Original Article

# Mortality and Survival Analysis of Burn Patients Admitted in a Critical Care Burn Unit, Saudi Arabia

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## Abstract

**Background:** Burn injury is associated with a high mortality risk. Recent epidemiological data on burn injury and mortality rate from Saudi Arabia is lacking.

**Objective:** This study aimed to analyze the survival rates and its predictability using the Baux score in patients with burn injury at a tertiary care hospital in Saudi Arabia.

**Materials and Methods:** This retrospective study included all patients admitted to the burn unit at King Fahd Hospital of the University, Al Khobar, between March 2014 and February 2020. Patients' burn characteristics and calculated revised Baux scores were collected. The age, burn wound size, type of burn, burn extension, and Baux score of the survivors and non-survivors were compared.

**Results:** A total number of 102 patients were included, and their mean age was 24.2 years (range: 9 months to 78 years). The mean affected total body surface area was 26.4%. Ninety patients (88%) suffered from flame/scald burn. The mortality rate was 17.6% (18 patients); all these patients had flame burns. No patient with a revised Baux score ≥110 survived ($n = 14$; 77% of the total deaths), while there was no mortality at score <36. Inhalational injuries were reported in 18 patients, of which 13 (72%) died. Patients with patent airway and no inhalation injury were 19 times more likely to survive than those with a compromised airway ($P < 0.001$). In terms of the depth of burn, partial thickness increased the likeliness of survival by 10 times compared with full thickness ($P < 0.003$).

**Conclusion:** Inhalational injury and burn size were the most prognostic factors of burn injury in this study. As all cases of mortality were from flame burns, regulation on flammable materials and safety measures should be promoted to the public.

**Keywords:** Burn unit; burns; Baux score; inhalational injury; mortality rate; Saudi Arabia

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## INTRODUCTION

Burn injuries are one of the most devastating traumas affecting the integumentary and renal, cardiovascular, respiratory, neurological, and musculoskeletal systems. According to the World Health Organization (WHO), around 200,000 people die each year worldwide because of burn- and thermal-based injuries. The mortality rate of burns is greater in low-and middle-income countries than in high-income countries.[1] In 2004, a study showed that the incidence of burns in North America was 19,000 compared to 243,000 in South East

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Asia.[2] Yet, in the United States, it is estimated that there is a burn-related death every 2 hours and a burn-related injury every 23 minutes.[3] According to the American Burn Association, there are 1.1 million burn-related injuries annually that need medical care, of which about 50,000 require hospitalization, 20,000 involve at least 25% of the total body surface area (TBSA), and about 4500 die.[1] In addition to the mortality rates, burns cause substantial morbidity that can be cureless in both physical and psychological domains.[4]

In Saudi Arabia, a systematic review found that burns tend to affect males more than females (58.6% vs. 41.4%, respectively).[5] The same study also revealed that 25% of the sample were <2 years old, and 50% were aged ≥16 years, indicating that most burn injuries occur in the pediatric population. The overall weighted percentage of mortality from multiple burns in Saudi Arabia has been reported as 5.9%, while in a burn unit from the Jizan region, it has been reported to be 16.7%.[4]

The Baux score (TBSA burn + age), originally developed in the 1960s, can provide an estimate of the likeliness of mortality in patients with burn injuries. The initial scoring lacked accuracy; however, Osler *et al.* modified the score to include inhalation injury to the calculation, as it was alone found to add 17 years to the patient's age or 17% of the TBSA.[6] Since this revision, several studies have investigated the prognostic power of the score and found it to demonstrate a higher level of accuracy compared with other prediction models. For example, Pantet *et al.* examined different scores models on 492 patients admitted to a burn ICU and found that the revised Baux score had the best mortality prediction compared with other scores (AUC: 0.919).[7] In addition, multiple studies have demonstrated the simple and reliable use of the revised Baux score in developing countries.[8,9]

With the advances in medical care and increasing awareness and safety measures, burn injuries, in general, have decreased worldwide. However, epidemiological data on burn injury and mortality rate in Saudi Arabia is lacking. Such data can represent a reference for guideline implantation and future quality control in burn centers. Accordingly, the current study was conducted to provide updated data regarding the survival rates in patients with burn injury at a major tertiary care hospital in the Eastern Province of Saudi Arabia using the revised Baux score.

## METHODS

### Study design, setting, and patients

This is a retrospective cohort analysis of patients admitted to the burn unit at King Fahd Hospital of the University (KFHU), Al Khobar, Saudi Arabia, between March 2014 and February 2020. KFHU is a major burn center in the Eastern Province, and along with two other burn centers in the region, it serves >6 million people.

### Inclusion and exclusion criteria

All patients admitted to the burn unit during the study period were included. These included patients admitted through the emergency department or emergency referral. Patients discharged against medical advice and those with minimal burn injuries managed in dressing clinics or with old burn scars were excluded from the study.

### Variables, definitions, and outcomes

Data regarding patients' age, length of hospital stay, and revised Baux scores were collected from the electronic medical records at KFHU. In addition, data were also collected for factors that contribute to mortality such as degree of burn, total affected surface area, inhalation injury, comorbidity, and endotracheal intubation. Inhalational injury was defined as any involvement to the orofacial area with a history of burn in closed space; when the case was equivocal, and laryngoscope was done to evaluate for a sign of injury. The primary outcome assessed in the study was the rate of mortality and its predictors. The secondary outcome was assessing the effectiveness of the Baux score in predicting mortality.

### Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS IBM, version 20). All variables were expressed as frequencies and percentages. The predisposing factors of interest were analyzed using a simple logistic regression. $P$ value < 0.05 was considered statistically significant.

## RESULTS

From March 2014 to February 2020, 106 patients were admitted to the burn unit at KFHU. Of these, four were excluded from the study because they left the hospital against medical advice, and thus no data were available regarding their recovery. The mean age of the final included sample was 24.2 years (range: 9 months to 78 years). Those aged 15–44 years (60; 58.8%, accounted for the highest proportion of patients followed by those aged 0–14 years (29; 28.4%) [Figure 1].

The mean TBSA of the total patients was 26.4%, and it ranged from 5% to 95% [Figure 2]. Flame injury was the most common cause of burn, affecting 88 patients (86.3%). Full-thickness burn was noted in 27 patients (26.5%), with a mean TBSA of 54.5%. A total

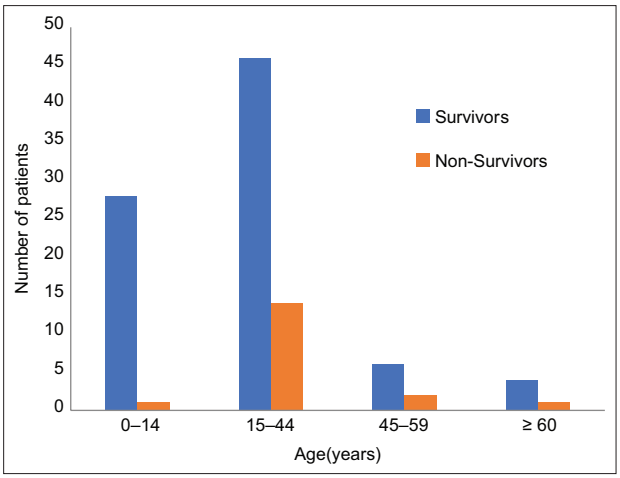


**Figure 1:** Distribution of mortality in relation to age

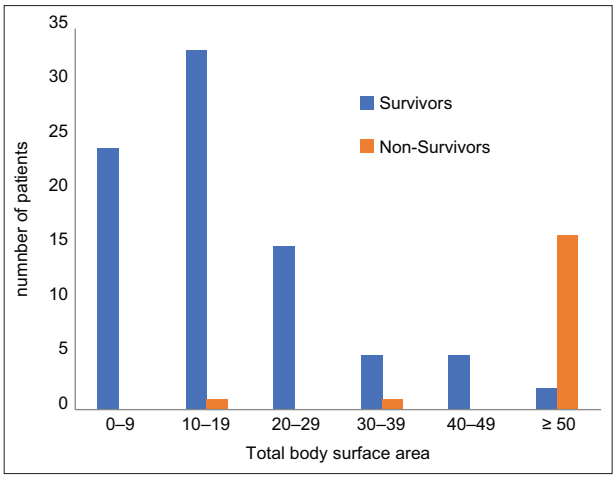


**Figure 2:** Mortality in relation to the affected total body surface area

of 18 (17.6%) patients died: all these patients had flame burns, 13 (72.2%) had evidence of inhalational injury, and 15 (83.3%) had full-thickness burns. Table 1 demonstrates the distribution of mortality in relation to age, TBSA percentage, and burn type.

Patients with patent airway and no inhalation injury were found to be 19 times more likely to survive than those with a compromised airway ($P < 0.001$). The depth of burn was also found to play a major role in survival: partial thickness increased the likeliness of survival by 10 times compared with full thickness ($P < 0.003$).

Table 2 demonstrates the percentage of death in relation to the revised Baux score. A directly proportional relationship was noted: as the score increased, the mortality rate also increased. Mortality rate was 100% for the modified Baux scores ≥110 [Figure 3]. In contrast, there was no mortality at scores <36.

## DISCUSSION

The overall mortality rate in the current study was 17.6%, which is lower than those reported in Cameroon (23.4%[10]) and Iran (21.4%[11]) but higher than those reported from other developing countries such as Malaysia (12.2%) and Iraq (13.3%).[12,13] In fact, the rate is significantly higher than those reported in large-scale studies from developing countries such as Turkey (0.9%)[14] and China (0.7%).[15]

These discrepancies in mortality rates could be owing to various factors, such as some countries having achieved a high level of safety measures in case of dealing with inflammable materials either in work, home, or public places. Heterogeneity in the inclusion criteria could also be another factor; for example, in the study from Turkey, the mean TBSA was 7.5% (±8.2%); however, the mortality rates substantially rose from the 0.9% to 57.9% among those with TBSA >40. In addition, mortality rates in burns also depend on various presentation and clinical factors, such as in-hospital complications and subsequent operative procedures.[16] Accordingly, the lack of a burn ICU and dedicated burn intensivists and specialists at our hospital, in addition to logistics problems, may have contributed to the relatively higher mortality rates in this study.

Osler *et al.* described a useful equation for predicting the mortality rate in burn injury (revised Baux score): age added to the percentage of TBSA plus a factor 17, if the patients have inhalational injury.[6] An interesting modification to this calculation was discussed in a study considering a pediatric population, which showed that the inhalational injury had a more negative effect on managing pediatric patients with burn trauma than adults. Therefore, 18 points rather than 17 should be added if the patient's age is <15 years.[17] Baux score has shown to have a high reliability in predicting the outcome of thermal injury. Using a multivariate analysis, Baux score was the most significant predictive tool in comparison to other mortality indices.[18]

Our study showed that age, TBSA, and inhalational injury are predictive for mortality and morbidities. In terms of age, this is mostly because the weak immune response and poor physiological compensation in elderly patients increases the likelihood of death secondary to infections or organ collapse during the resuscitation phase.[19,20] Furthermore, respiratory and inhalational lesions have previously been shown to be an independent factor in predicting mortality.[21,22]

Thermal burn, including scald, flame, and contact burns, were the most common type of burn injury in this study, and all mortality cases had flame burns. Such burns have

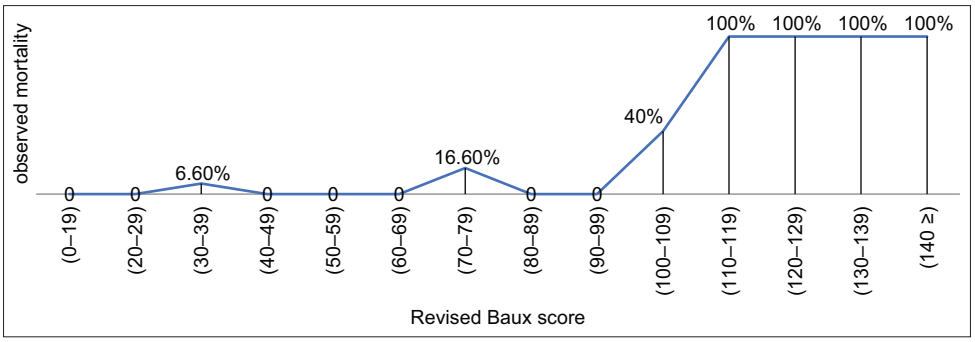


**Figure 3:** Mortality rate according to the revised Baux score

been reported to be disproportionately higher in pediatric populations and women such as housewives.[23] Flame burn particularly has been linked with the highest mortality rates and longest in-patient hospital stay periods.[24,25] The mean percentage of TBSA in this study was about 26%, which is similar to that reported from Europe in a systematic review (11%–24%), although there was a decreasing trend in the recent decades.[26]

## Limitations

The study has the inherent limitations of a retrospective study. In addition, this study reports data from a single center, and thus has limited representativeness. In addition, the microbiological profile was not analyzed because the wound swabs or tissue cultures were not collected for all patients. Nonetheless, the findings of this study provide crucial insight regarding the current medical care for burn injuries and provide an opportunity for improvement through the use of an objective measure, such as the revised Baux score.

## CONCLUSION

The mortality rate was 17.6%, with all patients having flame burns. No patient with a revised Baux score ≥110 survived. Inhalational injury and burn size were found to be the most prognostic factors of burn injury in this study. As the most common cause of mortality in burns was flame burns, regulation on flammable materials and safety measures should be promoted to the public.

## Ethical considerations

This study was approved by the Institutional Review Board (IRB) of Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia (Ref. no.: IRB-2020-01-251), on September 7, 2020. The study adhered to the principles of Declaration of Helsinki, 2013.

## Data availability statement

The datasets generated during and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

**Table 1: Mortality rates according to age, total body surface area, and burn type**

| Parameters | *n* (%) | Survivors, *n* (%) | Nonsurvivors, *n* (%) |
|---|---|---|---|
| Age (years) | | | |
| 0-14 | 29 (28.4) | 28 (27.5) | 1 (1) |
| 15-44 | 60 (58.8) | 46 (45.1) | 14 (13.7) |
| 45-59 | 8 (7.8) | 6 (5.9) | 2 (2) |
| ≥60 | 5 (4.9) | 4 (3.9) | 1 (1) |
| Total body surface area | | | |
| 0-9 | 24 (23.5) | 24 (23.5) | 0 |
| 10-19 | 34 (33.3) | 33 (32.4) | 1 (1) |
| 20-29 | 16 (15.7) | 16 (15.7) | 0 |
| 30-39 | 6 (5.9) | 5 (4.9) | 1 (1) |
| 40-49 | 4 (3.9) | 4 (3.9) | 0 |
| ≥50 | 18 (17.6) | 2 (2) | 16 (15.7) |
| Etiology | | | |
| Flame | 88 (86.3) | 70 (68.6) | 18 (17.6) |
| Chemical | 11 (10.8) | 11 (10.8) | 0 |
| Electrical | 2 (2) | 2 (2) | 0 |
| Mechanical | 1 (1) | 1 (1) | 0 |
| Burn degree | | | |
| Full thickness | 27 (26.5) | 12 (11.8) | 15 (14.7) |
| Partial thickness | 75 (73.5) | 72 (70.6) | 3 (2.9) |

**Table 2: Mortality rates according to the revised Baux score**

| Revised Baux Score | Mortality, *n* (%) |
|---|---|
| 0-19 | 0 |
| 20-29 | 0 |
| 30-39 | 1 (6.6) |
| 40-49 | 0 |
| 50-59 | 0 |
| 60-69 | 0 |
| 70-79 | 1 (16.6) |
| 80-89 | 0 |
| 90-99 | 0 |
| 100-109 | 2 (40) |
| 110-119 | 4 (100) |
| 120-129 | 3 (100) |
| 130-139 | 5 (100) |
| ≥140 | 2 (100) |

## Peer review

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## Conflicts of interest

There are no conflicts of interest.

## REFERENCES


1. Smolle C, Cambiaso-Daniel J, Forbes AA, Wurzer P, Hundeshagen G, Branski LK, *et al*. Recent trends in burn epidemiology worldwide: A systematic review. Burns 2017;43:249-57.
2. Othman N, Kendrick D. Epidemiology of burn injuries in the East mediterranean region: A systematic review. BMC Public Health 2010;10:83.
3. National Fire Protection Association (NFPA). Home Fire Victims by Age and Gender 2021. December. Available from: https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem [Last Accessed March 01, 2022].
4. World Health Organization. Burns 2018, March 6. Available from: https://www.who.int/news-room/fact-sheets/detail/burns [Last Accessed March 01, 2022].
5. Almarghoub MA, Alotaibi AS, Alyamani A, Alfaqeeh FA, Almehaid FF, Al-Qattan MM, *et al*. The epidemiology of burn injuries in Saudi Arabia: A systematic review. J Burn Care Res 2020;41:1122-7.
6. Osler T, Glance LG, Hosmer DW. Simplified estimates of the probability of death after burn injuries: Extending and updating the baux score. J Trauma 2010;68:690-7.
7. Pantet O, Faouzi M, Brusselaers N, Vernay A, Berger MM. Comparison of mortality prediction models and validation of SAPS II in critically ill burns patients. Ann Burns Fire Disasters 2016;29:123-9.
8. Lam NN, Hung NT, Duc NM. Prognosis value of revised Baux score among burn patients in developing country. Int J Burns Trauma 2021;11:197-201.
9. Lip HT, Idris MA, Imran FH, Azmah TN, Huei TJ, Thomas M. Predictors of mortality and validation of burn mortality prognostic scores in a Malaysian burns intensive care unit. BMC Emerg Med 2019;19:66.
10. Forbinake NA, Ohandza CS, Fai KN, Agbor VN, Asonglefac BK, Aroke D, *et al*. Mortality analysis of burns in a developing country: A CAMEROONIAN experience. BMC Public Health 2020;20:1269.
11. Khadem-Rezaiyan M, Aghajani H, Ahmadabadi A, Zanganeh M, Tavousi SH, Sedaghat A, *et al*. Epidemiology of severe burns in North-East of Iran: How is the burn size different in a developing country from developed ones? Burns Open 2020;4:4-9.
12. Lami FH, Al Naser RK. Epidemiological characteristics of burn injuries in Iraq: A burn hospital-based study. Burns 2019;45:479-83.
13. Tan Chor Lip H, Tan JH, Thomas M, Imran FH, Azmah Tuan Mat TN. Survival analysis and mortality predictors of hospitalized severe burn victims in a Malaysian burns intensive care unit. Burns Trauma 2019;7:3.
14. Albayrak Y, Temiz A, Albayrak A, Peksöz R, Albayrak F, Tanrıkulu Y. A retrospective analysis of 2713 hospitalized burn patients in a burns center in Turkey. Ulus Travma Acil Cerrahi Derg 2018;24:25-30.
15. Zheng Y, Lin G, Zhan R, Qian W, Yan T, Sun L, *et al*. Epidemiological analysis of 9,779 burn patients in China: An eight-year retrospective study at a major burn center in Southwest China. Exp Ther Med 2019;17:2847-54.
16. Zavlin D, Chegireddy V, Boukovalas S, Nia AM, Branski LK, Friedman JD, *et al*. Multi-institutional analysis of independent predictors for burn mortality in the United States. Burns Trauma 2018;6:24.
17. Karimi H, Motevalian SA, Rabbani A, Motabar AR, Vasigh M, Sabzeparvar M, *et al*. Prediction of mortality in pediatric burn injuries: R-baux score to be applied in children (pediatrics-baux score). Iran J Pediatr 2013;23:165-70.
18. Bajwa MS, Sohail M, Ali H, Nazir U, Bashir MM. Predicting thermal injury patient outcomes in a tertiary-care burn center, Pakistan. J Surg Res 2022;279:575-85.
19. Mann EA, Baun MM, Meininger JC, Wade CE. Comparison of mortality associated with sepsis in the burn, trauma, and general intensive care unit patient: A systematic review of the literature. Shock 2012;37:4-16.
20. Pham TN, Kramer CB, Klein MB. Risk factors for the development of pneumonia in older adults with burn injury. J Burn Care Res 2010;31:105-10.
21. Shirani KZ, Pruitt BA Jr., Mason AD Jr. The influence of inhalation injury and pneumonia on burn mortality. Ann Surg 1987;205:82-7.
22. Brusselaers N, Monstrey SJ, Vandijck DM, Blot SI. Prediction of morbidity and mortality on admission to a burn unit. Plast Reconstr Surg 2007;120:360-1.
23. Jamil H, Khalil F, Saeed M. Etiology and outcome of burn victims in a tertiary care facility. J Sur (PIMS) 2002;25:1.
24. Tripathee S, Basnet SJ. Epidemiology of burn injuries in Nepal: A systemic review. Burns Trauma 2017;5:10.
25. Abu Ibaid AH, Hebron CA, Qaysse HA, Coyne MJ, Potokar TS, Shalltoot FA, *et al*. Epidemiology, aetiology and knowledge, attitudes, and practices relating to burn injuries in palestine: A community-level research. Int Wound J 2022;19:1210-20.
26. Brusselaers N, Monstrey S, Vogelaers D, Hoste E, Blot S. Severe burn injury in Europe: A systematic review of the incidence, etiology, morbidity, and mortality. Crit Care 2010;14:R188.