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A Study on Factors Associated with Mortality of Patients Admitted with Burns at the University Teaching Hospitals, Lusaka, Zambia

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***Abstract*: The mortality rate following burn injury is an important outcome parameter. Burns more than 30% are associated with high mortality rate. In Zambia, there is no comprehensive model to predict mortality in hospitalized burn patients. In the surgical practice at UTH, there is high mortality of patients with less than thirty percent burns. The main goal of this study was to determine factors associated with mortality in patients with burns less than 30% treated at UTH. This was an observational prospective cross-sectional study performed during a 12-months period in the Department of Surgery at UTH, Lusaka, Zambia. During the study period, 269 patients who met the criterion of the study were enrolled. Multivariate logistic regression analyses were performed to identify factors associated with mortality. The mean age of the patients was 6.79 years (SD=11.1). Mean percent burned total body surface area (TBSA) was 13.7% (SD=6.9). There was no statistically significant association between age, sex and mortality in my study (p=0.48). The study found no statistically significant association between medical history and mortality (p=0.861). The mortality rate in this study was 13.8%. From the logistic regression, patients with patients with anaemia had a 5-fold likelihood of mortality; those with sepsis 3-fold likelihood of mortality; and those with difficulties in breathing were 12 times more likely to die than those without. The model calibrated well, as the predictions did not significantly differ suggesting a good model fit ($\chi 2=14.544$, p = 0.069).The present study showed that clinical characteristics such as fever, difficulties in breathing, anaemia, no weekly haemoglobin check-ups, sepsis, and pneumonia were found to be factors associated with mortality in patients with burns less than 30% TBSA Early detection of these factors leading to morbidity would reduce mortality in burn patients.**

***Keywords*: Burns, mortality, risk factor, survival, total body surface area burned.**

1. Introduction

Burn injury represents a local tissue response to an energy transfer from a physical (mechanical, thermal, electrical, radiation) or chemical source associated with or without a systemic response [1]. Burns are an important cause of mortality worldwide and burn injury affects approximately 1% of the general population every year [2]. Burns can be classified with respect to the cause, extent and severity of the burn. With regard to the cause, they may be termed as thermal or inhalational. Burns may also be classified by depth or thickness and involve first, second, or third-degree burns. First degree burns involve the epidermis only. Superficial second-degree burns extend to the papillary dermis while deeper second-degree burns include the reticular dermis. All third degree burns by definition involve the entire thickness of the skin (epidermis and dermis). Differently; burns are classified as either superficial, partial- thickness or full thickness burn injury [3].

Death by burn injury in low- and middle-income countries (LMICs) like Zambia is estimated to be eleven times higher than in high-income countries. The World Health Organization (WHO) estimates that 43,000 people die every year from burns in Africa at a rate of 6.1 per 100,000 [4]. Full thickness burns less than 30% have an ABSI score between 1 to 3 indicatives of low threat to life and 99% probability of survival. However, in Zambia, a review of the University Teaching Hospitals (UTH) records shows that the majority of burn mortalities that occur are less than 30%.

The immunosuppressing effects of burns, duration of hospital stay; mechanism of burn injury is associated with increased risk of patient morbidity and mortality. Infection is singly the most common factor for morbidity and mortality following burn injury [5]. While burn wound colonization and infection is an important factor that increases morbidity and mortality [6], the mortality rate varies depending on different factors, like age of patients, gender, burn surface area and body mass index. Body mass index influences infection risk in patients. This risk is even increased with the immunocompromising effects of burns.

Early–delayed split skin graft was found to reduce length of hospital stay and occurrence of infection [7] and will ultimately reduce mortality. Reference [8] identified the leading causes of death from 144 pediatric autopsy reports; The main causes of death over a 20-year period were sepsis (47%), respiratory

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failure (29%), anoxic brain damage (16%), and shock (8%). From 1989 to 1999, sepsis caused 35% of deaths but increased to 54% from 1999 to 2009, with a significant increase in the number due to antibiotic resistant organisms ($P < 0.05$) [8].

Knowledge of these factors will not only reduce mortality but prevent complications, shorten hospital stay, reduce costs and improve the functional outcome of burn patients treated at UTH. Clinicians may use this data in deciding additional treatment to standard guidelines and may also strengthen locally applicable standardized burn management protocols. Moreover, data obtained will contribute to influencing policy makers allocate more resources to improve the outcome of burn patients. In Zambia, there is no comprehensive model to predict mortality in hospitalized burn patients hence; the objectives of this study were to determine prevalence of mortality in patients with less than 30% burns, to correlate demographic characteristics with mortality of burns and to associate clinical characteristics with burn mortality at UTH.

2. Methods

A. Study Design

This was a prospective observational study conducted in the surgical unit at the University Teaching Hospitals, Lusaka, Zambia. Patients were followed prospectively during hospitalization and data collection was made through discharge or death over a period of 12 months from September 2019 to September 2020.

B. Participants

The study population consisted of 269 burn patients consecutively admitted to the Burn Unit. All patients with less than 30% burns injuries irrespective of age and sex were included in the study. All patients who met this inclusion criterion were systematically sampled by taking every second patient admitted to the surgical units based on the assumption that about 550 burn patients are seen each year i.e., 550/269=2.04. Patients were assessed for the cause and nature of the injury, the degree of involvement of the burn area. The mortality of those admitted for treatment was also noted.

Survivors were compared with non-survivors to determine which factors may predict a higher risk of mortality. Patients readmitted for reconstruction or other similar care were not included.

The variables studied to predict mortality during the hospital course included:

1) Independent variables

- Gender: male–female
- Age in years
- Place of residence and household income
- Smoking history
- Type of burn: 1. Superficial partial, 2. Mixed, 3. Deep partial, 4. Full thickness
- Mechanisms of burns: are divided into; flames, heat, flammable liquids; explosions, and other means.
- Burned area: Defined as a body percentage according to the Lund & Bowder chart [9].
- Invasive processes like use of venous lines and urinary catheters.
- Inhalation syndrome: suspected in facial burns, stridor, and/or exposure to smoke.
- Type of infections were defined based in clinical and/or microbiological parameters.
- Type of surgical treatment: debridement and graft requirement.
- Need for blood transfusion.
- Length of hospitalization.

2) Dependent variable

Mortality: mortality was considered infection related if the patient had clinical and/or microbiological evidence of infection at the time of death.

3) Statistical analysis

Statistical analysis was performed using SPSS (SPSS Inc., Chicago, IL, version 25). All values are expressed as mean ± standard error or as percentages. Each variable was tested for differences between survivors and non-survivors by univariate statistical methods with significance accepted at $p < 0.05$ (Chi squared test, Student's t test or Mann-Whitney test where appropriate). All variables significant by univariate analysis were included in the multivariate analysis. A pooled multivariate logistic regression analysis was used to test the hypothesis that the study variables used affected the likelihood of mortality. The dependent variance was death, and the model determined the probability of increased mortality given the independent variables. Stepwise logistic-regression analysis was performed selectively to assess the predictors of mortality. This analysis resulted in a final prediction model.

This study was approved by the University of Zambia Biomedical Research Ethics Committee (REF.153.2019) and the National Health Research Authority in Lusaka, Zambia.

3. Results

A. Participants

Two hundred and sixty-nine patients with <30% burns, admitted to the Burn Unit of the University Teaching Hospitals, Lusaka, Zambia, between September 2019 and September 2020, were included in the study. One hundred and thirty-eight were males and 131 were females. The mean age of the patients was 6.8 (±11.1) years (range 1-72 years) (Figure 1), 246 of the patients came from high density residences with 231 of them from households with a monthly income of < 2000 ZMK. Nearly all (268) of the patients were non-smokers.

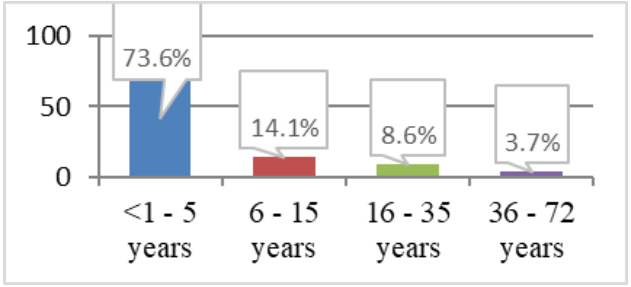

Fig. 1. The distribution of burns in various age groups

Hot liquids accounted for 84.4% of burns, an open flame was the second most common cause in 12.3% of burns; the rates of other causes were much lower (Figure 2). Children under 5 years old were injured mainly by hot liquids, while older children and adults over the age of 16 and older were burnt mainly by an open flame.

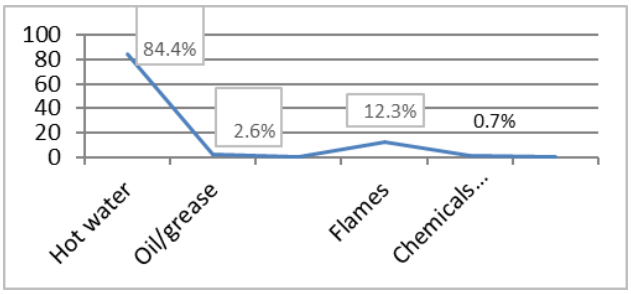

Fig. 2. Causes of burns among study subjects

B. Clinical Characteristics

The mean BMI of patients was 16.9 (±3.19) kg/m2 and the mean total body surface area burned was 13.7% (±6.9%) while superficial partial burns accounted for 80.7% of the degree of burns. Only one patient had inhalation burns. Fever was present in 168 of patients. Only 28 patients had difficulties in breathing while 23 patients were coughing and fluid resuscitation was performed on 263 patients. Anaemia was found in 98 patients and weekly haemoglobin check was done on 139 patients. Mean haemoglobin on admission was 11.3g/dl (±2.7). Circulatory failure was present in only two patients. One hundred and seven patients developed septicaemia and 15 patients developed pneumonia. The mean length of hospital stay was 14.6 days (±15.4). Thirty-seven patients (13.8%) died.

C. Evolution

Comparisons between surviving and non-surviving patients are given in Table 1. Patients with a mean TBSA burnt of 19.4% (±6.3) or higher were significantly associated with non-survival compared to patients with a mean TBSA burnt of 12.8% (±6.6) ($P < 0.001$). With regard to inhalation injury, the only non-surviving patient had inhalation injury ($p = 0.012$). With regard to presence of fever, non-survivors experienced fever significantly more than survivors ($p < 0.001$). Further, non-surviving patients difficulties in breathing more than survivors ($p < 0.001$) and a larger proportion of non-survivors were coughing more than survivors ($p < 0.001$). Also, non-survivors were significantly more anaemic than survivors ($p = 0.002$) and significantly, larger proportion of patients were protected from mortality by weekly haemoglobin checks than non-survivors ($p = 0.03$). Presence of circulatory shock was significantly associated with non-survival among patients ($p < 0.018$). In regard to infectious complications, 15 patients developed pneumonia and 12 of them patients died from pneumonia ($p < 0.001$). Of 107 patients with sepsis, non-survivors were significantly more septic than survivors ($p < 0.001$).

When these variables were combined using the logistic regression, the significant independent variables that remained were fever (OR: 9.84, 95% CI: 1.08 – 89.99), difficulties in breathing (OR: 7.27, 95% CI: 1.53 – 34.67), anaemia (OR: 6.05, 95% CI: 1.96 – 18.68), weekly Hb check-up (OR: 8.26, 95% CI: 2.47 – 27.67), sepsis (OR: 9.72, 95% CI: 1.86 – 50.76), and pneumonia (OR: 36.64, 95% CI: 9.68 – 138.65). This model predicts that the probability of death increases with fever, difficulties in breathing, anaemia, sepsis, and failure to monitor weekly Haemoglobin levels (Table 2).

Table 1
Comparison between surviving and non-surviving patients

	Non-survivors	**Survivors**	**p-value**
Age (years, M, SD)*	5.1±10.2	7.1±11.2	0.314
Female Gender (%)	20 (15.3)	111 (84.7)	0.483
TBSA burnt % (M, SD)	19.4±6.3	12.8±6.6	**<0.001**
Inhalation injury (%)	1 (100)	0	**0.012**
Fever (% patient)	35 (20.8)	133 (79.2)	**<0.001**
Dysnoea(% patient)	21 (75)	7 (25)	**<0.001**
Coughing (% patient)	14 (60.9)	9 (39.1)	**<0.001**
Anaemia (% patient)	22 (22.4)	76 (77.6)	**0.002**
Weekly Haemoglobin (% patient)	13 (9.4)	126 (90.6)	**0.034**
Sepsis (% patient)	29 (27.1)	78 (72.9)	**<0.001**
Shock (% patient)	2 (100)	0	**0.018**
Pneumonia (% patient)	12 (80)	3 (20)	**<0.001**
Length of hospital stay (M, SD)	10.4±11.3	15.3±15.8	0.068

*M, SD denotes Mean, standard deviation

Table 2
Factors associated with mortality based on logistic regression analysis

	Odds Ratio (95% CI) *	**p-value**
Total Burn Surface Area Burnt >19%	0.38 (0.12 – 1.21)	0.102
Fever (% patient)	9.84 (1.08 – 89.99)	**0.043**
Dysnoea(% patient)	7.27 (1.53 – 34.67)	**0.013**
Coughing (% patient)	2.48 (0.35 – 17.69)	0.365
Anaemia (% patient)	6.05 (1.96 – 18.68)	**0.002**
weekly Haemoglobin (% patient)	8.26 (2.47 – 27.67)	**0.001**
Sepsis (% patient)	9.72 (1.86 – 50.76)	**0.007**
Pneumonia (% patient)	36.64 (9.68 – 138.65)	**<0.001**

*CI denotes confidence interval

4. Discussion

This present study included 269 patients with less than 30% affected TBSA. And the prevalence of mortality due to burns was 13.8%. The prevalence of mortality was higher in this study compared to a study done in Nigeria [10] and Pakistan [11]. The slightly higher rate of mortality in hospitalized burn patients in our study may be explained in part the delayed in presentation to the health facility or inefficient management of burn patients in general hospitals and delayed referral of those severely injured patients who need more specialized care.

The study found that the mean age of patients in the mortality group was 5.2 years; however, there was no significant association between age and mortality, which is consistent with a study conducted in the Netherlands[12].This contradicts what other studies found[13], [14].

The study found that the mean affected TBSA was 19.43% in the mortality group and 12.8% in the surviving group. This showed a significant association between affected TBSA and mortality. This is similar to a consensus found in literature that increasing TBSA is associated with high mortality rates [14].

However, in multivariate analysis, TBSA failed to independently predict mortality. Despite the fact that degree and total body surface area burn have strong correlation with the mortality, a study by Ishtiaq [11] showed no mortality was recorded in less than 30% of total body surface area burned.

The study showed that the relationship between mortality and infection was significant. This finding was consistent with other studies [15], [5]. In this study, 29 patients died because of sepsis. In the study, difficulties in breathing showed significant association with mortality and it maintained its predictive effect in multivariate analysis. This concurs with Olaitan & Jiburum [10] who observed that acute respiratory syndrome was among the causes of death in patients with burns. Also, it can be concluded that despite having a less proportion (5.6%) of patients with pneumonia, majority of them (12 patients out of 15) died, showing a significant association between one having the disease and mortality in agreement with what has been reported before in literature [16].

Early surgical excision and temporary or permanent closure with grafts are important measures for prevention of infections and related deaths [17]. However, in the study, surgical intervention did not have significant influence on the mortality. This could be due to fewer to no surgical intervention employed in burn patients at UTH. Anaemia among patients had significant association with mortality. Out of 98 patients who had anaemia 22 died suggesting a significant relationship with mortality. Anaemia in these patients was detected on admission and during their ward follow-ups. Multivariate analysis showed this to be a predictor of mortality with patients with anaemia being five times more like to die than those without.

Our study had several limitations. The data we used in this study was collected as part of routine patient care and record keeping; as such we had a lot of missing data which was excluded in the analyses. This has an effect on the standard errors of our estimates, thereby affecting precision. We categorized our variables in such a way that would minimize data sparsity; hence we did not opt for other advanced ways of dealing with missing data such as multiple imputations Instead of dropping the missing records.

Although the sample size in our study was not large enough to draw definitive conclusions for some of the studied variables, the findings are important due to the paucity of systematic studies about this topic. Further research is necessary to support the data. Knowledge on risk factors for mortality can be helpful in developing strategies to prevent this effect which as well as adequate referrals to specialized facilities will ensure better management of these at-risk patients.

5. Conclusion

Early detection of factors leading to illness and death and taking necessary action and, in addition, early detection of potential complications after long-term follow-up in the ward, and appropriate actions can reduce both the incidence and mortality rates in patients with burns. From another point of view, the best way to reduce death associated with burns is to prevent burn injuries. In conclusion, the burn patients with these risk factors (infection [fever, sepsis, and pneumonia], difficulties in breathing, and anaemia) should be categorized as high risk for mortality at the time of admission. These patients also need special attention and care during hospitalization.

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