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Epidemiology and outcomes of burn injuries at a tertiary burn care center in Bangladesh

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ABSTRACT

Globally, burns are among some of the most devastating injuries and account for more than 265,000 deaths worldwide. In Bangladesh alone, nearly 3000 people die annually from burn-related injuries. This study was conducted at the National Institute of Burn and Plastic Surgery in Dhaka, Bangladesh in June of 2016. Data included conducting surveys of hospitalized burn patients (N=66) and a chart review of deceased burn patients (N=88). In addition to reporting on the demographic profile of patients, information was also obtained on clinical measures during hospitalization. For non-fatal burns, high risk groups included young adult males (early 30s) of lower socioeconomic status. Among children, the most vulnerable group was found to be children less than eight years old. The most common non-fatal types of burn injuries were flame (35%), electrical (31%) and scald (24%). Discharged patients had an average hospital stay of around 30 days with half of all patients requiring surgical intervention, thus indicating the severity of those cases and the need for resource-intensive care. Among the discharged patient population, factors significantly associated with a longer duration of hospital stay included severity of injury, not having received prior treatment before admission and whether or not patients required surgery during hospitalization.

Among the mortality cases, the high-risk groups also included young adult males and children of around eight years of age. The average total body surface area (TBSA) sustained in these cases was 46.4%, with 65% of deaths attributable to complications from flame burns. These findings highlight the frequency and severity of burn injuries, identify vulnerable population groups and list common causes of burns in this large developing country of 160 million people. Furthermore, these findings may be applicable to the epidemiology and outcome of burns in similar low and middle income countries.

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1. Introduction

The World Health Organization (WHO) reports that burn injuries account for an estimated 265,000 deaths annually [1]. In addition to inflicting substantial mortality, millions of non-fatal cases often leave people with lifelong disabilities and disfigurements. In 2013, such injuries accounted for an average of 12.3 disability adjusted life years per person [2]. Lack of access to appropriate clinical care and the inability to subsequently integrate burn victims back into their communities, creates an enormous social and economic burden for these victims and their family members. Progress has been made in high income countries to reduce the morbidity and mortality resulting from burn injuries, however, many of these advances in care and rehabilitation have not been translated to low- and middle-income countries (LMICs) even though nearly 90% of all burn injuries occur in LMICs [3]. Despite the emerging and growing evidence on improved burn care management in high-income countries, few studies in LMICs have been conducted to characterize the epidemiology of burns with respect to cause, type and severity, as well as on provisions of hospital care or assessment of outcomes. Given that burns are largely classified as unintentional in many LMICs, social awareness of burn prevention and fire safety measures is low. In addition, cost-effective and practical interventions implemented in high-income countries to reduce such risks have not been disseminated to the policy makers, health care practitioners and public health advocates of LMICs.

Despite the fact that 40% of world's burn injuries occur exclusively in South and Southeast Asia, few studies have been conducted in this region regarding burn epidemiology. In India, over a million people suffer moderate to severe burns each year [1]. In Nepal, burns continue to be the third most frequent cause of injury and are one of the leading causes of disability-adjusted life-years [1,2]. Studies conducted in Bangladesh, Colombia, Egypt and Pakistan show that 17% of children affected by burns each year are afflicted with temporary and permanent disability [1,4–6]. In Bangladesh, more than 3000 people die annually from burn injuries alone [1]. Burns affect men, women and children; however, prior research indicates that young women [17–35] tend to be the victims of unintentional burns [7,8], while men are more susceptible to unintentional burns within the workplace, and children are largely at risk for unintentional burns within the home [9,10]. Studies have indicated that at risk populations within Bangladesh include women of low socioeconomic status who work in the kitchen with cooking fires and kerosene lamps [4,11]. Previous studies [4,11–13] have identified certain population groups to be at high risk of burn injuries within LMICs, however research investigating short-term outcomes of patients who sustained serious burn injuries and describing care provisions in tertiary hospitals is limited.

Bangladesh, with its population of 163 million, has only one tertiary burn care center: The National Institute of Burn and Plastic Surgery at Dhaka Medical College Hospital. Therefore, it receives a wide range of patients from across the country who have sustained burn injuries requiring a higher level of care. Despite the high incidence of burns in Bangladesh, very few studies have attempted to comprehensively characterize the nature, etiology and risk factors for such injuries. Therefore, this study aims to identify the characteristics of populations who have sustained severe burns and to describe the 60-day outcomes of such patients who received care from a tertiary care center. Length of stay was used as a primary outcome of interest, as this is an indicator of injury severity and use of resources [14].

2. Methods

This cross-sectional study was conducted at the National institute of Burn and Plastic Surgery at Dhaka Medical College Hospital (DMCH) from May 26, 2016 to June 22, 2016. Data were collected from patients who had been admitted to the hospital for inpatient burn care during that month and who had either been discharged home in stable condition or had succumbed to their injuries during that time period. Inclusion criteria were defined as any patient who had sustained any burn injury requiring hospital admission to DMCH, who could provide consent and who was either discharged or had expired during the time of data collection. IRB approval was obtained from both the University of Texas Health Science Center San Antonio and the Centre for Injury Prevention and Research in Bangladesh (CIPRB). Written consent was obtained from each participant; for children under the age of 18, consent was obtained from the child's parent or guardian. Verbal translation of both the consent form and the survey were provided by medical physicians who were fluent in both English and Bengali. Surveys were administered on the day of hospital discharge and included demographic information in addition to information regarding basic burn injury causes and types. All other information detailing hospital complications, length of stay, outcomes, etc. were obtained via chart review.

The survey tool used was originally developed by Johns Hopkins University as part of their South Asia Burn Registry (SABR) and modified and abbreviated by our research team for this specific study. Total body surface area (TBSA) was determined via the Lund-Browder chart for both children and adults. Burns were further classified as mild (superficial), moderate (partial thickness) or severe (full thickness) according to the standards set forth by the American Burn Association [15,16].

In addition to data collected from discharged patients, a chart review was conducted on burn patients who expired during that month using the death registry of the hospital. Data for this group was limited to patient age, gender, type of burn, TBSA of burn and cause of death. For the discharged group, more complete data were available to report on income, gender, occupation, burn severity and place of injury. All data were recorded manually and then entered electronically into Excel. Stata version 14.0 for Windows (Stata Corp., College Station, TX) was used for analyses. Once data were de-identified, it was assessed for quality by investigating duplicates, out of range values, and missing data. An initial descriptive analysis of all the variables was performed. Univariate and multivariate log linear regression models were used to assess the factors associated with the length of hospital stay. As the length of hospital stay was not normally distributed, a log transformed variable was used for the linear

regression models. Small sample size limited the number of variable that can be included in the multivariate regression model. Hence it was only limited to clinical characteristic variables which are our major study variables of interest. Type of burn which was not significantly associated in the univariate regression was not included in the multivariate regression model. Demographic variables such as gender, marital status and family income which were not significant in the univariate analysis were not included in the multivariate regression analysis, except for age category. Coefficients from the regression analysis were given in Tables 3 and 4 and should be interpreted as percent change in the duration of the hospital stay for the given category compared to the reference category for categorical variables and as percent change in duration of hospital stay for one unit increase in continuous variables.

3. Results

Data were collected from 66 discharged patients and 88 deceased cases. Table 1 summarizes the characteristics of these two population groups by age. The results are stratified for children under the age of 18 and adults in order to delineate the differences in burn epidemiology. Mean age of discharged and deceased adults patients were 32.2 (±10.1) and 35.1 (±13.7) years respectively. Mean age of discharged and deceased children were 8.5 (±5.9) and 8.7 (±5.9) years respectively. The majority of patients in both groups were male. Flame burns contributed to the largest proportion of mortality among both adults (67.2%) and children (55%). Among the discharged group, scald burns were more common in children (37.5%) while flame (42.4%) and scald burns (39.4%) contributed to more injuries sustained by adults. About half of all children and 36.4% of adults suffered severe burns within the discharged patient group. In the discharged group, adults had, on average, a longer hospital stay than children [36.9 (±30.3) days vs 25.3 (±21.8) days]. Average length of hospital stay for the deceased group were similar for both children and adults (6.7 days).

Table 2 presents the data categorized by burn type. Patients with flame burns had a mean age of 25.9 years and were predominantly male (61.9%). Nearly 33.0% of flame burns were sustained during domestic chores, whereas 33.0% occurred during recreational activities and 28.6% during activities involving work outside home. Flame burns also had the longest hospital stay [mean (SD): 31.7 (±40.8) days]. Children were primarily affected by scald burns [mean age 14.0 years, 57.1% male]. About 78.6% of scald burns were sustained at home. Electrical burns were more common among males [80% with a mean age of 20.1 years]. Approximately 36% of electrical burns were sustained at a workplace and 32% occurred within the home. With regards to burn severity, patients with minor burns were predominantly male [61.5%; mean age 27.1 years]. Patients with minor burn injuries required a mean hospital say of 16.1 days. Moderate burns mostly occurred among males [68.0%; mean age of 19.95 years] with an average hospital stay of 32.6 days. Patients with severe burns were also predominantly male (75.0%) with an average age of 17.86 years and an average hospital stay of 37.1 days. The majority (>50%) of patients in all categories of burn type and severity were of low socioeconomic status with a monthly income of less than 10,000 takas ($124 USD).

Table 3 demonstrates the univariate linear regression analysis on the length of hospital stay as the outcome variable among the discharged alive (n=66) patients. Severity of injury, having received a surgery during hospital stay and having received prior treatment prior to hospitalization were significantly associated with length of hospital stay. Patients with severe burns had a 51% longer hospital stay compared to those with mild or moderate burns. Patients who received treatment prior to hospitalization to this tertiary care center had a 62% shorter duration of stay in this hospital compared to those who

Table 1 – Demographic and clinical characteristics of the sample by age group.

	Discharged (n=66)		Deceased (n=88)	
	Children	Adult	Children	Adult
	<18years (N=32)	18 or above (N=33)	<18years (N=20)	18 or above (N=67)
Age in years (M (SD))	8.5 (5.9)	32.2 (10.1)	8.7 (5.9)	35.1 (13.7)
Gender				
Female (% (n))	25% (8)	36.4% (12)	35% (7)	35.8% (24)
Male (% (n))	75% (24)	63.6% (21)	45% (9)	49.3% (33)
Unknown (% (n))			20% (4)	14.9% (10)
Type of Burn				
Flame (% (n))	21.9% (7)	42.4% (14)	55% (11)	67.2% (45)
Electrical (% (n))	12.5% (4)	6.1% (2)	10% (2)	3% (2)
Scald (% (n))	37.5% (12)	39.4% (13)	5% (1)	22.4% (15)
Other (% (n))	28.1% (9)	12.1% (4)	30% (6)	7.5% (5)
Severity of burn				
Minor (% (n))	12.5% (4)	27.3% (9)		
Moderate (% (n))	37.5% (12)	36.4% (12)		
Major (% (n))	50% (16)	36.4% (12)		
TBSA (M (SD))	14 (11.8)	14.9 (11.7)	39.5 (19.9)	48.3 (21.6)
Length of hospital stay (M(SD))	25.3 (21.8)	36.9 (30.3)	6.7 (5.8)	6.7 (9.7)

Notes: Percentages are column percentages.

Table 2 – Demographic and clinical characteristics by type of burn injury.

	Discharged				Deceased			
	Flame	Electrical	Scald	Other	Flame	Electrical	Scald	Other
Total [%(n)]	31.8% (21)	37.9% (25)	21.2% (14)	9.1% (6)	64.8% (57)	18.2% (16)	12.5% (11)	4.6% (4)
Age category								
Child (% (n))	33.3% (7)	48% (12)	64.3% (9)	66.7% (4)	19.3% (11)	6.3% (1)	54.6% (6)	50% (2)
Adult (% (n))	66.7% (14)	52% (13)	28.6% (4)	33.3% (2)	79% (45)	93.8% (15)	45.5% (5)	50% (2)
Unknown (% (n))	n/a	n/a	7.1% (1)	0% (0)	1.8% (1)	0% (0)	0% (0)	0% (0)
Gender								
Female (% (n))	38.1% (8)	20% (5)	42.9% (6)	16.7% (1)	42.1% (24)	6.3% (1)	45.5% (5)	25% (1)
Male (% (n))	61.9% (13)	80% (20)	57.1% (8)	83.3% (5)	38.6% (22)	81.3% (13)	45.5% (5)	50% (2)
Unknown (% (n))	0% (0)	0% (0)	0% (0)	0% (0)	19.3% (11)	12.5% (2)	9.1% (1)	25% (1)
Severity of burn								
Minor (% (n))	14.3% (3)	20% (5)	28.6% (4)	16.7% (1)	n/a	n/a	n/a	n/a
Moderate (% (n))	38.1% (8)	32% (8)	42.9% (6)	50% (3)	n/a	n/a	n/a	n/a
Major (% (n))	47.6% (10)	48% (12)	28.6% (4)	33.3% (2)	n/a	n/a	n/a	n/a
TBSA % (M (SD))	8.7 (17.3)	14.6 (13.4)	7.7 (10.9)	13.1 (16)	20.6 (50)	15.2 (37.6)	22 (35)	32.3 (62.3)
Length of Hospital Stay % (M (SD))	31.7 (40.8)	25.5 (33.4)	11.6 (13.4)	23.1 (26.7)	7 (5.9)	14.7 (8)	6.1 (8)	11.4 (9)
Education								
None	9.5% (2)	12.0% (3)	21.4% (3)	0.0% (0)	n/a	n/a	n/a	n/a
Middle	57.1% (12)	40.0% (10)	21.4% (3)	50.0% (3)	n/a	n/a	n/a	n/a
High	14.3% (3)	28.0% (7)	0.0% (0)	16.7% (1)	n/a	n/a	n/a	n/a
Other	19.1% (4)	20.0% (5)	57.1% (8)	33.3% (2)	n/a	n/a	n/a	n/a
Income								
<10,000	61.9% (13)	64% (16)	57.1% (8)	83.3% (5)	n/a	n/a	n/a	n/a
≥10,000	28.6% (6)	28% (7)	35.7% (5)	16.7% (1)	n/a	n/a	n/a	n/a
Unknown (% (n))	9.5% (2)	8% (2)	7.1% (1)	0% (0)	n/a	n/a	n/a	n/a
Occupation								
None	4.8% (1)	4% (1)	57.1% (8)	16.7% (1)	n/a	n/a	n/a	n/a
House wife	19.1% (4)	0% (0)	28.6% (4)	0% (0)	n/a	n/a	n/a	n/a
Laborer	14.3% (3)	20% (5)	0% (0)	33.3% (2)	n/a	n/a	n/a	n/a
Student	23.8% (5)	44% (11)	0% (0)	0% (0)	n/a	n/a	n/a	n/a
Other	28.6% (6)	24% (6)	14.3% (2)	33.3% (2)	n/a	n/a	n/a	n/a
Unknown (% (n))	9.5% (2)	8% (2)	0% (0)	16.7% (1)	n/a	n/a	n/a	n/a
Place of injury								
Home	52.4% (11)	36.0% (9)	78.6% (11)	33.3% (2)	n/a	n/a	n/a	n/a
Work	19.1% (4)	32.0% (8)	7.1% (1)	66.7% (4)	n/a	n/a	n/a	n/a
Other	19.1% (4)	24.0% (6)	0.0% (0)	0.0% (0)	n/a	n/a	n/a	n/a
Unknown	9.5% (2)	8.0% (2)	14.3% (2)	0.0% (0)	n/a	n/a	n/a	n/a
Surgery required	61.9% (13)	60% (15)	14.3% (2)	50% (3)	n/a	n/a	n/a	n/a

Notes: Percentages are column percentages.
For education, middle is defined by up to completion of primary school. High is defined as up to completion of secondary school. Other includes categories such as college or graduate school.

did not receive any care at other clinics. Having required a surgery during hospitalization was associated with significantly longer length of stay (134% increase). These factors remained significantly associated with duration of hospital stay when adjusted in multivariate models for age, place of injury and time to hospital admission from initial injury (Table 4). Adults had a significantly longer (46% increase) hospital stay compared to children when adjusted by other factors.

4. Discussion

This study seeks to contribute to the current understanding of how certain demographic and socioeconomic groups remain at high risk for burn injuries. In addition, it highlights how short-term outcomes (defined as within 60 days and having occurred during hospitalization) can be influenced by demographic factors, burn type and severity of burn injuries. Age and gender were both found to be related to the types of burns sustained. The majority of patients had low education and income. Most had at or below a sixth-grade education level as well as monthly income was only about 10,000 takas ($124 USD). Since this study was conducted at the only tertiary burn center in Bangladesh, which is a government-run public facility, patients of low socioeconomic status were likely to be over-represented in this study. However, previous studies indicate that population with lower socioeconomic status who live in rural communities are more vulnerable to burn injuries [3,4,12,13].

Flame burns were found to correlated with higher mortality, in addition to resulting in the longest duration of hospital stay. Over half of all flame burns occurred at home. One third of injuries were sustained by women during activities involving

Table 3 – Univariate analysis of log transformed length of hospital stay.

Variable	Exp (coefficient)	95%CI		p-Value
Type of burn (Ref: other)				
Flame	1.56	0.65	3.7	0.312
Electric	1.34	0.57	3.14	0.495
Scald	0.56	0.22	1.39	0.207
Severity (Ref: mild/moderate)				
Severe	1.66	1.02	2.69	0.040
Age Category (Ref: children <18yrs)				
Adult	1.35	0.83	2.22	0.226
Gender (Ref: female)				
Male	1.28	0.75	2.18	0.361
Marital status (Ref: other)				
Married	0.67	0.38	1.18	0.163
Family income (Ref:<10K Takas)				
10K to 30K	1.11	0.61	2.03	0.731
30K to 50K	0.75	0.22	2.57	0.647
Work related injury (Ref: No)				
Yes	0.81	0.48	1.35	0.410
Surgery during hospitalization (Ref: no)				
Yes	3.82	2.66	5.49	<0.001
Time since injury (days)	1.01	0.99	1.02	0.353
Received prior treatment (Ref: No)				
Yes	0.54	0.33	0.87	0.012

Table 4 – Multivariate analysis of log transformed length of hospital stay.

Variable	Exp (coefficient)	95%CI		p-Value
Severe injury (Ref: mild/moderate)	1.58	1.10	2.28	0.015
Adults (Ref: children <18yrs)	1.58	1.09	2.29	0.017
Work related injury (Ref: other)	1.12	0.73	1.71	0.595
Surgery during hospitalization	3.01	2.07	4.39	<0.001
Time since injury (days)	1.00	0.99	1.01	0.607
Received prior treatment	0.63	0.42	0.95	0.028

cooking and meal preparation, and one third were sustained by children under age five while at home. Previous studies also indicate that among adult women, flame burns most commonly occurred while cooking in the kitchen [15], and produced the highest mortality rates in Bangladesh [3], Kuwait [17], Iran [18] and India [19]. Population-based studies in Bangladesh also indicate that flame burns account for a large proportion of burn injuries among children under age five within the home [3]. Nearly three-quarters of adult patients with flame burns had at or below a sixth-grade education level and 76% were of low socioeconomic status.

Scald burns were found to contribute to morbidity among young children not only in Bangladesh but in other LMICs [3,6,21,22]. Subjects were young, with a significant proportion of injuries occurring in children under the age of five. Nearly 79% of all scald burns occurred within the home, with greater than half taking place during domestic activities such as cooking and eating. Typical Bangladeshi cooking includes boiling large quantities of rice, often resulting in standing pots of boiling rice water set on the floor which can easily spill on young children who are around. [3,20,23]. Therefore, interventions should once again focus on educating families about elevating cooking stoves and keeping hot food out of reach of young children. Previous studies indicate that community-based interventions focused on home interventions as detailed above, have been shown to be effective for reducing scald burns in children [24].

Electrical burns were also found to be a large contributor to patient mortality. Patients with electrical injuries resulted in the second longest hospital stay (at 25.5 days), with an average of 60% of patients requiring surgical intervention. With regards to demographics, burn injuries occurred primarily in working adult men as well as school-aged children. This study showed that two-thirds of all electrical injuries occurred outside home among both men and children. Therefore, interventions should primarily focus on targeting city infrastructure including powerline safety. However, it is worth noting that more severe injuries were common among adult males. The increased severity of burn injuries in men is possibly due to the predominance of occupational-related high voltage electrical injuries. High voltage electrical burns can have a number of severe sequlae including amputation, multi-organ damage and death [25–27] and can pose a significant burden on young men in LMICs [28].

Variables significantly affecting length of hospital stay included surgery during hospitalization, severity of burns and

whether or not the patient received burn care prior to hospital admission. The latter was defined as whether or not wounds were dressed prior to hospital arrival. As expected, more severe burns and patients who required surgical intervention had on average a longer hospital stay, as severe burns are associated with longer healing times and complications such as sepsis and skin graft failure [29]. In looking at interventions prior to hospital care, outcomes appeared to be dependent on access to care. Patients who were able to receive intervention prior to care at this hospital had shorter hospital stays. Barriers to receiving care likely include a lack of reliable transportation, underdeveloped roads and highway infrastructure, inadequate nearby healthcare resource as well as a lack of specialized burn centers in rural or other urban centers outside the capital city. A global assessment of prehospital care in several LMICs also cited lack of reliable transportation, funding and absence of legislative standards as primary barriers for a lack of prehospital care in developing nations [30].

Although burn injury surveillance in Bangladesh is limited as there is no unified database for recording demographics and outcomes, recent efforts with the Global Burn Registry are attempting to collect data identifying risk factors and prevention strategies for mitigating burn injuries [20]. Bangladesh is one of the most densely populated countries in the world and a substantial proportion of the population, both adult and pediatric, suffers from preventable burn injuries with a high degree of morbidity and mortality. As nation with a relatively high proportion of burn injuries within South Asia, burns in Bangladesh should be studied further. With improved injury surveillance, interventions can target specific risk factors and tailor adequate prevention strategies. Therefore, in the case of electrical burns, interventions should focus on preventative measures such as public education, training of laborers and infrastructural support to help increase powerline safely. Enhanced life expectancy and improved quality of life after burn injury have been attributed to early acute management and long-term rehabilitation techniques in the developed world [31]. Many of the non-immediate consequences suffered by the individuals from burns do not occur from the injury itself, but rather due the physical, social and economic barriers which exist in the society and workplace.

5. Conclusions

The findings of this study mostly corroborate findings of previous studies with respect to identifying high risk demographic groups [3,7–10]. Flame burns had the most severe outcomes and highest mortality rate. A large proportion of burns among children occurred either within or just outside home [3,32]. Research continues to identify high risk populations in other LMICs such as Pakistan [32], Nepal [3] and India. Socio-economic risk factors for burn injuries in LMICs also include poverty, education, income and occupation. However, prevention and early intervention should be priority [33,34]. This study highlights the importance of having ongoing injury surveillance programs not only to understand the morbidity and mortality patterns and trends of a preventable injury like burns, but also to develop and evaluate potential interventions.

6. Study limitations

As this was a cross-sectional pilot study, study findings may not be generalizable to all burn cases within this country. In addition, the epidemiology of burns has been shown to vary by seasons which, due to the short duration of data collection in this study, might have been overlooked. However, when compared to burn studies conducted in other LMICs, this study's findings were mostly comparable and consistent with results from other studies. Thus, clear patterns are observed by population demographics and type of burns sustained. Limitations with regards to data collection also included an inability to conduct historical data access and analyses owing to a lack of appropriate record keeping at this hospital. Small sample size also limited the number of variables that can be modelled into the regression analysis and hence limit the interpretation of the results and their generalizability. This highlights an important need for improved systems of data gathering via creating national burn registry and implementing standardized population-based surveys. In conjunction with legislative support, active burn surveillance will hopefully allow for the evaluation of future or ongoing interventions and strengthen the country's capacity to meaningfully reduce the burden of burn injury.

Author contributions

All authors have made substantial contributions as detailed below:

Morgan Bailey: study planning and design, data collection, data analysis and manuscript preparation.

Hari Krishna Sagiraju: conducting statistical analyses. sagiraju@livemail.uthscsa.edu

Siadur Mashreky: providing field level logistics, organizing data collection and survey review. mashreky@ciprb.org

Hasanat Alamgir: overall direction, planning and supervision of the study, manuscript preparation and final approval of submitted manuscript. Hasanat_Alamgir@nymc.edu

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Conflict of interest

The authors have nothing to declare.

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