ASSESSMENT OF ELECTRICAL INJURY ON SURVIVORS IN CMCH

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This is to certify that we have examined the above Master's thesis and have found that is complete and satisfactory in all respects, and that all revisions required by the thesis examination committee have been made.

Supervisor

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Prof. Dr. Sharmin Chowdhury

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Chairman of the Examination Committee

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List of Abbreviations

ACS	Acute Coronary Syndrome
BP	Blood pressure
BMI	Body Mass Index
CHD	Coronary Heart Disease.
CMC	Chittagong Medical College.
DM	Diabetes Mellitus
HTN	Hypertension
CMCH	Chittagong Medical College Hospital
PTSD	Post-traumatic stress disorder
ACS	Acute Coronary Syndrome
BP	Blood pressure
◦c	Degree Celsius

List of Tables

ABSTRACT

Electrical burn and sequels of electrical burn is a common phenomenon in our society. Electrical trauma can be caused by low-voltage current (less than 1000 V), high-voltage current (more than 1000 V), lightning and voltaic arc. Worldwide It causes serious injuries to a significant number of individuals every year with mortality rate of 20-30%,while as many as 74% of survivors experience permanent injury and consequence. Very few studies on electric burn injury and its sequels have been reported so far in Bangladesh. During this study we attempted to explore the occurrence of electric burn injury in different demographic areas and post burn sequels among patients suffering from electrical burn in a tertiary level hospital. We conducted a cross-sectional retrospective study that among 200 patients who were unfortunate victim of electrical accidental burn and were admitted in the Burn and Plastic Surgery Department of Chittagong Medical College Hospital, Chattogram. Data of the patients admitted during November 2021 to July 2022 were included for study. Among 200 cases, demographic data revealed that more males (89%) were affected than the females(11%).Highest no of victims was less than 40 years(90%). According to profession Students(28.5%), service holders(40%) and electrical service providers(15.5%) were the most vulnerable groups. Literacy of the large number(37%) of injured person was below secondary level and apparently most of the affected population(76.5%)was from rural areas. A high 70% patient had epidermal burn and maximum had areas of involvement of the body .We recorded that 32% patients were suffering from Post-Traumatic Stress Disorder (PTSD). Among the survivors, 6% were not able to do their daily activities after the injury. To conclude, post electrical burn sequels are need proper attention and care needs to be taken to avoid further complications. Use of good quality electric wires, home appliances, enforcement of safety rules in the home and workplace and up gradation of the health facilities are required to decrease the threat of severe electrical injuries.

Chapter-I: INTRODUCTION

1.1 Background

Burn injuries are the most devastating among the all injuries and a public health problem throughout the world. It is commonly seen in developing countries which cause significant morbidity and mortality (Mashreky, 2011). 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 individuals as well as their families (He et al., 2017; Sanchez et al., 2007)

Electrical burn injuries (EBI) area certain type of burn, though comprise a small proportion of the total burn admissions (4th most common cause), is the most devastating as they inflict significant morbidity and are potentially a mutilating type (Elloso et al.,2017). It may result in severe and extensive burns. Its overall mortality rate is 20-30%, with as many as 74% of survivors experiencing permanent injury and sequel (Maghsoudi et al., 2007). The mortality rate varies depending on the socioeconomic level, including 3%-15% in developed countries versus 21%-27% in developing countries. Electrical flash burns due to switchboard explosions in New South Wales a 9-year experience (Aggarwal et al., 2020)According to recent reports, its' mortality rate was 20% estimation of survival rate in electrical injuries, experience in Algerian Burn Centers (Habouchi et al., 2020). Most of these injuries are preventable. In adults, most injuries occur in the work-place, whereas children are exposed mostly at home. In nature, electrical injury might occur due to lightning. Education and awareness programs and safety measures, both by the individual and the state, can bring changes in the present situation. Socio-economic development worldwide has brought changes in the burn incidences; however, Bangladesh has not witnessed the same yet. (Alom et al., 2020)

The EBIs are divided into low voltage (<1000 kV, LVI) and high voltage (>1000 kV, HVI) injuries. This type of injury not only involves the skin but also involves deeper tissues that cause 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 (Song et al., 2005). In Bangladesh common cause of burns are thermal, electric and chemical. Among them electric burn injuries constitute about one third of

the total burn injuries and the incidence is 3.97 per 100,000 populations per year (Mashreky et al., 2011). These injuries result in substantial limitations that impede return-to-work (RTW) and decrease quality of life (MU HR et al. 1986; Inancsi et al., 1987). Several studies globally have proposed that EBIs are implicated in persistent functional, cognitive and neuropsychological sequel, including flashbacks, depression, anxiety and post-traumatic stress disorder (PTSD). There is scarcity of study in this field to evaluate the impact of electrical injuries on burn survivors. Moreover, clinical evidence regarding such effects is limited in Bangladesh, as the majority of reported findings are based on case reports or small clinical studies (Janus et al., 1996; Pliskinet al., 1998).

Although not very common, electrical burns deserve special attention. They comprise approximately 0.04% to 5% of all admissions to burn center in developed countries, and up to 27% in developing countries (Pliskinet al., 1998). Previous studies found that patients with high-voltage burns had experienced longer hospital stays and had more extensive burns than those with low-voltage burns, a finding consistent with other study findings (Pliskinet al., 1998).High-voltage burns are characterized by greater energy release and deeper, more extensive tissue damage, resulting in longer hospital stays. These two factors are directly related to mortality rates (Ding et al., 2019).

Though having potential of electric burn incidents followed by different complications in Bangladesh, very few studies addressed the issues. Therefore, we aimed to conduct this study to highlight the post burn squeal associated with EBIs in a tertiary care center of Chattogram and to identify demographic and social distribution of cases.

1.2. Objectives of the Study:

I. To ascertain the socio-demographic profiles of burn injuries.
II. To assess the patterns of post burn sequel of electrical burn injuries.

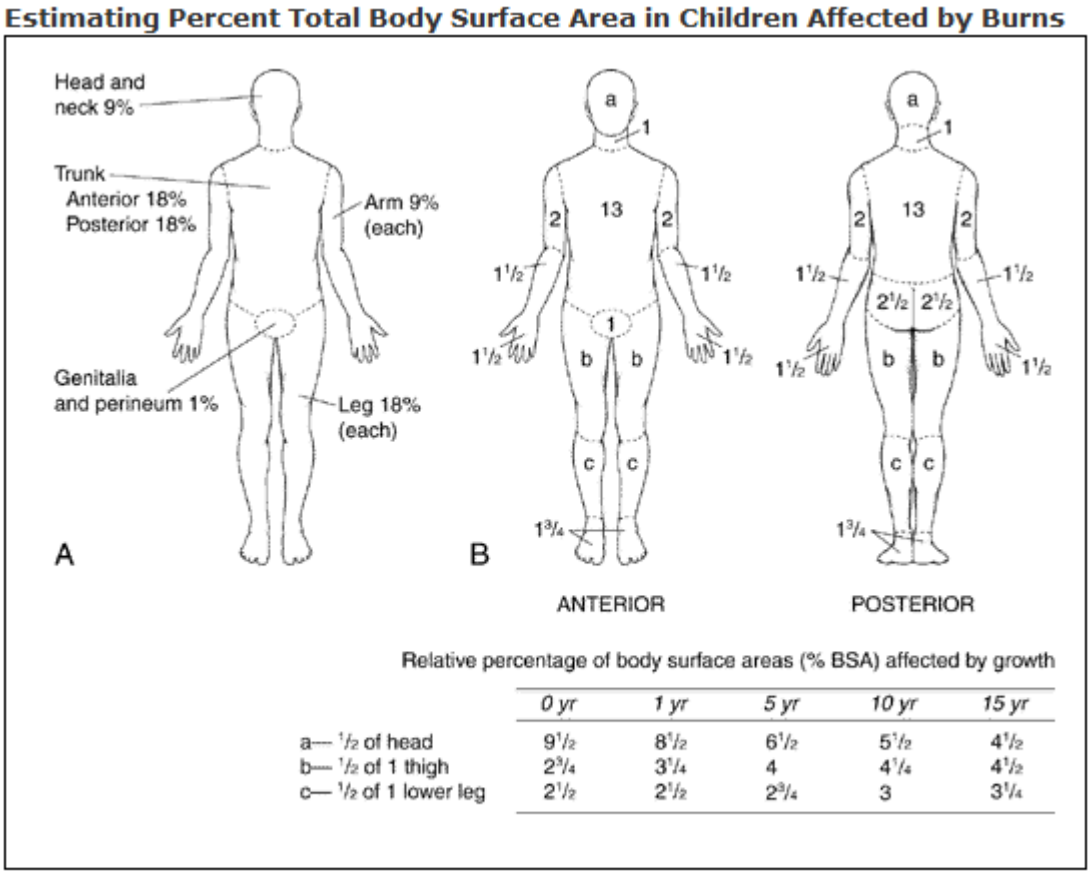
Chapter II: LITERATURE REVIEW

2.1. Burn

A burn is an injury to the skin or other organic tissue primarily caused by heat or due to radiation, radioactivity, electricity, friction or contact with chemicals. Thermal (heat) burns occur when some or all of the cells in the skin or other tissues are destroyed by: hot liquids (scalds).Burns is classified as first-, second-, or third-degree, depending on how deep and severe they penetrate the skin's surface. First-degree (superficial) burns affect only the epidermis, or outer layer of skin. The burn site is red, painful, dry, and with no blisters. Mild sunburn is an example of first degree burns. Second degree burns affect the epidermis and partial layer of dermis. The burn site is pale, painful. Flame burns are the example of second degree burn. Third degree burns affect the epidermis and both layer of dermis (Papillary and reticular layer).The burn site is whitish color, painless. High voltage electric burn is an example of third degree burn (Alom MR et al., 2020)

2.2. What is electrical burn?

Electrical burns are one of the most important public health issues in industrial societies and can lead to serious outcomes and socioeconomic problems. Electrical burns are usually classed as high-voltage (1000 V) and low-voltage (<1000 V).Electrical arc flash burns, in which no current passes through the body, are usually considered a separate class and frequently cause superficial burns. By contrast, electrical burns (characterized by electrical current passing through the body) may result in deeper and more extensive burns than electrical arc flash burns, and can result in higher morbidity and mortality (Shih, 2017).



(A) Rule of "nines"
(B) Lund-Browder diagram for estimating extent of burns

Figure 1: Calculation of percentages of burn (Ding et al., 2019)

2.3. Prevalence worldwide

Previous studies worldwide differ in reported prevalence and epidemiology for electrical burns. For instance, 94 patients with electrical burns were hospitalized in the Samsun Training and Research Hospital, Turkey, from 2008 to 2012; 47 patients sustained high-voltage injuries and 42 suffered low-voltage burns. In one burn care Centre in Pakistan, 85 children presented with electrical burn injuries, 71.76% of these had high-voltage burns and there were 35 major limb amputations. Of 202 patients with electrical injuries admitted to Kothari hospital in Tehran, Iran, between March 2011 and June 2012, 105 (52%) were construction workers (Ding et al., 2019). Contact with overhead power lines was the main mechanism of injury and the findings showed that construction workers were exposed to more severe complications and invasive procedures. Concomitant with advances in industrialization, there has been a high incidence of electrical burns in China in recent years. A thorough understanding of the epidemiological profile of burns would contribute substantially to the prevention and

treatment of electrical burn injuries. Although some studies have examined the epidemiology of electrical burns in different parts of China (Kurt 2012). The Department of Burn and Plastic Surgery in the first affiliated hospital of Guangxi Medical University is one of the largest and most well-regarded burn centers, and treats burn cases from Guangxi and Guangdong in southern China. This study was conducted to examine the epidemiological characteristics of electrical burns over a 10-year period by Song & Salehi where a total of 2019 burn patients were admitted with an annual admission of 288. This presented an incidence rate for burn injury (with admission) of 0.07 per 1000 general population. The male to female ratio is 2.2:1 and the mean age of admission is 32.5years. The mean extent of burn was 11.5% and patients with burn size 10% TBSA and less made up the majority of admissions at 70.7% while patients with burn size 30% TBSA and more made up 8.2%. The most common cause of burn injury is scald at 45.6% followed by flame at 35.2%. The overall mean LOS and mortality are 10.8days and 4.61%, respectively. An annual trend of falling mortality rate for admissions with burn size > 30% TBSA was observed-60% in year 2000 to 30% in 2003. This is a result of massive early excision and grafting of severe burn patients. 17.6% of patients were children of 12years and below, showing a 11.9% reduction from previous study in the 80s.

Socio-demographic distribution of electrical burn in a study done by (Akoz et al.,2015)on a total of 213 patients with electrical burns who were admitted to the emergency department (ED) between 2001 and 2011 were retrospectively analyzed. The mean age of patients was 33.7±10.8 (min: 18, max: 72 years), and 86.9% (n=185) of the patients were male. The majority of patients (63.4%; n=135) were living in city centers, followed by patients in the village (22.5%; n=48) and the countryside (14.1%; n=30), respectively.

2.5. Types of Electrical Burn

Electrical burns can be caused by a variety of ways such as touching or grasping electrically live objects, short-circuiting, inserting fingers into electrical sockets, and falling into electrified water. Lightning strikes are also a cause of electrical burns, but this is a less common event. With the advances in technology, electrical injuries are becoming more common and are the fourth leading cause of work-related traumatic

death. One third of all electrical traumas and most high-voltage injuries are job related, and more than 50% of these injuries result from power line contact.

Electrical burns can be classified into six categories, and any combination of these categories may be present on an electrical burn victim:

- **Low-voltage burn**. A burn produced by contact with a power source of 500 volts or less is classified as a low-voltage burn. The current at this voltage is not enough to cause tissue damage along its path except at the contact site. This type of burn may be mild, superficial, or severe depending on the contact time.
- **High voltage burn**. This burn is very severe as the victim makes direct contact with the high voltage supply and the damage runs its course throughout the body. Exterior injuries are misleading as most of the damage occurs underneath the skin. In this case, sub-dermal tissues are severely damaged.
- **Arc burn**. This type of burn occurs when electrical energy passes from a high-resistance area to a low-resistance area. No contact is required with an arc burn as the electricity ionizes air particles to complete the circuit. The heat generated can be as high as 4,000 °C (7,200 °F)—hotter than the boiling points of several metals and certainly hot enough to ignite a victim's clothing. A form of explosion dissipates excess energy from the arc. In addition, a high-current arc can produce a pressure wave blast in excess of 1,000 pounds per square inch (6, 90 kPa) of pressure. This can throw the victim and cause severe injuries.
- **Flash burn**. Flash burns are caused by electrical arcs that pass over the skin. The intense heat and light of an arc flash can cause severe burns in a fraction of a second. Although the burns can cover a large area of skin, they are largely superficial and the tissues beneath the skin are generally undamaged and unaffected. This typically occurs when the frequency of the AC current is significantly higher than the 50 or 60 Hz used in land-based electrical distribution systems (such as in aircraft).
- **Flame burn**. Flame burns are caused by contact to objects that were ignited by an electrical source when associated with flash and arc burns.
- **Oral burns**. This is caused by biting or sucking on electrical cords, and it most commonly happens to children Electric current typically passes from one side of the child's mouth to the other, possibly causing deformity.

2.5. Pathophysiology

Four electrical factors determine the severity of the damage caused by electrical burns: voltage, current, resistance, and frequency. The severity of the burn also depends on the pathway the current takes through the body. Generally, the pathway of the current will follow the course of the least resistant tissues: firstly blood vessels, nerves, and muscle, then skin, tendon, fat, and bone. Most commonly, electric injuries primarily damage the outer limbs, but more critical portions of the body may be affected as well causing severe complications.

As the body comes into contact with an electrical source, it becomes part of the electrical circuit. As such, the current has a point of entry and an exit at two different points on the body. The point of entry tends to be depressed and leathery whereas the exit wound is typically more extensive and explosive. It is hard to accurately diagnose an electrical burn because only the entry and exit wounds are visible and the internal damage is not.

2.6. Symptoms and Signs of Electrical Burn

Superficial electrical burn may present with pain and skin injury. But long duration electrical burn may present with extensive skin injury along with arrhythmias and renal failure. (Picture 1, 2 and 3)

Picture2.1: Flash Burn

Picture 2.2: Low Voltage Electric Burn

Picture 2.3: High Voltage Electric Burn

2.7. Prevention of Electrical Burn

We should follow the manufacturer safety instructions for electrical appliances. This includes not using and immediately unplugging any appliance with a damaged electrical cord. If this cannot be done safely (i.e. damage is too close to the plug), the circuit breaker should be turned off beforehand. While touching the metallic areas of an AC electrical appliance while also simultaneously touching faucets, water pipes, another metallic AC appliance, or being even partly immersed in water (including wet feet). This could ground the body through metal or water, with the risk that a faulty appliance is electrically "hot" on its outside cover or chassis.(Lari AR et al. 2000)

2.8. Sequels of Burns:

The scars are sequel of the burn." In other words, sequels are the late effects of an injury. Perhaps the most common sequel is pain. Many patients receive treatment long after an injury has healed as a result of pain. Complications of deep or widespread burns can include: Bacterial infection, which may lead to a bloodstream infection (sepsis) Fluid loss, including low blood volume (hypervolemia) Dangerously low body temperature (hypothermia) Complications from electrical injuries are similar to those of other thermal burns, such as infection (which can progress to sepsis), compartment syndrome, and rhabdomyolysis (due to extensive muscle damage from internal burns (Lari et al., 2000)

Chapter III: MATERIALS AND METHODS

3.1. Study area and period

The study was conducted at the Department of Surgery under Chittagong Medical College Hospital (CMCH), Chattogram. This is a tertiary health care facility situated at the city center and patients from all over the district of Chattogram and sometimes division visits with a range of health problems. The Department of Surgery has a burn unit where most of the burn patients are admitted from inside and around Chattogram district and division. We retrieved the patient's data from the hospital record book for the period of November 2021 to July 2022.

3.2. Research Type:

It was a retrospective cross-sectional type of study.

3.3. Study Population:

Patients who visited the hospital unit with a history of electrical burn and admitted in CMCH, Chattogram during the study period. Patients record with the age 12 years and above were included into the study.

3.4. Sample size and its estimation:

Sample size was calculated by the following statistical formula:

$$n=\frac{z^2 pq}{d^2}$$

Here z= standard normal deviate usually set at 1.96

p= assumed prevalence of electric burn injury which was taken approximately 50%, i.e., q=1-p=50%;

d=degree of accuracy usually set at 5% (0.05);

So desired sample size n=384.65, however,

After fulfilling the inclusion and exclusion criteria, during the study period, we could recruit 200 participants. So, a total of 200 case records with the history of electrical burn were included in the study.

3.5. Sampling technique:

A non-probability purposive sampling technique was followed to recruit the samples. All data records during the study period were collected with the consent of hospital authority and records fulfilling the inclusion criteria (having a history of electric burn and age 12 years and above) and exclusion criteria (incomplete case records) were selected for the study.

3.6. Data collection:

Data available in the hospital case records regarding demography (age, sex, educational level, occupation etc.), clinical findings (type of burn, severity etc.) and sequel of the injury (like pain PTSD etc.) was retrieved and stored in a Microsoft Excel sheet.

3.7. Statistical analysis:

After collection, the data were compiled, cleaned and analyzed by SPSS-20 and qualitative data was presented by tables (frequency, percentage etc.) and graphs.

Chapter IV: RESULTS

4.1. Distribution of EBIs according to demographic variables

Table-1 showing the demographic distribution of EBIs. Among the EBIs, 89% was male. Maximum victims were less than or equal 20 years (46.5%) followed by 21 to 30 years age group (25%). Students, service holders and electrical service providers were the most injured persons. Literacy was below secondary and most was from rural areas.

Table 1: Demographic distribution of EBIs in the study area

Variable names	Category	Number (n)	Percent (%)
Sex	Male	178	89
	Female	22	11
Age group	≤20 years	93	46.5
	21 to 30 years	50	25.0
	31to 40 years	7	18.5
	≥40 years	20	10.0
Nature of works	Electricity related service	31	15.5
	Services	80	40.0
	Student	57	28.5
	Others	32	16.0
Educational levels	Primary	10	5.0
	Secondary	64	32.0
	Higher secondary	55	27.5
	Graduate	13	6.5
	Post graduate	4	2.0
	Illiterate	41	20.5
	Others	13	6.5
Locality	Rural	153	76.5
	Urban	47	23.5
Comorbidity	COPD	2	1.0
	HTN	25	12.5
	HTN+DM	3	1.5
	Others	6	3.0
	None	148	74.0

4.2. Patterns of EBIs

Table 2 represents the patterns of EBIs among the study population. It was observed that, among all the burn patients, burn was attributed majorly accidentally (88%) followed by job related cause. A range of parts of the body were affected; 25% had it in limbs followed by 23% in hands. Most of the burn (70%) involved only epidermis and 16% had deep burn. In terms of percentages of body affected, 71% of the population had less than 10% affected areas. 20% population was presented with 10 to 20% burn. 31% to 40% burn was observed in 3.5% patients.

Table 2: Patterns of Electrical Burns

Variable name	Category	Number (n)	Percent (%)
Cause of burn	Accidental	176	88.0
	House hold	3	1.5
	Job work	21	10.5
Location of burn	Both upper limbs	2	1.0
	Face	1	0.5
	Face and, foot	1	0.5
	Face and, forearm	1	0.5
	Face and ,limb	4	2.0
	Face, neck and, hand	1	0.5
	Face, trunk and ,limb	2	1.0
	Finger	4	2.0
	Foot	1	0.5
	Forearm	1	0.5
	Forearm and, foot	1	0.5
	Hand	47	23.5
	Hand and ,foot	6	3.0
	Single Limb	14	7.0
	Limb, face and ,scalp	1	0.5
	Limbs	51	25.5
	Limbs and, scalp	1	0.5
	Limbs and, trunk	43	21.5

	Neck and ,ear	1	0.5
	Neck and, foot	2	1.0
	Neck and ,hand	1	0.5
	Scalp	4	2.0
	Scalp and, foot	1	0.5
	Trunk	9	4.5
Depth of burn	Epidermal	140	70.0
	Mixed	28	14.0
	Deep	32	16.0
Percentages of burn	<10 %	143	71.5
	11 to 20 %	40	20.0
	21 to 30%	9	4.5
	31 to 40 %	7	3.5
	>41%	1	0.5

4.3. Sequels of EBIs

Assessment of sequels of burn revealed that, 32% of the patients were suffering from PTSD and 2 cases lost their job. Moreover, 6% of the population became unable to do their daily activities after the incident (Table 3).

Table 3: Sequels of Electrical burns

Variable name	Category	Number (n)	Percent (%)
PTSD	Yes	64	32.0
	No	136	68
Job loss	Yes	2	1.0
	No	198	99.0
Able to do daily activities	Yes	188	94.0
	No	12	6.0

Chapter V : DISCUSSION

There are 2 possible consequences of electrical injury: the person either survives or dies. For those who survive electrical injury, the immediate consequences are usually obvious and often require extensive medical intervention. However, the long-term sequel of the electrical injury might be more subtle, pervasive, and less well defined, and are particularly difficult to diagnose, as the link between the injury and the symptoms can often go unrecognized by patients and their physicians(Baileys et al.,2008).Many who suffer electrical injury have considerable difficulty returning to work. The appearance of non-resolving, non–path-related symptoms following electrical injury is a scientific puzzle. In the study we found male gender were the most vulnerable group as they usually handle the electrical tolls mostly. Younger age groups were found more prone to injury as they are the main working force of a family. Lower education was related with less awareness as found in our study. Urban environment is mostly occupied with more electrical structures and that's why urban community were mostly affected. Limbs were the most commonly affected body part, as electrical works needs the involvement of limbs more.

In our study, 32% patients were suffering from PTSD and 2 cases lost their job and 6% were not able to do their daily activities. In a study by Feuerbach and colleagues, 64 % of burn-injured individuals were diagnosed with at least one lifetime psychiatric disorder prior to the burn, 51 % were diagnosed with a disorder during the year before the burn, and the prevalence of alcohol abuse or dependence was 41 %(Feuerbach et al.,1997). In a Swedish study, 66 % of burn patients were diagnosed with a lifetime disorder, 52 % had a disorder during the year before the burn, and the prevalence of substance abuse or dependence was 32 %(Dyster, 2008). In a recent Finnish study, 60 % of the patients in burn care were diagnosed with a lifetime psychiatric disorder (Palmu et al., 2010). These figures are higher than those obtained in population-based studies from the United States and Norway. The lifetime prevalence for any psychiatric disorder was reported to be 47 % in the United States (Kessler 2005), 52 % in a Norwegian urban area and 31 % in a rural area (Kringlen et al., 2006).

In addition to a good number of case reports on PTSD after electrical burn injury. Neuropsychiatric profile of a case of post-traumatic stress disorder following an electric shock. (Laforce et al., 2000) several studies were conducted using the neuropsychological testing succeeding electrical burn injuries have observed that PTSD

is a significant problem that may lead to defective cognitive performance and reduced capacity to return to work (Grigorovitch et al., 2013). Impact of post-traumatic stress disorder and depression on neuropsychological functioning in electrical injury survivors. J Burn Care Res. 2013;The no-let-go phenomenon involuntary muscle contraction that prevents the victim from breaking away associated with low-voltage electrical injury also led to increased rates of PTSD and depression(Kelley et al., 1999). Risk factors for psychiatric sequele. Ann N Y Acad Sci. 1999; 888:356–63. (Kelley et al., 1999).Therefore, it would be crucial to asses if there are any variations in rates of psychiatric disorders in low-voltage and high-voltage burn injuries.

With the advancement of industrialization in different countries worldwide, there has been an increase rates of electrical burns in recent years. An in-depth perception on the epidemiological characteristics of electrical burns would contribute significantly to the prevention and treatment of electrical burn injuries. While some studies were conducted to assess the epidemiology of electrical burns in different parts of the world, there is little or no research on electrical injuries in Bangladesh, which is undergoing fast industrial expansion. The burn unit of Department of Surgery at the Chittagong Medical College is one of the largest and most well-regarded burn centers, and treats burn cases from all over Chattogram district. The epidemiology and factors associated with electrical burns are not previously studied in the research area. Therefore, this study was conducted to gather the baseline data on the socio-demographic distribution of the burn patients and examine the epidemiological characteristics of electrical burns over a 1-year period. As secondary data (register data) was used for the present study, an in-depth and targeted survey on PTSD was not plausible. However, the baseline data would be a good source of evidence to conduct future extended study for developing electrical burn injury interventions.

Electrical burns are an important public health problem. Their prevention should be emphasized in male adults, especially with respect to industrial workers, incidents in the spring and summer, and high-voltage injuries. Future multicenter studies with long-term follow-up are needed to provide a thorough knowledge on electrical burns in Bangladesh and to develop strategies to improve interventions for electrical burns

Chapter VI: CONCLUSION

In the present study male gender with younger age groups were found more vulnerable to electrical burns and some sequel was observed like pain and PTSD. An extended targeted active survey is recommended to understand the epidemiology and associated risk factors of electrical burn injuries in Bangladesh to develop prevention strategies. We need to build up mass community awareness to overcome the electrical burns.

Chapter VII: LIMITATIONS

It was a single center study with a smaller sample size. So national scenario may not be got from the study. Other potential limitations was it was a retrospective study and there was a lack of long term follow up of the patients and if it would be done more chronic complications of post burn squeals could be addressed.

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