

ORIGINAL ARTICLE

Magnitude of electric burns at a burn center in tertiary level hospital

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Abstract

Background: Burns are a public health problem throughout the world. Electrical injury is a major cause of burn injury which causes significant functional disability, disfigurement and mortality. In Bangladesh, the number of electrical injuries are increasing but they are typically underreported.

Aims: This study was conducted to analyze the epidemiological variables of electrical burn injuries and identify preventable measures through them in Khulna region of Bangladesh.

Methods: This descriptive study is a prospective analysis of patients suffering from electrical burns admitted at Burn and plastic surgery department from July 2017 to June 2018. The study population consists of 68 patients who sustained electrical injuries irrespective of age and time with cutaneous burns, admitted at this Center. Patients with electrocution but no electrical cutaneous burn injuries were excluded from this study.

Results: Majority were males (77.94%) of working age and injuries were work related (52.94%) of which 32.36% were construction workers. The primary cause in majority of the cases (57.35%) was accidental direct contact with electric wire followed by secondary contact with electrical power lines by metal rods and electrification of different metallic equipments (42.64%). Most of the patients admitted were high voltage electrical injuries (54.42%). Among them 16.17% had severe electrical burns and 2.94% had associated traumatic injuries. There was a delay in time of injury to hospital admission, 35.29% arrived at the emergency room 8 or more hours after the injury. Most (63.24%) of the patients underwent surgery, majority of which had moderate to severe burns. Length of hospital stay was 3-102 days. Two patients (2.94%) died during this study period due to renal failure and septicemia.

Conclusion: Most of the electric burn patients acquired injury at working place and primary cause was direct or secondary contact with powerline. Immediate preventive measures should be taken to reduce the incidence of electric burns.

Keywords: Electric burn, Epidemiology, Bangladesh.

Introduction

Burn injuries are the most devastating among all injuries and a public health problem throughout the world. It is commonly seen in developing countries which cause significant morbidity and mortality.¹ Burns are also one of the most expensive traumatic injuries due to the extended hospital stay and rehabilitation. The injuries result in higher rates of permanent disability and economic hardship for the individual as well as their families.^{2,3}

Electrical injury, a certain type of burn, is the most devastating and is the 4th most common cause of admission in burn units worldwide. This

type of injury not only involves the skin but also involve deeper tissues, that causes multiple acute and chronic manifestations not seen in other burns. Individuals tend to stay longer in hospitals, as well as morbidity and mortality rates are much higher.⁴ In Bangladesh common cause of burns are thermal, electric and chemical. Among them electric burn injuries constitute about one third of total burn injuries and the incidence is 3.97 per 100000 populations per year.¹

Electric injuries usually occurs in adult population primarily affect men, are most often work related. Electric injuries are typically divided into low voltage and high voltage. An electrical

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burn occurs due to electricity passing through the body and due to ignition of cloths. Usually an electric burn patient has a lower affected body surface area than other burn patients but morbidity and mortality are relatively high.^{5,6} The severity of the damage determined by four factors, those are voltage, current, resistance and frequency. Generally the pathway of the current will follow the course of the least resistance tissue: firstly blood vessels, nerves, muscle, skin, tendon, fat and bone. Skin involvement in electrical injuries has 3 degrees of severity like other burn. But in most of the cases the burns are deep in nature and there is deeper tissue damage even when the overlying skin is normal and operation is needed in many cases.

Burn centers of developed countries across the world have been reporting less and less incidence of electrical injuries.⁷ This is in part due to good preventive measures, first aid and burn care for electrical injuries.⁸ Despite this downward trend in the world, in developing country like Bangladesh the number of patents with electrical injuries appears to be increasing. This may be due to increased exposure to potential hazards and the lack of appropriate training and education regarding safety and proper handling of electricity. With the rapid pace of industrialization in Bangladesh, the risk mostly involves front line construction workers.

To make a preventive strategy of a disease, it is important to know the epidemiology of that disease. There are few epidemiological studies of electric burn injuries in Bangladesh. Most of them were population based and conducted in different regions of Bangladesh. There is no documented hospital based study on electric burn injury in Bangladesh. This is the first epidemiological study in this populated area of Khulna. This study was aimed at estimating the nature and cause of electrical burns observed at the burn center of Khulna Medical College Hospital.

Materials and Methods

This is a descriptive study conducted prospectively in Burn and Plastic Surgery department, Khulna Medical College from July 2017 to June 2018. The study population consists of 68 admitted patients who sustained electrical burns having cutaneous injuries irrespective of age and time of burn. Patients with electrocution but no electrical cutaneous burn injuries were excluded from this study.

The study population was divided into two age groups, adult (age>18 yrs) and pediatric (age<18

yrs). The percentage of total body surface area (TBSA) involvement was classified as minor (<10% TBSA), moderate (11-19% TBSA) and severe (>20% TBSA) based on the American Burn Association classification of burn severity. Type of electrical burn refers to voltage intensity, high voltage (>1000 v) or low voltage (<1000 v). Injury was classified as work related if the injury was caused or contributed by events or exposures in the work environment or non work related.

The time it takes from the injury to admission to the burn center was categorized as either immediate (<1 h), early (<8 h post-injury), intermediate (>8 h), or late (>24 h post-injury). Patients were also grouped in relation to the length of hospital stay, those who stayed for less than or equal to 7 days, those who stayed between 7 days to 14 days, those who stayed between 15 and 28 days, and those who stayed for more than a month. Subjects were also grouped based on the type and number of operations. Patients were managed according to our burn guidelines.

Electrocardiogram monitoring was done and initial labs/diagnostics were taken. Patients with moderate to major burns were resuscitated using the Parkland formula, regulated to maintain an adequate urine output which was monitored hourly. All patients received tetanus immunization according to guideline. Prophylactic antibiotics were used. Escharotomy/fasciotomy was done when there were clinical signs of compartment syndrome. Wound care was done with silver sulfadiazin and hydrocolloid dressing. Wound status was assessed regularly during dressing changes. Debridement of necrotic tissues was done in appropriate cases. Skin grafting was done after appearance of granulation tissue and when there was no sign of infection. Limb/Digits amputations were performed after the formation of the demarcation line which was mostly after 7 days. Physiotherapy started from the day of injury. Splinting and positioning were maintained to prevent contracture. Informed consent were taken from all patients. Data were collected in prescribed form and analyzed by statistical method using percentage.

Results

A total of 512 burn patients were admitted at department of Burn and plastic surgery, Khulna Medical College hospital from July 2017 to June 2018. Among them 68(13.28%) patients were with electrical injuries.

This study reveals that most of the electrical burn patients admitted were adult (76.47%). Most of burns occurred at working place (52.94%) followed

by at home (41.18%). Non occupational (47.06%) persons were mostly affected as well. Construction workers (32.36%) were more affected than electricians (20.58%) (Table-I).

Table I

Demographic profile of patients with electric burns (n=68)

Variable		Number of patients	%
Sex	Male	53	77.94
	Female	15	22.06
Age	<18 years	16	23.53
	> 18 years	52	76.47
Place of burn	Home	28	41.18
	Working place	36	52.94
	Street	02	2.94
	Tree	02	2.94
Occupation	Electrician	14	20.58
	Construction worker	22	32.36
	Non occupational (Children, Student, (Housewife)	32	47.06

Direct contact with electric powerline (57.35%) were the common mode of electric injury. In 42.64% of the cases, accidental contact with electrical power lines by metal rods in the hands of construction workers and accidental electrification of different metallic equipments caused the electric injury. Concomitant bone fracture was seen in 2.94% of patients with electrical injuries (Table II).

Table II

Nature and mode of injury and associated trauma (n=68)

Variable	Type	Number	%
Type of electric injury	Low voltage (<1000v)	31	45.58
	High voltage (>1000v)	37	54.42
TBSA (Total Body Surface Area)	Minor (<10%)	39	57.36
	Moderate (11-20%)	18	26.47
	Severe (>20%)	11	16.17
Mode of injury	Direct contact	39	57.35
	Secondary contact	29	42.64
	Flame (Ignition of cloths)	25	36.76
Associated trauma	Fracture of bone	02	2.94

Table II also shows that high voltage electrical injury (54.42%) was a common cause of admission. Almost all of individuals with severe

TBSA burns (16.17%) came from high voltage (98.67%) and only 43.95 of individuals with minor TBSA burns came from high voltage electric injuries.

Most of the patients (44.12%) consulted at this center between 1-8 h post-burn, 10.29% more than 8 h after injury and 25% patients arrived at this center after 24 hours (Table III). It also shows that 67.65% of patients stayed in the hospital longer than 14 days (duration of 14-28 days and >1 month).

Table III

Time of hospital arrival and hospital stay (n=68)

Variable		Number of patients	%
Time of arrival	<1 hour	14	20.59
	1-8 hour	30	44.12
	>8 hour	07	10.29
	>24 hour	17	25.00
Hospital stay	<7 days	15	22.06
	7-14 days	07	10.29
	14-28 days	05	7.36
	>1 month	41	60.29

A total of 58 operations were performed on 43 (63.24%) patients, most of which had moderate to severe burns. Common surgical procedure performed were STSG (35.29%). Next common procedure were wound debridement (30.88%). Flap surgery (10.29%) and amputation (7.35%) and fasciotomy/escharectomy were the other procedure performed (Table IV).

Table IV

Operative procedures for the patients (n=68)

Variable	Number of patients	%	
Operation done	Yes	43	63.24
	No	25	36.76
Number of operation	1 surgery	28	41.18
	2 or more surgery	15	22.05
Type of operation	Wound debridement	21	30.88
	STSG (Split thickness skin graft)	24	35.29
	Flap Surgery	07	10.29
	Fasciotomy/Escharectomy	03	4.41
	Amputation	05	7.35

While admitted at this burn center, 3 patients (4.41%) sustained Compartment syndrome while 2

patients (2.94%) had cardiac complications. Two patients (2.94%) died during this study period due to renal failure and septicemia (Table V).

Table V
Complications of electric burns (n=68)

Complications	Number of patients	%
Compartment syndrome	03	4.41
Cardiac complications (Dysarrhythmia)	02	2.94
Deformity (Hand, Foot, other joints)	06	8.82
Death (Septicaemia, Renal failure)	02	2.94

Discussion

In the 2012 WHO data, burn deaths every year amounted to 195,000 and majority occur in low and middle-income countries and almost half occur in the WHO South East Asia Region. Of the different types of burns, electrical burns are one of the most distressing.⁹ There are no studies on the global epidemiology of electrical injuries but a number of regional studies provide some data. There are few epidemiological reports on electric burn injuries in Bangladesh. The most recent published study on electrical injury in Bangladesh was in 2011.¹

From July 2017 to June 2018 a total of 512 burn patients were admitted at department of Burn and plastic surgery, Khulna Medical College hospital. Among them 68(13.28%) patients were with electrical injuries. The incidence of electrical injury is higher in developing countries than in developed countries. International data shows that electrical injuries account for 5.8% of all burn cases. For example, the USA (3.7%), Italy (4%), Singapore (2.8%), Taiwan (5.6%) and China (6.9%).^{10-13,17} In this Study the incidence of electric burn is 13.28%. However, developing countries have electrical burn admission rate between 21-27%.¹⁴ The high incidence of electrical burns may be the consequence of the low social and economic level of the population, improperly insulated wires, poorly placed and managed electrical switches, illegal electrical connections, and repair work on the electricity grid done by non professionals.⁴ The demographic profile of electrical burn patients in this study is consistent with other studies.

In this study, adult male (77.94%), construction workers (32.36%) were more affected. This can be attributed to the lack of appropriate training and

education with regards to safety and proper handling of electricity plus the increased exposure to potential hazards due to the country's rapid industrialization. A 10-year retrospective study in China, which reviewed 383 patients, also revealed similar findings. Their patients were predominantly male (90.3%), and were composed by those injured in work-related incidents (78.30%).¹⁷ Salehi et al. 2014 also showed similar finding to our study.¹⁶ In India, 84 patients with electrical injuries were analyzed from 2004 to 2009 to identify the causative and demographic risk factors. The age of patients ranged from 3 to 61 years and males accounted for 84.5%.¹⁸ Work-related activity was responsible for the majority of these high voltage injuries, with the most common occupations being linemen and electricians. These patients tended to be younger men in the prime of their working lives who are more at risk due to the fact that their occupation involves more exposure to electric current, high voltages, heavy machinery and equipment.^{15,18} This may also be due to improper equipment, education and/or training. Human error can also be a factor but proper training and education can negate this, as was indicated in other studies. In Bangladesh, Mashreky et al. also showed male predominance (52%) in their study. But this study showed that most (78%) of the burn occurred at home. In our study most (52.94%) of the electric burn occurred at working place. This might be due to improvement of safety of household electric equipments (like switch, socket, proper insulated wire, circuit breaker etc.) and due to rapid industrialization and growing economy of Bangladesh, more people are being engaged in construction work and electrical work.

Paediatric electric burns are also common and most of them are due to carelessness and lack of education. In this study, 16(23.53%) cases of electric burn occurred in less than 18 years ages. Majority (87.50%) of them were at home and due to direct and indirect accidental contact with faulty electrical appliances and chewing wires. In two cases (12.5%) patient sustained electric burn outside home during kite flying and climbing up a mango tree. The epidemiology of electric burns at this age group is similar to many of the studies.¹⁻⁹ Electrical wirings in Bangladesh are often installed low enough that they can easily be reached and some are very close to houses and trees. A number of patients (32.36%) reported that they sustained their injuries from secondary contact from these low lying live wires with such objects as metal rods, metal ladders etc. Fall of branch of tree on electric wire often causes tearing

of wire and contact with persons walking on street. In our study 2.94% patients sustained electric burn during walking on street due to contact with torn electric wire. Contact of electric wire sometimes causes electrification of tree and ignition. 2.94% patients sustained such type of burn during climbing on trees. One (1.47%) patient was burned due to contact with electrified aluminium tin when the house made of tin was electrified due to improper insulation of wire. The incidence can be reduced by proper installing the electric wires and by being careful during construction work, climbing on trees.

High voltage electrical injury (54.42%) was noted to be a common cause of admission at the Khulna medical college hospital burn center which was also directly related to severity of injury and length of hospital stay. In most of cases of high voltage injuries, different types of surgery needed and it caused lengthy hospital stay. This has similarity with other studies, where high voltage was directly correlated to severity, clinical complications, and amputation.^{15,16} A higher proportion of amputations and compartment syndrome were noted along with lengthier hospital stays, higher number of patients subjected to flaps surgery as well as a higher incidence of cardiac arrhythmias.⁹

In this study mortality rate was 2.94%. This is similar to other study. Mortality of electric burn patients are decreasing in the world as well as in our country due to a marked improvement in initial monitoring and resuscitation, better wound management, and early excision and grafting. In other countries, morbidity and mortality rate from electrical injury are as follows: Czech Republic (17.07%), Turkey (9.1%), Taiwan (6%), United States (3-15%).¹⁰⁻¹³ In a study in China, one hospital had no mortalities. They attributed this to the early excision of necrotic tissue, resulting in a decreased risk of late invasive infection. The avoidance of invasive infection, often leading to sepsis, limits this most common cause of death in the burn unit.¹⁷ The variation of morbidity and mortality may simply arise from severity of injuries, characteristics of electrical injury, and level of specialized care that each patient receives. However, it would be rational to assume that some patients died before proper medical assistance could be rendered at an institutional level as here are three variants in electric injuries. Death of the victim on the scene of incident, transportation to hospital and treatment, and death in the hospital in spite of the treatment, which may underestimate the mortality from electrical injuries. In the United States, the most common

cause of death after electrical injury remains to be cardiac arrest following acute arrhythmias at the site of the accident. The decrease in electrical injury related mortality over time is probably as a result of advance in modern burn care and trauma.

Prevention is not easy. There are different risk factors and epidemiological patterns in different communities. Government programs must be utilized to educate people on safety and proper handling of electricity. Education, enforcement and training should be stressed as the primary weapons to combat this problem. The enforcement of existing safety regulations should be reiterated, and the employers should do stricter adherence to these regulations. Workers exposed to electric current and electrical equipment should be fully trained/ certified and properly dressed. The education will lessen the burden of having electrical burns, which affects the person, the family as well as the workplace.

Short term hospital based study is its principal limitation. Late outcome of the electrical burn patients including return to work, disability, deformity, quality of life were not assessed. This study only represent the magnitude of electric burn in Khulna region. The findings are not be applicable to the whole country. A large scale population based study is needed to know the exact epidemiology of electrical burn injuries in whole Bangladesh.

Conclusion

The incidence of electrical burn is increasing at alarming level due to our country's rapid pace of industrialization, lack of proper education and training with regards to safety and proper handling of electricity. Immediate preventive measures, should be taken to reduce the incidence of electric burns including proper education, training, enforcement of law, proper installation of electric system as well as public awareness.

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