

Pediatric Burn Management by Emergency Medicine Trained Non-Physician Clinicians in Rural Uganda

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Abstract

Purpose: Burns are a significant global health problem known to be a common cause of disability, disfigurement and death. This is especially true in pediatric patients though there are few studies that look at the medical management and outcomes of this vulnerable population. This study aims to highlight the strongest predictors of mortality in pediatric burn patients at 72-hours and the role that non-physician clinicians had in caring for these patients.

Methodology: This is a retrospective study of data from all children under 5 who presented with burns to a rural district hospital Emergency Department in Rukungiri, Uganda between November 2009 and July 2014.

Results: 109 patients presented with burns and were admitted to the hospital during the study time. At 72-hour follow-up 82 patients remained on an inpatient ward, 16 had been discharged, 7 died, and 4 were lost to follow-up. Patients who presented with hypothermia has the highest rate of mortality. Analgesia medication, including ketamine sedation, was provided to more than 90% of patients. Though not significant given the limited sample size, there was no suggestion of increased mortality in children sedated by ketamine by non-physician clinicians.

Conclusion: This study suggests that trained non-physician clinicians were able to manage pediatric patients with burn injuries and provide initial assessment, treatment, and crucial analgesic administration. This study suggests that trained non-physician clinicians were able to manage pediatric patients with burn injuries and provide initial assessment, treatment, and crucial analgesic administration.

Keywords: CPediatric Burns Under 5; Burn Management in Low and Middle-Income Countries; Non-Physician Clinician; Emergency Medicine in Uganda

Abbreviations

U5: Pediatric Patients Under Five; ED: Emergency Department; NPCs: Non-Physician Clinicians; LMICs: Low and Middle-Income Countries; DALYs: Disability-Adjusted Life Years

Introduction

Burns are among the leading causes of disability-adjusted life years (DALYs) in low and middle income countries (LMICs) [1,2]. Children are particularly vulnerable to burns, which are the 11th leading cause of death worldwide in children ages 1 - 9 years, and the 5th most common cause of non-fatal childhood injuries [3]. The World Health Organization reports that children under 5 years of age are most at risk, and that infants in Africa have almost three times the incidence of burn deaths as children worldwide [2,3]. While the incidence and mortality from burns in LMICs are both higher in children, there are few studies on pediatric burns that focus on the timing of deaths, care at non-tertiary centers, or the care of under-five burn patients [4-10]. Understanding the current medical management and disease progression of this vulnerable population under 5 is essential to identify opportunities for improvement in care, and thereby reduce morbidity and mortality.

The role of emergency care as part of pediatric burn management in LMICs also has not been systematically explored, and thus the utility of emergency care in preventing early death and in stabilizing severely burned children remains undefined. In our study, we reviewed all visits of pediatric patients under five (U5) seen in the emergency department (ED) and admitted to the hospital with a primary or secondary diagnosis of burn. We described the strongest predictors of mortality at 72-hours and highlight the role non-physician clinicians (NPCs) trained in emergency medicine had in caring for these pediatric burn patients.

Materials and Methods

This retrospective study characterizes U5 pediatric patients admitted from the ED with burns at a district hospital in the rural Rukungiri district of Uganda. This hospital has a six-bed ED staffed by NPCs, but does not have a designated inpatient burn unit or intensive care unit. For the duration of this study, there was no formally trained surgeon or burn specialist on staff at the hospital.

Since 2008, Global Emergency Care (GEC), a nonprofit organization, has been implementing an emergency medicine training program at this location which integrates on-site provider training, research, and clinical care. Nurses were recruited for this intensive emergency medicine training program and are now the sole clinicians in the ED, as there are no emergency medicine trained physicians in Uganda [5]. The training program, hospital setting, and data collection methods have been described elsewhere [11].

This study was derived from a GEC maintained site-specific patient database of all ED visits which includes demographic data, chief complaint, vital signs, diagnostic testing performed, results, ED disposition and 72-hour follow up [11,12]. Data was stored and managed in Microsoft excel® from 2009 - 2012 after which it was transitioned to a Microsoft Access® database. The data for this study was initially extracted from the database as part of a larger study analyzing all admitted patients < 60 months of age between November 2009 and July 2014 [11]. Among the admitted patients, those with a primary or secondary ED diagnosis of burns were included in this study, regardless of presenting ED chief complaint. The dataset was maintained in a de-identified Excel spreadsheet following extraction from the main database.

Data points analyzed in this study were selected based on their relevance to acute burn care and outcomes, as well the quality and completeness of data available within the study sample. Vital signs included respiratory rate, oxygen saturation, and temperature; one set was taken from all patients on arrival to the ED, and most patients had at least one additional set recorded during their ED stay. Tachypnea, was defined *a priori*, as respiratory rate (RR) > 60 breaths per minute for age 0 - 2 months, RR > 50 for age 2 - 12 months, and RR > 40 for age > 12 months. Hypoxia was defined *a priori* as an oxygen saturation < 92%. A temperature $\geq 38^{\circ}\text{C}$ was denoted as febrile, and $\leq 35^{\circ}\text{C}$ as hypothermic. In assessing 72-hour inpatient mortality as the primary outcome of interest, univariate data analysis was performed using Fisher's exact test for categorical data with the level of significance for all analyses set to $p = 0.05$.

Ethical approval for this study was obtained from the University of Massachusetts (Worcester, MA, USA) and the Mbarara University of Science and Technology (Mbarara, Uganda) and Ugandan National Council of Science and Technology, (Kampala Uganda).

Results

Between November 2009 and July 2014, 109 pediatric U5 patients were admitted from the ED to an inpatient unit for burns. This accounted for 3.1% of the total admitted U5 patients (3,482) during this time [13]. The average patient age was 2.0 years (SD 1.1) and 18 patients (16.5%) were under 1 year of age. 51 (46.8%) of the patients were female. Of the 109 patients who received a burn diagnosis, 100 (91.7%) also presented with a chief complaint specifying burns or scalds. Time since injury and mechanism of burn were only documented in a minority of cases and thus could not be sufficiently analyzed.

During the ED encounter, 17 patients (15.6%) were observed to be febrile $\geq 38^{\circ}\text{C}$ and 12 patients (11.0%) were hypothermic $\leq 35^{\circ}\text{C}$. 18 patients (16.5%) were observed to be tachypneic, and 17 patients (15.6%) were hypoxic. In regard to ED treatment, 54 patients (49.5%) received intravenous fluids and 65 patients (59.6%) received antibiotics. 100 patients (91.7%) received some form of analgesic medication (Table 1). Additionally, 48 patients (44.0%) underwent procedural sedation with ketamine for burn care and wound debridement.

Analgesic class	Total patients receiving at least one dose
Paracetamol/Acetaminophen	75 (68.8%)
NSAIDS	12 (11%)
Opiates	27 (24.8%)
Ketamine	48 (44%)

Table 1: Analgesic Administration.

The majority of patients (100, 91.7%) received at least one form of analgesia, while more than half (56, 51.4%) of the patients received more than one form of analgesia while in the ED.

Burn was the primary ED diagnosis in 106 (97.2%) of the patients. Severity of the burn (e.g. degree, depth of tissue involvement) or TBSA was only recorded in the database for 31 patients (28.4%), thus limiting data analysis. 10 (9.2%) patients were documented as having a first-degree, or superficial burn, 19 (17.4%) patients had a second-degree, or partial-thickness burn, and 2 (1.8%) patients had a third-degree, or full-thickness burn. Only 4 (3.7%) patients had both the degree of burn and estimated TBSA documented. In addition to burns, 15 patients (13.8%) had additional diagnoses (primary or secondary), the most common of which were respiratory infections, malaria, and malnutrition. Furthermore, 15 patients (13.8%) were diagnosed with sepsis, and an additional 10 patients (9.2%) were found to have fever of unknown origin.

On ED disposition, 107 patients (98.2%) were transferred to an inpatient medical or surgical ward and 2 patients were taken directly to the operating theatre. At 72-hour follow-up, of admitted patients, 82 (75.2%) remained on an inpatient ward, 16 (14.7%) had been discharged from the hospital, 7 (6.4%) patients had died, and 4 (3.7%) were lost to follow-up. The 72-hour inpatient mortality rate for U5 burns was 6.4% (Table 2), compared to an U5 all-cause mortality rate of 4.8% during the same period [15] Of those patients who died, 6 (85.7%) were female. Both patients admitted directly to the operating theatre died; they were both female and had descriptive ED diagnoses indicating more severe burns, including third-degree burn and 40% TBSA.

	ED Disposition	72-hour follow up:	
		Alive	Expired
Medical/surgical ward	107 (98.2%)	82 (83.7%)	5 (71.4%)
Theater	2 (1.8%)	0	2 (28.6%)
Discharged home	0	16 (16.3%)	0
Total U5 Burn Patients	109	98 (89.9%)	7 (6.4%)

Table 2: Disposition from the Emergency Department.

*Disposition of pediatric burn patients from the ED. Follow-up at 72 hours done by local research assistants.
4 (3.7%) patients were lost to follow up.*

The baseline clinical and demographic data was similar between those who received ketamine versus those who did not, apart from hypoxia (Table 3). Only 3 of the patients who underwent ketamine sedation were hypoxic (6.3%), compared to 14 patients with hypoxia who did not undergo sedation (23%, $p = 0.031$). While the difference in mortality rate between the ketamine and non-ketamine groups (2.1% vs. 9.8%, respectively) was not statistically significant given the limited sample sizes ($p = 0.132$), there was no suggestion of increased mortality in children sedated with ketamine by these non-physician clinicians.

	Total Patients	Hypoxic in ED	Mortality at 72-hour follow up
Received Ketamine sedation	48 (44%)	3 (6.3%)	1 (2.1%)
No Ketamine administration	61 (56%)	14 (23%)	6 (9.8%)

Table 3: Ketamine usage for procedural sedation.

The baseline clinical and demographic data was similar between those who received ketamine versus those who did not, apart from hypoxia. One patient who received Ketamine in ED died after admission to the ward.

Discussion

Burns are a significant global health problem accounting for an estimated 265,000 deaths annually [3]. Non-fatal burns are widely known to be a major cause of morbidity, including disability, disfigurement, and subsequent social stigma and rejection. Literature from LMICs has demonstrated that pediatric patients account for nearly half of all burn injuries seeking care, and in some populations this has been reported to be as high as 73% [14,15]. This is likely attributed to children’s exploratory stage of development without comprehension of environmental dangers. Injuries such as oral burns secondary to placing an electrical cord in one’s mouth or hand burns from touching a scalding pot are examples seen in unwitting children [13]. Such risks become increasingly hazardous when children gain independent mobility and are especially significant in areas of low socioeconomic status where children often lack adequate supervision. Though children bear the brunt of both incidence and mortality from burns in LMIC, there are few studies on pediatric burns that focus specifically on younger subsets of the population [4,5]. To our knowledge this is the first study from a rural emergency department in Africa to document pediatric burn outcomes in children under 5.

Oligoanalgesia is a common problem in pediatric patients [16,17]. In our study, which included ketamine sedation, NPCs provided analgesic medication to more than 90% of patients (Table 1). While analgesics were routinely administered in this study, it is unknown when during the stay in the ED the medications were given, or if they were administered prior to interventions such as wound debridement and dressing, although anecdotally, the providers tend to give analgesics immediately after initially evaluation. However, our study design did not allow us to capture pre- and post-analgesia pain assessments or to document any delays to analgesic administration. These points would be useful to further assess appropriate analgesia during ED treatment and to determine if redosing of pain medications is routinely occurring. Nonetheless, the high rate of analgesic use is encouraging in a rural setting in Uganda.

The mortality rate for U5 burns in our study was highest amongst those who presented with hypothermia, 3 out of 12 (25%) children died. This is compared to mortality rate of normothermic U5 patients, 3 out of 80 (3.8%) and febrile patients, 1 out of 17 (5.9%). While the low number of patients within these categories does not statistically allow for a logistic regression analysis, it is still a noteworthy finding that patient with hypothermia had the highest rate of mortality. Hypothermia is a known complication of severe burns with extensive TBSA involvement caused by impaired dermal temperature regulation, environmental exposure, and large quantities of IV fluids used in resuscitation; it may also be due to sepsis or excessive application of first aid techniques such as applying cool water to a burn. Children are especially vulnerable given their higher ratio of body surface area to volume. Hypothermia has multiple negative physiologic effects including impaired immune and stress responses, disruption of normal coagulation, and dysfunction of appropriate neurologic and cardiac homeostasis [18]. While it is shown to be predictive of poor burn outcomes in studies from adult populations in high-income countries, to our knowledge, this is the first study to identify hypothermia as a predictor of mortality in young children from LMICs [19,20].

The rate of antibiotic use in this cohort was quite high as there were 65 patients (59.6%) who were administered at least one antibiotic. There are several possible explanations for this finding. First, over a quarter of the patients were either febrile or hypothermic, indicating a possible infection. Since cultures and many other diagnostic tests are widely unavailable in LMICs, patients may have received antibiotics as a precaution when signs of infection are present. Additionally, 40 (36.7%) of these patients had a documented infection unrelated to the burn, which attests to the high prevalence of infectious diseases among children in this region.

The risk of infection is known to rise significantly after 24 hours following a burn [21,22]. Since this study was conducted in a rural area, children often present days after a burn and frequently have non-sterile burn dressings applied by lay-providers lacking any formal medical training. This obviously increases the risk of infection and may have contributed to the high antibiotic use. Although the NPCs are specifically instructed not to routinely prescribe antibiotics for burns during their formal training, it is possible that antibiotics were over-prescribed in this setting due to clinician factors or biases.

Limitations

The main limitations in this study are the retrospective nature and the modest patient sample size. As previously mentioned, the data for this study was derived from a larger study analyzing all admitted pediatric patients between November 2009 and July 2014 [11], however only 109 patients presented with inclusion criteria of “burn”. Data from multiple rural hospitals or an even longer time frame would help provide a more accurate assessment of mortality in this setting.

Other limitations in this study were the incomplete documentation describing the mechanism of burn, TBSA burned, and degree of burn on all patients. Of 109 patients, depth of tissue involvement was only recorded for 31 (28.4%) patients, with just 4 of these having an estimated TBSA burned. 53 (48.6%) patients were given a diagnosis of “burns” without additional description. 45 (41.3%) patients had one or more regions of the body identified as being burned (Table 4). 10 (9.2%) patients had a food or water related burn documented, such as “burned with hot water” or “burned with beans” and 1 (0.9%) patient was burned with a hot lamp. With only 11 (10.1%) patients having a documented mechanism of injury this information was not statistically, or descriptively, significant.

Face	8	Hand	3
Chest	2	Arm	10
Abdomen	5	Leg	7
Back	3	Foot	3
Buttocks	3		

Table 4: Number of patients with documented location of burn.

Location of burn on was documented on 45 (41.3%) patients, with some patients having than one body region identified. TBSA and degree of burn was not routinely documented.

A full set of vital signs was not fully documented on all patients, and repeat vital signs were reported even less consistently. Hypothermic patient had the highest rate of mortality at 72-hours in our study, however, it should be noted that the most commonly used measurement in this ED is an axillary position, which may be falsely low. Since data was for this study was extracted from a larger study, not all information available was relevant to burns. The study also did not include pediatric patients with a burn who were discharged home, which would provide a more complete assessment of burn prevalence and management. It would be useful to conduct a prospective assessment to further characterize the mechanism, severity and demographics of pediatric patients who are burned and thereby more accurately identify predictors of mortality. This information would be also instrumental from a programmatic standpoint to help implement public health measures, such as safety related to cooking fires or hot water storage to limit pediatric exposures.

Conclusion

Burns are a serious problem in LMICs, especially among the pediatric population. Delays in seeking and obtaining medical care for burns places patients at an increased risk of infection, disability, and death. This study suggests that trained NPCs were able to manage a fairly ill cohort of pediatric patients with burn injuries and provide initial assessment, treatment, and crucial analgesic administration.

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Conflict of Interest

The authors confirm the absence of any potential conflict of interest or funding.

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