds per unit variation in each of the indexes showed that the odds ratio of mortality was 5.17 times and the odds ratio of the ICU admission increased 3.33 times by keeping other variables constant with a one-unit increase in the ABSI score and keeping other variables constant, the odds ratio of mortality rate and ICU admission increased 1.29 times and 1.21 times, respectively by increasing the percentage of full-thickness burns by one percent.

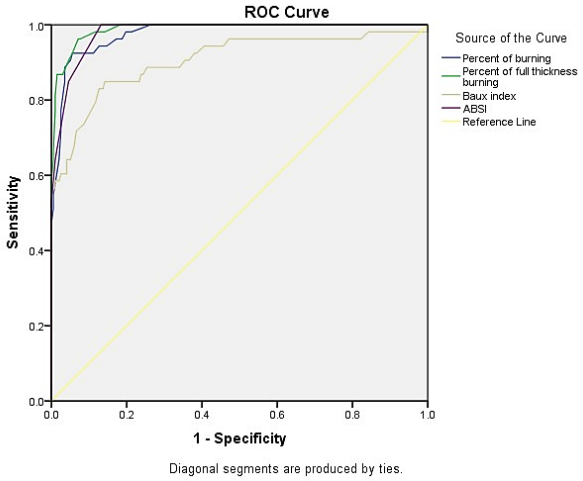

Figure 1. Value of burn percentage, full-thickness burns, ABSI, and Baux in predicting mortality of patients

Table 4. Comparison of the survival rate of patients based on ABSI score between our study and study of Tahir SM

ABSI	Treat to life	Probability of survival in Tahir SM. Study (%)	Probability of survival in our study (%)
2-3	**Very low**	≥99	100
4-5	**Moderate**	98	100
6-7	**Moderately severe**	80-90	100
8-9	**Serious**	50-70	55.8
10-11	**Severe**	20-40	13.3
≥12	**Maximum**	≤10	0

Table 5. Predictive value of burn size, full-thickness burn size, ABSI and Baux index in patients' mortality and ICU admission

	Variable	AUC (95% CI)	Cut off point	Sensitivity	Specificity	PPV	NPV
Mortality	**Burn size**	0.98 (0.96-0.99)	33.5	0.92	0.94	0.94	0.92
	Full thickness burn size	0.99 (0.98-0.99)	19.5	0.98	0.88	0.89	0.88
	Baux index	0.90 (0.85-0.96)	75.5	0.85	0.86	0.85	0.85
	ABSI	0.98 (0.97-0.99)	8.5	0.85	0.95	0.94	0.86
ICU admission	**Burn size**	0.96 (0.94-0.99)	19.5	0.93	0.88	0.88	0.93
	Full thickness burn size	0.92 (0.87-0.97)	14.5	0.90	0.88	0.88	0.90
	Baux index	0.87 (0.82-0.92)	64.5	0.82	0.80	0.80	0.82
	ABSI	0.95 (0.92-0.98)	6.5	0.93	0.83	0.84	0.93

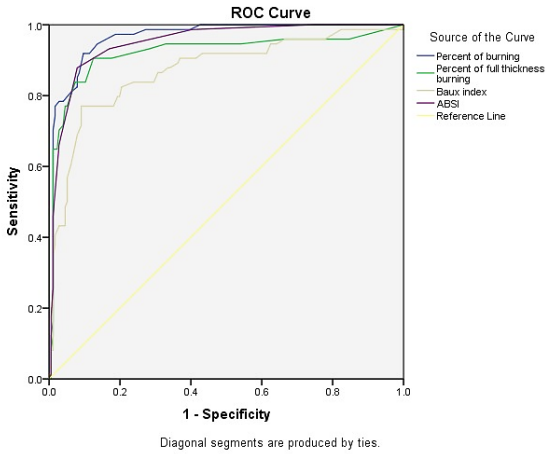

Figure 2. The value of burn percentage, full-thickness burns, ABSI, and Baux in determining the need for ICU admission

Table 6. Effect of burn size, full-thickness burn size, ABSI and Baux index in patients' mortality and ICU admission

	Variable	Coefficient (β)	Odds ratio	*P*
Mortality	**Burn size**	-0.15	0.86	0.117
	Full thickness burn size	0.25	1.29	0.014*
	Baux index	0.02	0.98	0.527
	ABSI	1.64	5.17	0.009*
ICU admission	**Burn size**	0.19	1.21	<0.001*
	Full thickness burn size	-0.15	0.86	0.002*
	Baux index	-0.04	0.96	0.11
	ABSI	1.2	3.33	0.001*

***significant**

Discussion

The burn is a complication caused by direct contact or exposure to thermal, chemical, electrical, or radiation sources (21) and requires care in specialized wards (22). Long-term hospitalization risk factors include high TBSA, high ABSI score, respiratory injury, fire-related injury, and comorbidities (20).

Despite a large number of prognostic models for burn patients, different results have been reported for them (12). These differences may be due to differences in the demographic variables of the population under study or patient care standards (6,12,23-25). It's important to use epidemiological and patterns of burning injuries to introduce the best prevention method (26).

In this study, three mortality prediction models were evaluated for 250 hospitalized burn patients, 53 of whom died. The most common cause of burns in the female and male genders was burning with hot liquids and fire, respectively. There was no significant relationship between mortality rate and age; however, there was a significant relationship between variables such as percentage of burn, percentage of full-thickness burns, and inhalation injury and all indexes can be evaluated in the early stages of patient admission and thus the present study also confirmed the importance of these variables upon the admission.

Horbord *et al*., carried out a study aiming to evaluate the predictive value of ABSI in the incidence of comorbidities and the mortality rate of burn patients. The percentage of the total body surface area (%TBSA) affected by burn and age had the highest association with poor prognosis in patients and the least association was related to respiratory burn and full-thickness burn (16). In a study on factors affecting the mortality rate in adult burns, Lionley *et al*., (2000) showed that the odds ratio of mortality increases by 200% in the case of a one-unit increase in ABSI score (17). With regard to burns, Kalinen *et al*., also carried out a study on the causes of mortality in burn patients and found that 40% of deaths occurred due to multiple-organ failure (19).

In the current study, logistic regression and odds ratio showed that a one-unit increase in ABSI score led to a 5.17 times increase in the odds ratio of mortality is and 3.33 times increase in the odds ratio of ICU admission. By increasing the percentage of full-thickness burns by one percent, the odds ratio of mortality and ICU admission increases by 1.29 and 1.21 times, respectively.

These results indicate the higher value of the ABSI score than the other items. Almost all scores had high and acceptable AUC for prediction of mortality and the need for ICU admission. Compared to the results of the Tahir SM *et al*., study (13) in terms of survival probability, results of the present study also showed that increasing the score above nine significantly reduces survival, and no survival rate even exists for patients in the current study in cases of scores above 12.

The limitations of the current study include the lack of recording of vital signs, underlying diseases, complications during hospitalization, and long-term follow-up of patients after discharge.

As stated, the prediction of burn-induced mortality can be helpful in finding suitable solutions to reduce mortality and to resuscitate patients. The results of the study showed that the indexes of burn percentage, full-thickness burns, and ABSI can be used to predict mortality rate of burn patients. Comparison of the indexes showed that the ABSI index had more value in terms of odds ratio in mortality.

Considering the difference in the survival rate reported in the current study with previous studies, investigation of the cause of death in patients with ABSI> 9 and taking appropriate measures to reduce their mortality are recommended. According to the results of the study, it is recommended to use more simple criteria such as burn percentage or full thickness burns to predict mortality rate in case of mass burns so that more effect and intervention can be done and subsequent outcome of patients become better. It is also recommended to carry out future studies as multicenter taking into account other factors such as BMI, underlying diseases, and etc.

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