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Epidemiology of operative burns at Kijabe Hospital from 2006 to 2010: Pilot study of a web-based tool for creation of the Kenya Burn Repository

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Abstract

Introduction—In order to implement effective burn prevention strategies, the WHO has called for improved data collection to better characterize burn injuries in low and middle income countries (LMIC). This study was designed to gather information on burn injury in Kenya and to test a model for such data collection.

Methods—The study was designed as a retrospective case series study utilizing an electronic data collection tool to assess the scope of burn injuries requiring operation at Kijabe Hospital from January 2006 to May 2010. Data were entered into a web-based tool to test its utility as the potential Kenya Burn Repository (KBR).

Results—174 patients were included. The median age was 10 years. There was a male predominance (59% vs. 41%). Findings included that timing of presentation was associated with burn etiology ($p = 0.009$). Length of stay (LOS) was associated with burn etiology ($p < 0.001$). Etiology differed depending on the age group, with scald being most prominent in children ($p = 0.002$).

Conclusions—Burn injuries in Kenya show similarities with other LMIC in etiology and pediatric predominance. Late presentation for care and prolonged LOS are areas for further investigation. The web-based database is an effective tool for data collection and international collaboration.

Keywords

Burn; Africa; Etiology; Prevention; Injury; DALY; LMIC; WHO; TBSA

1. Introduction

Burn injury in resource-poor settings is a complex problem, the scope of which has not been adequately defined. The World Health Organization (WHO) estimates that the annual death toll due to burns is over 310,000, with burns in low and middle income countries (LMIC) accounting for 95% of all annual burn deaths [1]. Among those populations, women and children are the most frequently affected [2,3]. In addition to burn-related mortality, burn-related disability causes a marked functional and economic impact. Functional disability is defined in the Global Burden of Disease (GBD) report as daily-adjusted life years (DALY) or the number of years lost due to poor health, disability, or early death. Strikingly, fires rank third worldwide for DALY lost due to unintentional injury in Africa, second in Eastern Mediterranean and South East Asian countries, yet fifth in high-income countries. Worldwide, burns covering greater than 20% total body surface area rank first among injury types causing of short or long-term disability. There are an estimated 116 million cases of such burns, roughly four times the prevalence of HIV/AIDS (31 million) [4].

In 2008, the WHO and the International Society of Burn Injury (ISBI) proposed a 10-year plan to develop interventions for burn injury in the resource-poor setting. The plan emphasizes the dearth of available data characterizing the burn injuries in of these populations as a significant hindrance to implementing and testing burn prevention strategies [5]. Peck and colleagues characterized the scope of burn injury in LMIC based on data from small retrospective studies. They, along with others, similarly noted that improved surveillance with formal epidemiological studies is necessary to improve disparities in burn injury [6-14].

Unfortunately, to date, efforts to create formal burn databases in LMIC have been unsuccessful, primarily owing to lack of finances, interest, and awareness of the burden of burn injuries. Characterization of the scope of the problem in LMIC will not only allow for focused intervention, advocacy and public education, but will also strengthen future requests for resources for clinical care and training.

Collaboration between burn surgeons at Vanderbilt University Medical Center (VUMC) and those at the African Inland Church (AIC) Kijabe Hospital (KH) in Kenya was initiated to further delineate the burden of burns in Kenya and to create a web-based repository for thermal injury at KH. This study describes the epidemiologic characteristics of operative burns at KH, and demonstrates the effectiveness of a web-based data collection tool as the potential future Kenya Burn Repository.

2. Methods

2.1. Setting and participants

Kijabe Hospital is in Kijabe, Kenya, a rural setting (population 4679), and has only 260 beds. However, it serves as a tertiary care center because of the medical specialists available [15,16]. The subject sample comprised 174 patients who underwent operation from January 2006 to May 2010.

2.2. Study design

This study was designed as a retrospective case series with collaboration between Vanderbilt University and AIC Kijabe Hospital in Kenya. Patients with burn injury were identified by a manual search of operative logs. At the time of our retrospective review, the computer system in which patients were registered was unavailable. For this reason our search was limited to the operative log. Case descriptors included debridement, split thickness skin graft, full thickness skin graft, burn contracture release, excision of scar or keloid, flap, reconstruction, tissue expander, and burn. The patient identification number was then matched to the patient chart, and the patient was included if burn was the etiology of injury. Patients with any other reasons for surgery, such as trauma or congenital malformation, were excluded.

2.3. Database development

The database was created using REDCap electronic data capture tool hosted at VUMC [17]. REDCap (Research Electronic Data Capture) is a secure, web-based application designed to support data capture for research studies providing: (1) an intuitive interface for validated data entry; (2) audit trails for tracking data manipulation and export procedures; (3) automated export procedures for seamless data downloads to common statistical packages; and (4) procedures for importing data from external sources.

Authors ED and PT had rights to edit the database, and all editing was performed prior to initiating data entry. The data were entered at KH by a research assistant who was trained in the use of the database and the chart review process. The private health information (PHI) was safe-guarded by removing identifiers prior to downloading the data for analysis by the authors and biostatistician. For example, medical record numbers were reassigned, and dates were adjusted to maintain length of stay information but remove actual admission and discharge dates.

Table 1 presents data collected. These fields were based on a registry worksheet published by the American Burn Association (ABA) and the ISBI and adapted to suit data collected at KH [18]. Data variable descriptors matched these fields, and data were entered with a windows format and dropdown menus where descriptors were written in full, i.e. not coded as a descriptor. More detailed etiologic information, when available, was entered in the history of present illness.

When patients returned for follow-up visits, outcome information was recorded under the same medical record number, but with a “follow-up” template, therefore avoiding multiple entries for the same burn.

2.4. Statistical analyses

Descriptive statistics were calculated as the median with interquartile range (IQR) for continuous variables. For categorical variables, frequency and percentage were presented. Pearson Chi-square tests were used to examine the association between two categorical variables. Wilcoxon rank sum and Kruskal–Wallis tests were used to compare continuous outcome between groups. All statistical analyses were performed using open source R statistical software (version 2.10.0, Vienna, Austria).

2.5. Ethical considerations

This study was approved by both the Vanderbilt University Institutional Review Board and the AIC Kijabe Hospital Ethics Committee.

3. Results

3.1. Patient demographics

The mean age was 14 years $\pm$ 13. The median age was 10 years with an interquartile range (IQR) of 3–20. Fifty-nine percent were male, while 41% were female.

3.2. Burn characteristics

Table 2 gives characteristics of the burns. Of the total 174 burns, 24% had no documentation of etiology, leaving 133 burns with recorded etiology (Fig. 1). Scald burns were the most common, comprising 46% (95% CI: 0.38–0.54), followed by flame with 39% (95% CI: 0.31–0.47). For total body surface area (TBSA), of the total 174 burns, the median percentage was 4% (IQR 2–8%), with a mean of 6.5 ± 8.1 . The most common reason for surgery was contracture release or reconstruction. The majority of the burns were deep, with 89% being deep partial thickness or deeper. A minority (2.3%) were associated with inhalation injury, 3.4% required fluid resuscitation at the time of admission, and one patient was on the ventilator for 2 days.

3.3. Etiology

Burn etiology and severity are reported in Table 3. When comparing burn depth to burn etiology, a significant association was noted ($p < 0.001$). Mean TBSA varied among burn etiology, with flame causing the largest burns on average ($p = 0.004$). Length of stay (LOS) was also different depending on etiology. While flame burns are less prevalent than scald burns, the median LOS is nearly twice as long, and the mean nearly three times as long ($p < 0.001$). Fig. 2 demonstrates the association between etiology and admission status. Scalds presented more frequently in the acute setting, while flame burns were more frequent among the patients presenting with scar contractures ($p = 0.009$).

3.4. Gender

When comparing the gender distribution of burn etiology, there was no significant difference found (Table 4).

3.5. Age

Comparison among age groups was also performed. While the majority of the burns were in children ages 0–14 (62%), the burn depth distribution among age groups was similar ($p = 0.89$, Table 5). LOS was insignificantly higher for older patients with median of 26.5 days for ages > 45 vs. 14 days for 0–14 year olds ($p = 0.14$). The distribution of etiology by age group did reach significance ($p = 0.002$). Scald was most prominent in children (59%) while flame burns were more common in all the adult age categories.

3.6. Outcomes

Outcomes for wound healing at the time of discharge were also recorded (Table 2). Outcome data did not include ICU LOS, however hospital LOS was recorded. The average LOS was 25.2 days. While mortality data was recorded, only one patient died, and this was due to a pre-existing illness, therefore burn-related mortality was unable to be assessed from our patient cohort. At discharge, one patient died, three (1.7%) left against advice, and three were transferred to other facilities. The remainder (96%) went home.

3.7. Database function

The web-based data collection tool was found to be extremely effective. It allowed for data acquisition to proceed in the absence of the PI (ED), while immediate access to review the

data was available. It was hosted by VUMC mainframe server, which is a secure site for the data to be stored. Maintaining the program and data on the computers available at KH would have posed significant frustrations due to frequent power outages and older equipment. Quality was monitored by physical oversight of data entry by PN, and random review by ED of cases entered. In addition, the biostatistician was located at VUMC, and was able to access the data without concern for transfer of identifiable PHI across international boundaries.

4. Discussion

The main findings were that burns requiring operation were predominately chronic burn scars, scald burns among children, and burns suffered by males across all age ranges. The database functioned as a useful tool for the data collection process. Epidemiological reports on burn injury sometimes exclude burns presenting for contracture release/reconstruction [19-21], as their goal is to capture the incidence of acute burns. However, by including this category it becomes clear that either many burn victims do not seek medical care until scar contracture has produced debilitating deformity or functional deficits, or that those who did receive acute care did not receive adequate treatment, leading to avoidable complications. This is a concerning finding, given that long-term functional outcomes in burn injury are worse when scar contractures have already occurred. In addition, these burns are at high risk for developing squamous cell carcinoma, as reported in a recent case series on Marjolin's ulcers seen at KH [22]. Because the burns require operation, they create a profound financial burden to the patient and hospital, in addition to the disability incurred by the scar contracture. Flame was the most common etiology for these late presentations. More information is needed to understand why this occurs, and community education interventions undertaken to encourage earlier presentation or referral for deep burns.

With a median age of 10 years old, and an average age of 14 years old, children suffer a disproportionate burden of burn injury in Kenya, a finding consistent with those in other LMIC [10,23-25]. This may be reflective of the population of Kenya, where the life expectancy is significantly shorter than in the US (59.5 years vs. 78.4 years) and the median age is 18.9 years. By comparison with the USA, where the percentage of the population under 15 years old is 24%, it is 42.2% in Kenya [26,27]. It is notable that the acute new admissions and pediatric burns were primarily from scald injury. Many other studies in LMIC show a similar pattern [9,12,14,24,28-32]. This may indicate parents are more willing to invest in healthcare for their children. If that is the case, they may also be more open to implementing preventive methods for their children, a promising finding for planning future interventions.

Such prevention efforts have been reported, but to date there are few tools available to assess their impact [6,7,34]. Amosy et al. is a group from Sweden who developed a safer, cost effective, locally reproducible stove for a slum area of Nairobi [34]. Partnering with such groups is ideal for implementing and evaluating the effectiveness of such interventions. Atiyeh, et al. describes methods of prevention such as education campaigns, environmental modification, i.e. product modification of stoves, and legislation of building codes, but notes that "there is a palpable lack in most LMICs of comprehensive data to document the extent of the burn problem in order to guide policy makers and medical personnel" [10]. Another group of authors from South Africa make the same argument, with more targeted suggestions for the burns problem in developing countries, i.e. radio campaigns, using fire grids to guard open fires, and parental education [11]. They also comment that these are "promising prevention strategies", but that they "lacked evaluation of effectiveness". These prevention efforts in the absence of evaluation tools create compelling arguments for databases such as is proposed here.

The current study found that more male burn victims receive operations at KH than do female burn victims. Globally females suffer more mortality from burn injuries than males [23]. Locoregional studies have more varied results with regards to incidence of burn injuries, some showing a male predominance [9,12-14,24,29,30,35-39] and others with more female victims [20,28,31-33]. When only studies from African countries were reviewed, more males were burned in Kenya, Ethiopia, Nigeria, Ghana and South Africa [12,14,35-37,39]. In Zimbabwe, females were the majority [32]. The results from KH may not necessarily reflect a predominance of male burns, but rather that families preferentially incur the cost of operation for males, under the assumption that they have more wage-earning potential. This theory was posited by several other authors across the globe [29,31,36]. Unfortunately, if true, this represents a significant gender disparity for females who suffer burn injury.

The median TBSA is much lower than the 17% found by article authors in a previous study from the Kenyatta National Hospital [35]. KH is in a rural setting, and receives acute burns from the surrounding area of Kijabe as well as chronic burn scars for reconstruction from further afield. For this reason, the median TBSA of 4% is not representative of most burn injuries in Kenya. By contrast, the Kenyatta National Hospital, located in Nairobi (population estimate 3 million [40]), is the largest referral and teaching hospital in Kenya and East Africa. Thus, these burn injuries, in an overcrowded urban setting, typically involve a larger percentage of body surface area.

The few patients with inhalation injury were all involved in a church fire that was part of the election violence in Eldoret in 2008. They were initially treated at Moi Teaching Hospital, then transferred to KH for wound management two weeks later. This explains the disparity in having patients with inhalation injury, but only one on mechanical ventilation. The burn depth reflects that the patients were chosen from the operative log, and therefore required more than just topical treatment.

LOS is quite long for the low TBSA reported. It is longer for flame injuries, which is the prevalent injury type that presented for reconstruction. In a population with few wound care resources available outside a hospital setting, sometimes not even clean water, patients were typically kept until their wounds had nearly healed. This would seem to be a burden to the hospital, but the alternative would be readmission for failed graft or wound sepsis, which would incur an even greater cost. This being said, there may be ways to provide outpatient wound care or shorten the hospital course by accelerating the rate of healing. Nutritional status was not studied, but is a known factor that impacts healing. At KH, food is provided by family members, which means those who were malnourished initially would remain so. Both outpatient wound care and nutritional supplements are possible interventions to shorten LOS.

We are unable to comment on mortality caused by burn injury with this study due to the single case mortality.

As a trial for the database being a site for the future KBR, it proved to be a valuable tool. The next step is prospective data collection on all burn admissions, utilizing a burn injury history and physical form at the time of patient admission, conceptually similar to those used by Van Neikerk [14]. In addition, KH has a computerized registration system from which these patients can be identified. This system was not functional at the time of our retrospective review due to a computer upgrade, but will be available for future identification of patients. Similar to the publications of the NBR [19,21], reporting will describe specific minimum data. Missing data is a perpetual problem for any data collection effort, however efforts will be made for complete collection, as well as reporting of missing

variables. A proposed minimum data set includes patient gender, age, total burn size and depth, total hospital days, number of procedures performed, and disposition. The database will be hosted by VUMC, and be available for use in Kenya as a web-based tool. ED and PN will provide oversight for data entry and maintenance. Quality indicators will include minimal clearly erroneous entries, for example when ICU LOS exceeds hospital LOS [21]. In the setting of many LMIC, it is untenable to expect scant resources to be directed toward data collection. Therefore, as the recent epidemiologic publications regarding prevention of burn injury cite lack of data as a major stumbling point to identify effective interventions, it behooves us to proceed with international collaborations to fill the void [9-14].

5. Study limitations

Inadequate records prevented the inclusion of all patients admitted with thermal injury during the study period. In similar studies that reported percentages of burn admissions that received operations, these ranged from 29% to 52% [28,30-32]. Therefore this study likely missed a majority of patients admitted with burn injury. This undoubtedly contributed to the lack mortality data.

The data presented were divided into broad categories of injury, without subdivision into subtypes of injury i.e., flame: kerosene vs. coal fires. Subtypes were recorded, for example scalds were characterized as steam, water or grease, but this information was only available for a minority of the burns, and therefore not reported here. With an admission form, this will be recorded consistently. In addition, each burn was recorded with a history of present illness in narrative fashion. Therefore when more data is available, this portion of the record could be reviewed to collect more specific etiologic information in order to plan prevention strategies.

6. Conclusions

This retrospective study characterizes distribution of burns requiring operation by type, severity, presentation, demographics and outcomes at Kijabe Hospital. The number of cases of scar contracture emphasizes the need for training and empowering healthcare workers at all levels of acute burn care to reduce the number of post-burn complications. In addition, the preponderance of males compared to females undergoing operation for burns may represent a gender disparity, and is an area for further investigation. The burns among children confirm that efforts need to be made to further characterize and prevent scald injury in this population.

While the number of patients was small, as a pilot study, the database was useful for collecting a great deal of information on the patients involved, indicating that this web-based tool is a valuable method with which to accomplish prospective data collection with an international collaboration. The study also emphasizes the shortcomings of a retrospective case series and supports the establishment of the prospective Kenya Burn Repository, which ideally will be utilized at other hospitals in Kenya as well. The KBR could then be used to enhance burn data collection, establish prevention and treatment strategies, and measure outcomes.

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Fig. 1. Etiology of burn

Fig. 2. Distribution of burns etiology by admission status

Table 1

Demographics	Burn history	Medical history	Physical exam	Treatment	Outcomes
Patient number	Narrative HPI	Past medical history	Inhalation injury: Y/N	Fluid resuscitation: Y/N	Discharge date
Date of Birth	Etiology	Neuromuscular	TBSA, %	Mechanical ventilation, days	Wound at discharge
Gender	Flame	Seizure	Body sites burned	Total operations	Closed
Admit date	Scald	Cardiovascular	Head/neck	Wound management	Open, not grafted
Injury date	Water	Pulmonary	Torso	Topical antibiotics	Open, healing, >50% graft take
Admit status	Grease	Asthma	Extremities	Debridement	Open, wound sepsis, <50% graft take
Outpatient	Steam	Obstructive	Hands/feet	Skin graft	Disposition
Acute new admission	Contact	Gastrointestinal	Perineum (Diagram)	Contracture release	Home
New admission for contracture/reconstruction	Electrical	Reflux	Depth of burn	Flap/reconstruction	Other hospital
Acute transfer from outside hospital	<1000 V	Peptic ulcer	Superficial	Rehabilitation	Left against advice
Readmission for revision/rehab	>1000 V	Genitourinary	Superficial-partial	Description of operation	Death
	Chemical	Infectious disease	Deep-partial	Time to wound closure, days	Cause of death
	Acid	HIV	Full-thickness		Burn shock
	Alkali	TB	Involvement of subcutaneous tissue/muscle/tendon/bone		MSOF/metabolic
	Unknown	Malaria	Concomitant trauma		Pulmonary failure
	Environment	Diabetes Mellitus	Fracture		Cardiac arrest
	Residential	Keloid	Visceral injury		Pre-existing illness
	Work place	Other	Brain injury		Treatment withdrawn
	Motor vehicle	Family History	Other		
	Circumstances	Keloid	Photo if available		
	Accident	Hypertension			
	Assault	Lung disease			
	Self-inflicted	Diabetes			
	Arson	Social history			
		Tobacco			
		Alcohol			
		Occupation			

Table 2

Characteristics of the burns.

	<i>N</i>	
Admission status	174	
Outpatient	1%	1
Acute new admission	37%	64
New admission (contracture release/reconstruction)	44%	77
Acute transfer from outside hospital	18%	31
Readmission (revision/rehabilitation)	1%	1
Depth of burn	174	
Superficial	1%	1
Superficial partial	10%	18
Deep partial	29%	51
Full-thickness	57%	100
Involving muscle, tendon, bone	2%	3
Wound status at discharge	170	
Closed	1%	1
Open, not grafted	18%	30
Open, healing (>50% graft take)	81%	137
Open, wound clean and <50% graft take	1%	1
Open, wound sepsis and <50% graft take	0%	0

N is the number of non-missing values.

Table 3

Comparison among burn etiology.

	Flame N = 52		Scald N = 61		Contact N = 12		Electrical N = 3		Chemical N = 5		p-value
Depth of Burn	n		n		n		n		n		
Superficial	0%	0	3%	2	0%	0	0%	0	0%	0	<0.001 ¹
Superficial Partial	6%	3	23%	14	0%	0	0%	0	0%	0	
Deep Partial	15%	8	41%	25	33%	4	67%	2	0%	0	
Full-thickness	77%	40	33%	20	58%	7	33%	1	80%	4	
Involving muscle	2%	1	0%	0	8%	1	0%	0	20%	1	
TBSA	2.0 4.0 10.0 (9.2±11.9)		3.0 5.0 10.0 (7.4±6.5)		2.0 2.0 5.5 (5.2±5.9)		2.0 2.0 5.0 (4.0±3.5)		1.0 1.0 1.0 (1.0±0.0)		0.004 ²
Length of Stay	15.0 24.0 38.5 (44.2±57.8)		6.0 11.0 19.0 (15.6±15.1)		15.2 30.0 47.8 (34.8±22.5)		11.0 11.0 26.5 (21.3±17.9)		8.0 14.0 25.0 (16.2±9.9)		<0.001 ¹

a, *b*, and *c* represent the lower quartile *a*, the median *b*, and the upper quartile *c* for continuous variables, *x*±*s* represents $\bar{X}$ ±1*S.D.*¹ Pearson test.² Kruskal–Wallis test.

Table 4

Comparison between male and female.

	Male <i>N</i> = 102		Female <i>N</i> = 72		p-value
Depth of Burn					0.35 ¹
Superficial	1%	1	1%	1	
Superficial Partial	11%	11	10%	7	
Deep Partial	30%	31	28%	20	
Full-thickness	58%	59	57%	41	
Involving muscle	0%	0	4%	3	
TBSA	2.0 3.0 6.8 (5.8±7.5)		2.0 4.0 9.2 (7.6±8.9)		0.12 ²
Length of Stay	8.0 15.0 26.0 (30.7±77.1)		8.8 19.0 37.2 (36.1±58.1)		0.21 ²
Etiology of Burn					0.092 ¹
Flame	41%	32	36%	20	
Contact	4%	3	16%	9	
Scald	47%	37	44%	24	
Electrical	4%	3	0%	0	
Chemical	4%	3	4%	2	

a, *b*, and *c* represent the lower quartile *a*, the median *b*, and the upper quartile *c* for continuous variables, $\bar{x} \pm s$ represents $\bar{X} \pm 1$ S.D.

¹ Pearson test.

² Kruskal–Wallis test.

Table 5

Comparison among age groups.

	0-14 N = 108	15-29 N = 39	30-44 N = 21	>45	p-value
Depth of Burn					0.89 ¹
Superficial	2%	0%	0%	0%	
Superficial Partial	12%	8%	5%	17%	
Deep Partial	31%	23%	33%	17%	
Full-thickness	54%	67%	57%	67%	
Involving muscle	1%	3%	5%	0%	
TBSA	2.0 4.0 9.0 (6.4±6.7)	1.0 4.0 7.0 (6.3±7.9)	2.0 3.0 5.0 (8.0±14.1)	2.0 2.5 3.8 (5.5±7.1)	0.85 ¹
Length of Stay	7.0 14.0 27.2 (33.6±83.5)	6.5 19.0 45.0 (34.8±46.5)	11.0 15.0 37.0 (27.9±24.1)	23.8 26.5 28.5 (27.7±7.8)	0.14 ²
Etiology					0.002 ¹
Flame	31%	45%	58%	67%	
Contact	6%	10%	21%	0%	
Scald	59%	35%	16%	0%	
Electrical	1%	3%	0%	33%	
Chemical	2%	6%	5%	0%	
Admission Status					0.62 ¹
Outpatient	1%	0%	0%	0%	
Acute new admission	38%	26%	43%	67%	
New admission (contracture release/reconstruction)	44%	59%	29%	17%	
Acute transfer from outside hospital	17%	15%	29%	17%	
Readmission	1%	0%	0%	0%	

a, b, and c represent the lower quartile a, the median b, and the upper quartile c for continuous variables, x±s represents $\bar{X} \pm 1$ S.D.

¹ Pearson test.

² Kruskal–Wallis test.