Original Article

Better among the two for Burn Mortality Prediction in Developing Nations: Revised Baux or Modified Abbreviated Burn Severity Index?

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Abstract

Background: Burns is one of the leading causes of mortality in developing countries like India. Most of the major burns requiring hospital care are not triaged adequately for the use of medical resources. An efficient mortality predicting scale would not only help in better care to those who will benefit the most but also make it easy to explain to patient's attendants. Among the various tools, revised Baux (rBaux) and modified Abbreviated Burn Severity Index (ABSI) are two most commonly used scales in developed nations. We proposed this study to analyze the reliability of these two scoring scales in our burn population. **Aim:** This study aimed to retrospectively study the two scoring systems and analyze them for their reliability in predicting mortality compared to actual observed mortality in each case. **Materials and Methods:** This study was conducted on all burn patients admitted to the intensive care unit of our hospital. Data on their demographic profile, total burn surface area, thickness of burns, inhalational injury, and other comorbidities were collected from files. rBaux and modified ABSI (mABSI) were calculated. The end result in the form of survival or nonsurvival was also recorded. Appropriate statistical analysis using Mann–Whitney *U*-test, Chi-square test, and receiver operator characteristic curve was done to look for a better scoring system out of the two. **Results:** A total of 504 patients were included in the study, out of which 337 were survivors. Female gender was not a risk factor for mortality in our study. The median rBaux score in the survivor group was 100 (80–110) and in nonsurvivor group was 111 (103–123). The median mABSI score in the survivor group was 8 (7–9) and in nonsurvivor group was 10 (9–11). The area under the receiver operating characteristic curve shows mABSI having better specificity for predicting mortality. rBAUX, though more sensitive, overestimates mortality than actual observed mortality. **Conclusion:** mABSI predicts mortality better than rBaux. A multicentric prospective study is recommended for mABSI to be used as a standard mortality predictor in burns in India.

Keywords: *Burn mortality prediction, burn survival, modified Abbreviated Burn Severity Index, revised Baux*

Introduction

In developing nations like India, utilizing available medical resources to get the best outcome, can sometimes be very difficult. Being able to predict the survival prognosis in Burns can help in the optimal use of health-care facilities and resources. Furthermore, such prognosis predictor scores can be useful in providing proper insight to family and friends. The literature mentions many scoring systems such as Baux[1] and Cape town burn score.[2] Abbreviated Burn Severity Index (ABSI),[3] FLAMES,[4] none of which is proved superior to others. Baux was developed in 1960[1] and revised in 2010.[5] In revised baux (rBaux) , the parameter of inhalational Injury was added. Modified ABSI (mABSI) was developed in 2020[6] and was a modification of ABSI which was introduced in 1982 [Table 1].[3]

This present study was designed to retrospectively analyze rBaux and m ABSI and compare their reliability in predicting nonsurvival in actual observed mortality.

Materials and Methods

This retrospective study was conducted on patients admitted from January 2016 to December 2022 in the burns intensive care unit of the Plastic Surgery Department at a Tertiary Care Hospital in Punjab, India. The study was executed after approval from the Institute Ethical Committee (IEC no. 2023-815, Ref No. DMCH/R&D/2023/154). File records of all burn patients with age more than 18 years

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were studied. IEC did not allow the inclusion of children in the study.

Burn patients with associated trauma or life-threatening conditions, isolated inhalational injury (no skin involvement), admission after >24 h of burn (delayed referral), and those who left treatment against medical advice, were excluded from the study.

Ours' is a tertiary care and referral center where all burnt patients, on arrival in emergency are inserted with two large bore IV cannulas or central line and started with Ringer lactate as per Parkland formula. Airway and breathing are managed and wounds are dressed with silver sulfadiazine after calculation of percentage using the rule of nine. These patients are shifted to intensive care units and managed as per standard protocols for burn care.

Data on total burn surface area, thickness of burn, presence of inhalational injury, and comorbidities along with demography profile were retrospectively collected from file records.

Both the scores were thereby calculated from this obtained data.

rBaux score was calculated as age (in years) + burned area (%) + (17 × I).

where I = 1 if the patient has an inhalational injury and I = 0 if there is no inhalational injury.

mABSI score was calculated as per a point scale chart of variables – Age and total burnt surface area, presence of inhalational injury, and full-thickness burns [Table 1]. This score ranged from 2 to 13.

The observed outcome in terms of mortality in these patients was also recorded from files and patients were divided into two groups: survived and nonsurvived.

Data thus collected were described in terms of range; mean ± standard deviation, median for the continuous variables, frequencies (number of cases), and relative frequencies (percentages) for categorical variables in both the groups. Kolmogorov–Smirnov test was used to check the normality of data. Comparison of quantitative variables between the study groups was done using Mann–Whitney *U*-test for nonparametric data. For comparing categorical data, Chi-square test of independence (Pearson Chi-square test or simply the Chi-square) was performed. The receiver operating characteristic (ROC) curve, to plot test sensitivity as the y-coordinate versus its 1-specificity or false-positive rate as the x-coordinate. A criterion was chosen maximizing the Youden index (sensitivity-[1-specificity]) (If sensitivity and specificity are diagnostically equally important or desirable, the Youden index [J] is indicative for performance (the larger the better) at a given cutoff). Area under the curve (AUC) was measured to provide an aggregate measure of performance across all possible classification thresholds. A $P < 0.05$ was considered statistically significant. Stata version 12.1 (Stata Corp LP, College Station, TX, USA) was used for the statistical analysis.

Table 1: Modified Abbreviated Burn Severity Index

Variable	Patient characteristics	Score
Age	0–40	1
	41–70	2
	71–80	3
	81–90	4
	91–100	5
Inhalational injury		1
Full thickness burn		1
TBSA (%)	1–10	1
	11–20	2
	21–30	3
	31–40	4
	41–50	5
	51–60	6
	61–70	7
	71–80	8
	81–90	9
	91–100	10
Total burn score	**Threat to life**	**Probability of survival (%)**
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
12–13	Maximum	<10

TBSA: Total burnt surface area; mABSI: Modified Abbreviated Burn Severity Index

Results

A total number of 504 patients were included in this study, out of which 337 were survivors and rest nonsurvivors. The median (interquartile range [IQR]) age of population was 36.5 (29–50) years and males outnumbered females. Table 2 shows the patients' distribution as per their demographic profile, type of burns, and outcome. The most common cause of burns was noted to be thermal in nature, followed by electrical and chemical. In the nonsurvivor group, inhalational burns were present in 79 patients (i.e., 47.5% of total inhalational burn patients). The median (IQR) total burn surface area was 50 (40–65) in survivor group and was 65 (50–75) in nonsurvivor group [$z = -4.975$; $P = 0.001$; Table 2].

Full-thickness burn was present in 460 patients out of which 322 survived and 138 could not. The percentage of presence of comorbidities was 68.9% in the survivor group and 31.1% in nonsurvivor [nonsignificant; $P = 0.752$, Table 2].

The rBaux of all patients ranged from a minimum of 47 to a maximum of 150 with a median (IQR) of

103 (86.75–115). The mABSI ranged from a minimum of 2 to a maximum of 12 with median (IQR) of 8.[7-10] The median (IQR) rBaux score in the survivor group was 100 (80–110) and in nonsurvivor group was 111 (103–123) with a significant $P = 0.001$. The median IQR mABSI score in the survivor group was 8 (7–9) and in nonsurvivor group was 10 (9–11) ($P = 0.001$) [Table 3]. On calculating the area under the ROC curve and at maximum Youden index, the cutoff value of rBaux is 98.5 with a sensitivity of 98.0% and specificity 48.3% and that of mABSI is 9.5 with a sensitivity of 65.7 a specificity of 86.2% [Table 4]. Thus, the AUC comes out to be significantly higher for mABSI showing its better specificity [$P = 0.001$; Table 5]. However, the overall accuracy shown in Table 5 of mABSI is higher than the rBAUX score and the 95% confidence interval also does not overlap so this means mABSI is better than the rBAUX score.

Discussion

Mortality-predicting scores in burns are a useful method to allot burn care resources adequately for better outcomes especially when these are limited. It helps to decrease the economic burden on patients as well as hospitals. Baux scale made in 1960[1] and ABSI score made in 1982,[3] are not applicable now, in light of the tremendous improvement in burn care management in the form of bronchoscopy, ventilation, better intensive care, early excision, and grafting[7]. Many scales such as the Boston scale,[8] Belgium outcome in Burn injury scale,[9] SOFA score,[10] and FLAMES score[4] have been used to predict mortality in burn patients, but no single score is proven to be superior to others. Baux was revised by Osler *et al.*[5] by introducing inhalational injury in the calculation.

Researchers such as Lip *et al.*[11] and Halgas *et al.*[12] have demonstrated that rBaux is easy and accurate to calculate burn mortality. Its predictive value is much higher than Baux. They also could demonstrate that rBaux was better than ABSI. Bartels *et al.*[6] designed the mABSI score in 2020 by excluding the female gender from ABSI and giving value to sequential increase in age and total body surface area (TBSA). Furthermore, any presence of full-thickness burn or inhalational injury carried 1 point each in this score, irrespective of grade of severity [Table 1]. Before 2020, the literature shows the validity of all these mortality predictors in developed nations. mABSI was the first-ever score to be made in a developing nation.[6] The present study was conducted to compare the reliability and predictive value

Table 2: Demographic profiles of patients

Parameter	Total (n=504), n (%)	Survivors (n=337), n (%)	Nonsurvivors (n=167), n (%)	P
Age (years)**	36.5 (29–50)	33 (25–45)	42 (32–55)	0.001#
Gender: Male (%)	386 (76.5)	275 (81.7)	109 (65.7)	0.001*
Female (%)	118 (23.5)	62 (18.2)	58 (34.3)	
Type of burns				
Thermal burns	440 (87.4)	280 (63.6)	160 (36.4)	0.001*
Electric burns	35 (7)	29 (85.7)	7 (14.3)	
Chemical burns	28 (5.6)	28 (100)	0	
Inhalational injury	122 (24.2)	43 (12.8)	79 (47.5)	0.001*
TBSA (%)**	55 (40–70)	50 (40–65)	65 (50–75)	0.001*
Full thickness burns	460 (91.4)	322 (95.6)	138 (82.8)	0.001*
Comorbidities	97 (19.2)	69 (68.9)	28 (31.1)	0.752*

*Chi-square test of independence; **Median (IQR); #Mann–Whitney test. IQR: Interquartile range; TBSA: Total burnt surface area

Table 3: Comparison between values revised Baux and Modified Abbreviated Burn Severity Index in survivors and nonsurvivors

	Total		Survivors		Nonsurvivors		Z	P*
	Median	IQR	Median	IQR	Median	IQR		
TBSA (%)	55.00	40–70	50	40–65	65	50–75	−4.975	0.001
Age	36.50	29–50	33	25–45	42	32–55	−3.871	0.001
rBaux	103.00	86.75–115	100	80–110	111	103–123	−7.416	0.001
mABSI	8.00	7–10	8	7–9	10	9–11	−9.334	0.001

*Mann–Whitney test was used. IQR: Interquartile range; rBAUX: Revised Baux; mABSI: Modified Abbreviated Burn Severity Index

Table 4: Youden index

Test result variable(s)	Positive if greater than or equal to[a]	Sensitivity	1-specificity	Specificity	Youden index
rBaux	98.50	0.980	0.517	0.483	0.463
mABSI	9.50	0.657	0.138	0.862	0.519

[a]Cutoff value. rBAUX: Revised Baux; mABSI: Modified Abbreviated Burn Severity Index

Table 5: Area under the receiver operating characteristic curve

Statistic	rBaux		mABSI	
	Value	95% CI	Value	95% CI
Area (SE)	0.763 (0.027)	0.71–0.82	0.827 (0.024)	0.78–0.88
rBaux - mABSI		Z=−2.388; P=0.017		
Sensitivity (%)	97.98	92.89–99.75	65.66	55.44–74.91
Specificity (%)	48.28	41.23–55.38	86.21	80.69–90.63
Positive likelihood ratio	1.89	1.65–2.17	4.76	3.28–6.91
Negative likelihood ratio	0.04	0.01–0.17	0.4	0.30–0.53
Disease prevalence (%)	32.78	27.51–38.39	32.78	27.51–38.39
Positive predictive value (%)	48.02	44.64–51.42	69.89	61.54–77.11
Negative predictive value (%)	98.00	92.50–99.49	83.73	79.58–87.17
Accuracy (%)	64.57	58.89–69.96	79.47	74.47–83.88

CI: Confidence interval; rBAUX: Revised Baux; mABSI: Modified Abbreviated Burn Severity Index; SE: Standard error

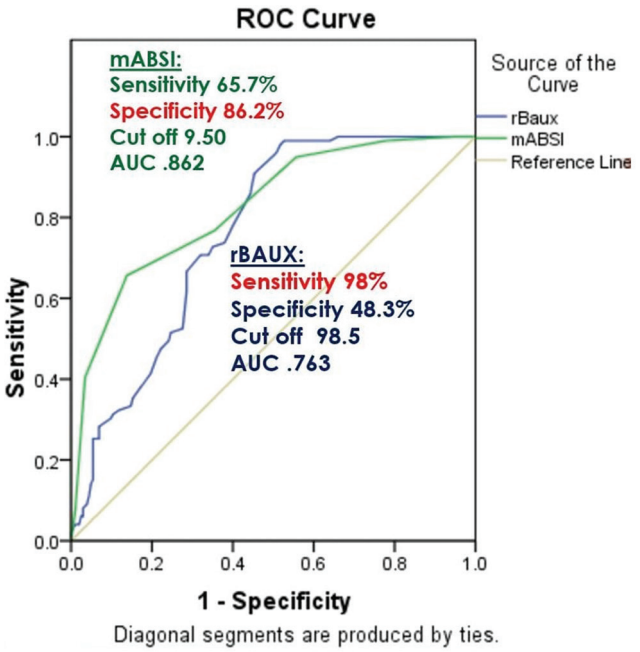

Figure 1: Receiver operating characteristic curve to predict mortality. ROC: Receiver operating characteristic; AUC: Area under curve; rBAUX: Revised Baux; mABSI: Modified abbreviated burn severity index

of rBaux with mABSI in a tertiary care referral center of a developing nation.

In our results of 504 patients, female gender was not found as a risk factor for mortality. In India, Women suffer three times more burn injuries than men,[13] but in our study, the majority of patients were male (76.5%), complying with the results of many other studies.[14,15] Occupational etiology is the proposed reason for the same. We analyzed that there is increase in mortality of 30% in patients with inhalational injury despite of the best respiratory management such as bronchoscopy and early ventilation. Ryan *et al.*[8] observed similar results. TBSA and age were found to be statistically associated with high mortality. The presence of comorbidities did not affect burn mortality ($P > 0.001$) in the present retrospective study.

Both rBaux and mABSI have age, TBSA, and inhalational as common variables with the difference that rBaux gives more importance to age while mABSI's modified point scale is more precise. Smith *et al.*,[16] Brusselaers *et al.*,[17] and Bartel *et al.*[6] studied individual variables for burn prediction. They concluded that in mABSI, point scale unit increase in variables increases the predictability for mortality.

For all the included patients getting the same care, the median value of rBaux is 111 among nonsurvivors. Dokter *et al.*[18] their study also showed a median value of rBaux to be 111 (103–123) in nonsurvivors. In our study, the median value of mABSI among nonsurvivors is 10 (9–11). Bartel *et al.*[6] depicted that mABSI score more than 9 have only 66% chances of mortality. In their scoring system, they showed 91.4% chances of mortality if score was >12. In the present study, nonsurvival was found to be more when the patient has an inhalational injury. Bartel *et al.*[6] also indicated that age and TBSA have a larger effect on survival when the patient also has an inhalational injury.

Furthermore, it has been seen that mABSI predicts mortality more accurately in age groups <20 years and >60 years, whereas similar accuracy is not demonstrated by rBaux. Forster *et al.*[19] suggests that rBAUX prediction for mortality increases many folds for these age groups and thus it overestimates it than actual observed mortality.

On studying the area under ROC curve [Figure 1], we could clearly demonstrate that rBaux has better sensitivity, but it overestimates mortality than actual observed death, whereas mABSI has better specificity and positive predictive value that predicts the mortality more accurately. On applying the paired sample area difference under ROC, the P value was significant between mABSI and rBaux [Table 5]. mABSI predicts mortality more reliably than rBAUX, as the area under ROC is more with mABSI.

The drawbacks of our study are that it is a retrospective study from a single center which has highly specialized burn care facilities. The applicability of our results in larger developing nation's population with scarce availability of burn care is a challenge that remains to be taken.

A multicentric and prospective study may be an answer to overcome this drawback.

Conclusion

mABSI predicts mortality more accurately than rBaux. Its utility in developing nations as a tool for triage and patient counseling can be a big boon for adequate allotment of limited medical resources.

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Conflicts of interest

There are no conflicts of interest.

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