JBUR 5232 No. of Pages 7
ARTICLE IN PRESS
BURNS XXX (2017) XXX–XXX

Available online at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/burns

The effect of pre-existing malnutrition on pediatric burn mortality in a sub-Saharan African burn unit

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ARTICLE INFO

Article history:
Accepted 25 March 2017
Available online xxx

Keywords:
Burn mortality
Pediatric burn mortality
Malnutrition
Pediatric burns
Sub-Saharan Africa

ABSTRACT

Introduction: Nutritional status predicts burn outcomes in the developed world, but its effect on burn mortality in the developing world has not been widely studied. In sub Saharan Africa, burn is primarily a disease of children, and the majority of children in sub-Saharan Africa are malnourished. We therefore sought to determine the prevalence and effect of malnutrition on burn mortality at our institution.

Methods: This is a retrospective review of children aged 0–5, with anthropomorphic measurements available, who were admitted to our burn unit from July 2011 to May 2016. Age-adjusted Z scores were calculated for height, weight, weight for height, and mid-upper arm circumference (MUAC). Following bivariate analysis, we used logistic regression to construct a fully adjusted model of predictors of mortality.

Results: Of the 1357 admitted patients, 839 (61.2%) were aged 0–5. Of those, 512 (62.9%) had one or more anthropomorphic measurements available, and were included in the analysis. 54% were male, and the median age was 28 months. The median TBSA was 15%, with a majority of burns caused by scalds (77%). Mortality was 16%. Average Z-score for any of the indicators of malnutrition was -1.45 ± 1.66. TBSA (OR: 1.08, 95% CI: 1.06, 1.11), decreasing Z-score (OR: 1.19, 95% CI: 1.00, 1.41), and flame burn (OR: 2.51, 95% CI: 1.40, 4.49) were associated with an increase in mortality.

Conclusion: Preexisting malnutrition in burn patients in sub-Saharan Africa increases odds of mortality after controlling for significant covariates. Survival of burn patients in this region will not reach that of the developed world until a strategy of aggressive nutritional support is implemented in this population.

1. Introduction

Burn disproportionately affects the developing world, with over 90% of global burn mortality occurring in low- and middle-income countries (LMICs). In sub-Saharan Africa (SSA), burn is predominantly a pediatric disease, with 60% of overall mortality affecting the 0–15 age group [1]. The sub Saharan Africa region is responsible for 64 and 78% of the

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http://dx.doi.org/10.1016/j.burns.2017.03.022

Please cite this article in press as: J. Grudziak, et al., The effect of pre-existing malnutrition on pediatric burn mortality in a sub-Saharan African burn unit, Burns (2017), http://dx.doi.org/10.1016/j.burns.2017.03.022

world's burn deaths in children aged 0–4 and 5–14, respectively [2–5].

The hypermetabolic effect of burns is well documented [6–9]. Patients with severe burns can lose up to 25% of their lean body mass after an acute burn [8,10], and losses of lean body mass can occur despite nutritional intervention. Children are especially vulnerable, given their smaller reserve and increased caloric and protein requirements in relation to body size [11,12]. Optimization of nutritional status following burn is an essential intervention in high income country (HIC) burn units, where the prevalence of malnutrition in the general population is low. Interestingly, in LMICs, where baseline prevalence of malnutrition is much higher, there is a paucity of data regarding the effect of pre-existing malnutrition on burn mortality [13].

The World Health Organization (WHO) defines moderate pediatric malnutrition as a weight-for-age between −2 and −3 Z-scores below the median of the WHO growth standards; moderate wasting and stunting are described as weight-for-height and height-for-age falling between −2 and −3 Z-scores, respectively [14]. The Academy of Nutrition and Dietetics (AND) and the American Society for Parenteral and Enteral Nutrition (ASPEN) have also established a set of indicators for the diagnosis of under-nutrition in patients aged 1 month to 18 years. For patients with only one anthropomorphic measurement available, mild and moderate malnutrition are defined by Z-scores falling between −1 and −1.9; and −2 and −2.9, respectively, for weight-for-height-for-age; body-mass-index-for-age; or mid-upper-arm-circumference (MUAC)-for-age. For patients who are followed over time, additional indicators include decline in weight gain velocity (<2 years of age), weight loss (2–20 years of age), deceleration in weight-for-height Z-score, and inadequate nutrient intake [15,16].

The prevalence of malnutrition in children living in SSA is high [12,14,17]. Malawi, a landlocked country in southeastern Africa, is one of the poorest nations in the region, with a 2015 per capita gross domestic product (GDP) of $350. Its human development index (HDI) puts it 173rd out of 186 countries in the world. Life expectancy is 62 years at birth [18]. As of 2015, 20.7% of the population could not meet the minimum daily energy consumption, and in 2010, 72.2% of the population lived below $1.25/day. The prevalence of underweight (weight for age Z-score <−2) in children 0–5 living in Malawi worsened between 2009 and 2014, from 12.1 to 16.7% [17].

Because of the confluence of the high malnutrition prevalence and burn mortality in LMICs, we hypothesize that the presence of pre-existing malnutrition in children age ≤5 years presenting with burn is associated with increased mortality in a sub-Saharan Africa burn unit.

2. Methods

We performed a retrospective review of prospectively collected data entered into the Kamuzu Central Hospital (KCH) burn unit database. KCH, located in Malawi's capital of Lilongwe, is a public, 600-bed, tertiary care hospital with a catchment population of approximately 5 million people. The KCH burn unit was commissioned in 2011 in partnership with the North Carolina Jaycee Burn Center. It has 31 beds, 8 nurses, 2 nursing assistants, and 1–2 clinical officers, who oversee clinical management and perform surgeries with attending surgeon oversight [5].

Children aged 0–5 years old who were admitted to the burn unit between 1 July 2011 and 1 May 2016 were included in this study. The primary aim was to determine the relationship between pre-existing malnutrition, defined using the WHO and AND/ASPEN indicators, and burn mortality. Primary outcome was mortality among pediatric patients admitted to the burn unit during the period under study.

We examined demographic and clinical characteristics of the entire cohort, as well as between patients with and without anthropomorphic measurements. Only children with anthropomorphic measurements were then included in the bivariate analysis of variables that correlated with mortality. Bivariate analysis was performed on each of the independent variables based on mortality outcome, using Pearson's correlation, two tailed Fisher's exact test, 2-sample t-test, or Kruskal–Wallis testing, as appropriate. Means are presented with standard deviations and medians with interquartile ranges (IQR). All of the variables found to significantly affect mortality in bivariate analysis, as well as variables with a significantly unequal distribution among the measured and unmeasured groups, were used in multivariate logistic regression to construct a fully adjusted model of significant predictors of mortality. This multivariate logistic regression model was applied only to children with anthropomorphic measurements.

Currently, dates of birth are not routinely collected. Instead, parents report patient ages in months for approximately the first 18 months, and years thereafter. We therefore assigned a conservative age estimate (equal to the year plus 0 months) and a liberal one (equal to the year plus 6 months) for all children aged 1–5 who did not have exact ages in months reported on admission, and performed two Z-score calculations for all of the indicators. Total body surface area burned (% TBSA) is currently assessed twice: once in the casualty department, and the second upon arrival on the burn ward. Because there was no statistically significant difference between these measurements, TBSA measured in the casualty department was used for this analysis. The 46 absconders (5.5% of patients, evenly distributed among the two groups) were included in the "living" category for the purposes of the final outcome.

All statistical analysis was performed using STATA/SE 13.1 (StataCorp LP, College Station, TX). Age-adjusted Z-scores were calculated for height, weight, and weight-for-height, using the STATA zscore06 package [20], which is based on 2006 WHO data. MUAC-for-age Z score was calculated using WHO software available online, based on 2007 WHO data [21]. Z-scores lower than −6 standard deviations (SDs) of the mean for height, weight, and lower than −5 SDs for weight for height for age and MUAC for age, were dropped from subsequent analysis, per WHO recommendations [22]. After removing outlying Z-scores, we constructed a combined Z-score variable using the available indicators of malnutrition as recommended by WHO, AND, and ASPEN. Because there was no statistical difference in Z-scores or age distribution based on