Cohort Study

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Role of the revised Baux score in predicting mortality among burn patients in an African low-income country: a multicentre prospective cohort

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Introduction: Burn injury is a major cause of mortality. Majority of the burns occur in low and middle-income countries like Uganda. Uganda has a limited number of burn centres and medical resources, making a predictor of mortality necessary in allocation of the limited resources. Although the revised Baux (r-Baux) score has been validated and used in many high income countries, no study has assessed its role in an African low-income country; the reason this study was done.

Methods: This was a prospective multicentre cohort that enroled 101 burn patients with moderate and severe burns admitted in three tertiary hospitals in western Uganda. Follow-up was done until discharge, documenting mortality. A receiver operator characteristic curve was used to determine the role of r-Baux score in predicting mortality.

Results: This study included 101 patients, with a mean age of 21.3 (SD = 16.8) years. The majority of the participants were male (69.3%). The area under the curved for r-Baux score's prediction of mortality was 0.943 ($P < 0.001$). The most appropriate cut-off was determined to be 74.5. At this cut-off, r-Baux score predicted mortality with a sensitivity of 100% and specificity of 83.5%. After controlling for burn severity using Poisson regression, a patient with r-Baux score greater than 74.5 was 1.358 times more likely to die (adjusted risk ratio = 1.358, 95% CI = 1.195–1.543, $P < 0.001$).

Conclusion: The r-Baux score was found to be excellent at predicting mortality among burn patients in Uganda and therefore should be done for all patients at admission, in order to predict mortality and do proper planning.

Keywords: burns, predictor, r-Baux score, uganda

Introduction

Burn injury is a major global public health concern[1]. According to the WHO, over 95% of fire-related burns occur in low-income and middle-income countries like Uganda[2]. In low-income and middle-income nations, burn injuries are still a substantial source of mortality and disability[1]. In 2018 the world health organisation named the African region as the one bearing nearly two-thirds of the total burden of burn injury[2]. Many low-income countries have limited burn units with limited resources for management of burn patients, which reasons may contribute to the mortality. The use of a prognosis score may help the health facilities in African low-income countries to evaluate and optimally use resources in burn care, improving outcomes and reducing the burden[3].

HIGHLIGHTS

- Majority of the burns occur in low and middle-income countries like Uganda.
- A predictor of mortality is necessary in allocation of the limited resources.
- The r-Baux score is excellent at predicting mortality among burn patients even in resource limited settings.

The Baux score which predicts mortality based on the sum of the patient's age and burn extent was introduced and widely used since 1961[3]. The Baux score was revised in 2010 by Osler because the advances in management of burns had significantly improved burn wound care, limiting the original Baux score in terms of predicting mortality[3]. The revised Baux (r-Baux) score is determined by the formula: r-Baux score = (TBSA + age + [17 × R]), where R = 1 if patient has inhalation injury and R = 0 if not[4].

A number of studies have compared r-Baux score to other burn scores and found it to be either as good or superior[5–7]. The scores to which r-Baux has been compared include the abbreviated burn severity index (ABSI), Belgian outcome in burn injury (BOBI) score, fatality by longevity score, acute physiology and chronic health evaluation II (APACHE II) score, the Ryan score plus the measured extent of burn and sex score (FLAMES)[5–7].

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The r-Baux score has also been evaluated in many countries including Indonesia[8], Ireland[7], Malaysia[5], Germany[9], Switzerland[10], Kuwait[6] , Iran[4] among others and found to be acceptable at predicting mortality in burn patients. Despite the many studies done assessing the role of r-Baux score in predicting mortality, such studies in an African low-income country are hard to come by, the reason this study was done.

Methods

Study design, setting and population

This was a prospective cohort multicenter study carried out at three tertiary hospitals in western Uganda. The hospitals do not have burn units and therefore the patients were managed in the general surgical ward. The patients are usually managed by general practitioners or surgery residents under the supervision of general surgeons. All patients admitted with burns during the study period were evaluated for eligibility. This work has been reported in line with the STROCSS 2021 criteria[11].

Eligibility

Inclusion criteria

All patients with moderate or severe burns according to the American burn association (ABA) classification, admitted to the surgical wards of the study centres were included in the study if they consented. For those unable to consent for themselves, the consent was obtained from the next of kin.

Exclusion criteria

Patients were excluded if they presented with burns that had been managed by traditional healers with pus discharge from the wounds. This was done to minimise bias.

Sample size and sampling

The sample size was determined using the modified Daniel formula. Using findings by Albutt *et al.*[12], $\boldsymbol{n} = \frac{(Z_\alpha + Z_\beta)^2 p(1-p)\text{x}D}{e^2}$; $P = 6.4\%$; $\alpha = 5\%$; $\beta = 20\%$ at statistical power of 80%; $e = 5\%$; $D = 2.0, n = 375$. On adjusting to a finite population of 120, and adding 10% to cater for loss of follow-up, the required sample size was 101. Consecutive enrolment was done in which consecutive patients that satisfied the eligibility criteria were enroled

Study variables and data collection procedure

Participants who fulfilled the inclusion criteria were enroled into the study after signing an informed consent form. However, for very ill patients, consent was obtained from their next of kin. Assessment and resuscitation of the patients was done in accordance to the advanced trauma life support (ATLS) protocols. Participants were consecutively recruited by the principle investigator and trained research assistants until the required number of participants was obtained. At admission, the age, percentage surface area burnt and presence of inhalational injury were determined. The r-Baux score was computed for each patient using the formula : r-Baux score = (TBSA + age + [17 × R]), where R = 1 if patient has inhalation injury and R = 0 if not[4]. The severity of burn according to the American burn association (ABA) and social demographic characteristics of the patients were also documented. Participants were followed up to discharge to determine if death occurred or not.

Quality control

The questionnaire was pretested for validity and reliability and necessary adjustments made before starting data collection. The research assistants were trained about the protocol to follow during the research. The principal investigator or his assistant crosschecked the data daily to ensure completeness. An accurate history and physical examination of the patients was done.

Date analysis

Date analysis was done using SPSS version 26. Using the receiver operator characteristic curve, the area under the curve was determined. The most appropriate cut-off for predicting mortality was also determined. Using the cut-off, the sensitivity and specificity of the r-Baux score was determined. Using Poisson regression, the significance of r-Baux score in predicting mortality was determined controlling for severity according to the ABA classification. Variables were considered significant if they had a p value of less or equal to 0.05 at 95% level of confidence.

Ethical considerations

All methods were carried out in accordance with relevant guidelines and regulations. Ethical approval was obtained from an accredited Research and Ethics Committee. Informed consent was obtained from all subjects and their legal guardian(s).

Results

This study included 101 patients, with a mean age of 21.3 (SD = 16.8) years. The majority of the participants were male (69.3%). Using the ABA classification, 67.3% of the participants had moderate burns yet 32.7% had major burns. The mean total body surface area burnt was 37.4 (SD = 16.4). Inhalational injury was seen in 10 (9.9%) of the study participants. The mean r-Baux score was 61.4 (SD = 27.7). Ten of the participants died, representing a mortality of 9.9%.

The area under the curved for r-Baux score at predicting mortality was 0.943 ($P < 0.001$). The most appropriate cut-off was determined to be 74.5. At this cut-off, r-Baux score predicted mortality with a sensitivity of 100% and specificity of 83.5% (Table 1 and Fig. 1). After controlling for burn severity using Poisson regression, a patient with r-Baux score greater than 74.5 was 1.358 times more likely to die (adjusted risk ratio = 1.358,

Table 1

Cross tabulation of the predicted mortality using r-Baux score at a cut-off of 75.5 versus actual mortality

	Actual mortality	
	Survived	Died
Predicted mortality by r-Baux at 74.5 cut-off		
To survive	76	0
To die	15	10

Sensitivity = 100%, Specificity = 83.5%, Area under the curve = 0.943 ($P < 0.001$).
r-Baux, revised Baux.

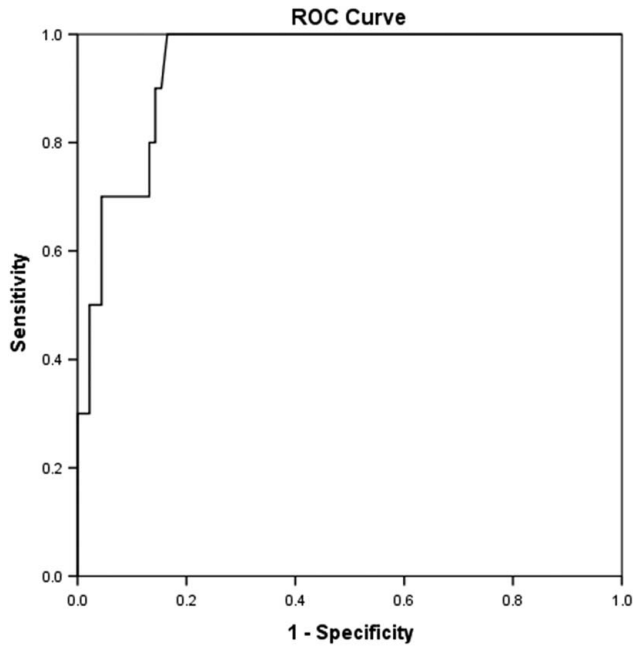

Figure 1. Receiver operator characteristic (ROC) curve for revised Baux score as a predictor of mortality.

95% CI = 1.195–1.543, $P < 0.001$). When sex and age were added to the model in Poisson regression, the r-Baux score at a cut of 74.5 still significantly predicted mortality (adjusted risk ratio = 1.369, 95% CI = 1.204–1.558, $P < 0.001$).

Discussion

This study aimed at assessing the role of the r-Baux score in predicting mortality among burn patients in Uganda. In a study where the majority of the participants had a moderate injury (67.3%), and a mortality of 9.9%, it was observed that the r-Baux score predicted mortality with an AUC of 0.943, sensitivity of 100% and specificity of 83.5%. In this study it was noted that r-Baux score predicted mortality even when injury severity was put into consideration.

In relation to burn severity, our findings are in agreement with Agbenorku[13] in Ghana among patients with burn injury, where it was found that majority of the patients had moderate burns accounting for 52.4%, followed by major burns accounting for 42%. Also in agreement with Kotecha *et al.*[14] in Kenya who evaluated patients with thermal burns presenting to the emergency department and found moderate burns in 35% of the participants, major burns in 30%, with the rest being minor. This kind of distribution can be explained by the fact that major burns are more common in older patients due to the fact that they have a thinner atrophic skin[15], which results in deeper and more severe burns, yet moderate burns are more present in young adults[16]. Since the majority of our study participants were in the age group of 18–55 with a mean age of 21.3, it would make sense that majority of our study participants had moderate burn.

In relation to mortality, the mortality we found was comparable to that reported by Groohi[17] and Setoodehzadeh[18] where the fatality rate for serious burn injuries was reported to range from 1.4 to 34%. The mortality observed in this study was higher than that reported by Tracy[16] who reported an overall in-hospital death rate of 1.7% after doing a two country registry audit in Australia and New Zealand. The mortality we observed was lower than that reported by Setoodehzadeh[18] who reported a mortality of 14% after doing a case control study among 430 patients in Iran, Forbinake[19] who studied 440 individuals in Cameroon over an 8-year period and reported a mortality rate of 23.4 percent (103 patients), and Ludovic *et al.*[20] who reported a mortality rate of 41.2 percent among children with burns in Cameroon. The differences observed in mortality can be attributed to the level of care, as all the studies that reported mortalities above that found in our study were done in low-income countries which are typical of having inadequate care for burn patients due to limited resources. Also differences in severity of burn injuries could have contributed to the differences in the mortalities observed.

In relation to r-Baux score as a predictor of mortality, our findings agree with reports in other countries where r-Baux score was found to be an excellent predictor of mortality. The area under the curve (AUC) reported in our study was equal to that reported by Tan[5] in Malaysia (0.94) and Hassan[6] in Kuwait (0.946). The AUC we obtained was slightly higher than that reported by Obed[9] in Germany (0.9), Woods[7] in Ireland (0.925), Pantet[10] in Switzerland (0.92), Wardhana[8] (0.87) and Herlianita[21] (0.89) in Indonesia. Lam *et al.*[3]. in Vietnam (0.96) reported a higher AUC for r-Baux score. The sensitivity and specificity seen in this study were comparable to that reported by Hassan[6] in Kuwait (96% and 90%, respectively) but higher than that reported in Indonesia by Iustitiati and Nata'atmadjaa[22] (80.82% and 80.00%, respectively).

Study limitations and strengths

This study was done in hospitals that had no burn units. For this reason, the findings are representative of most settings in Uganda, but may not be representative of the facilities with burn units.

Bronchoscopy was not available at the study centres for confirmation of inhalational injury, however, thorough history and physical examination were done to assess for inhalation injury.

Conclusion

The r-Baux score was found to be excellent at predicting mortality among burn patients in a setting with no burn unit. Its ability to predict mortality was independent of burn severity. The r-Baux score should be used for all patients at admission even for patients in resource limited settings with no burn units, in order to predict mortality and do proper planning. Despite the score's results, all burns should be treated actively, using other reserves such as treatment in the intensive care unit or transfer to specialized centres when feasible.

Ethics approval and consent to participate

All methods were carried out in accordance with relevant guidelines and regulations. Ethical approval was obtained from the Research and Ethics Committee of Kampala International University Western Campus REC number KIU-2022-147. Informed consent was obtained from all subjects and their legal guardian(s).

Consent for publication

The patient data were anonymised, no patient identifying characteristics are submitted for publication.

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Author contribution

S.M.B. was the principle investigator, conceived and designed the study, collected data, analysed data and wrote the draft of the manuscript. J.M. participated in data analysis, discussion of results and revised the manuscript. A.A.O., I.E., G.V.Z. and S.F.M. participated in discussion of results and revised the manuscript. A.K. and X.F.O. supervised the work, revised the manuscript and all authors approved the final paper.

Conflicts of interest disclosure

The authors declare that they have no conflict of interest

Research registration unique identifying number (UIN)

1. The study has been retrospectively registered at www.researchregistry.com.

Guarantor

Samuel Mandro Baraka.

Availability of data and materials

The SPSS data file that was analysed has been submitted as a supplementary file.

Provenance and peer review

Not invited.

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