



**Prevalence and outcome of electrical burn at AaBET,
Yakatit12, ALERT Hospitals, Addis Ababa, Ethiopia,
2023**

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Addis Ababa, Ethiopia

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Abstract

Background: Electrical burns account for a small percentage of all burn injuries. However,

In burn patients, they are a major source of disability, and can cause significant morbidity and

Mortality

Objectives: The primary aim of this study is to determine the prevalence and outcome of electrical burn at AaBET, Yakatit 12, and ALERT Hospitals

Methods: This retrospective chart review study was conducted from January 2022 to December 2022, and systematic random sampling was used. And descriptive statistics and percentages were used for analysing our data. Data was entered and analysed using SPSS version 25. Descriptive analysis was used for statistical analysis and logistic regression was used to determine the association between dependent and independent variables tables and figures was used to describe the result. Multi-variable logistic regression was performed and variables having a P value < 0.05 were declared as statistically significant.

Result: A total of 162 electrical burn patients chart was reviewed and analysed on three study areas in this study. Among 162 patient's 144 (88.9%) patients are males and 18(11.1%) were females with a male to female ratio of 8:1. The age range of the patient was from 15 months to 75 years with a mean age of 38.73(SD 16.165) years. The

upper extremity is the most affected body part and is involved in 85(52.5%) of followed by anterior trunk 27 (16.7%), the Lower extremity 26 (16.0%), posterior trunk 15 (9.3%), Head 5 (3.1%) and perineum 4 (2.5%). In multivariate analysis variables such as age >56 is 1.3 times more likely to cause death, AOR: 1.3(95%CI: 0.2, 2.43), delayed presentation to hospital >24 hours is 2.01 times more likely to cause death, AOR: 2.01(95%CI: 0.21, 2.18), affected anatomical location, being injured on anterior trunk 1.3 times more likely to cause death, AOR: 1.3(95%CI: 0.01,12.18), depth of burn, full thickness/3rd degree burn was 4.3 times more likely to cause death, AOR: 4.3(95%CI: 0.96, 19.3),.

Timeframe: the study was conducted from January 2022 to December 2022

Estimated Budget: estimated (44,800 ETB) source from St. Paul Hospital Millennium medical college

Keywords: Electrical injury, burn, prevalence, outcome

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Acronyms and Abbreviations

AaBET: Addis Ababa Burn, Emergency and Trauma Hospital

AC: alternate current

ALERT: all Africa leprosy rehabilitation and training center

AOR: Adjusted odds ratio

CDC: Centers for Disease Control

CI: Confidence Interval

COR: Crude Odds Ratio

CK: creatine kinase

DC: Direct current

ED: Emergency department

HVI: hypersensitivity vasculitis

LOS: Length of stay

LVI: Lymphovascular invasion

NHPH: National Public Health Partnership

OPD: Out Patient Department

PTSD: Post Traumatic Stress Disorder\

TBSA: Total Body Surface Area

TETAF: Texas EMS Trauma & Acute Care Foundation Trauma Division

WHO: World Health organization

CHAPTER ONE

1. Introduction

1.1. Background

Electrical burns are serious injuries that are caused by exposure to electrical current. They account for small proportion of all burn injuries, but can have severe and long-lasting consequences. The prevalence of electrical burns varies depending on the population being studied, but certain occupations like electrical workers and construction workers are at the increased risk(1).

Electrical burns can cause both surface and internal injuries, which can lead to a range of outcome including nerve damage, tor dysfunction, and even death. The severity and log-term implications of electrical burns make them distinct from other types of burn injuries, requiring care and management(2).

In recent years, there have been advancements in understanding the pathophysiology of electrical burns, as well as improvements in their treatment and rehabilitation. This includes new techniques for wound care and pain management, as well as novel approaches to improving function and reducing disability prevention of electrical burns is essential due to the potential for serious consequences. This involves implementing safety measures in work place, wearing appropriate protective equipment, and avoiding contact with electrical sources whenever possible(3).

In addition to physical injuries electrical burns can also have significant psychological impact on those affected, including anxiety, depression, and post-traumatic stress disorder (PTSD). Treatment for electrical burns requires a comprehensive approach that addresses both physical and psychological needs(4).

Research into electrical burns is on-going, with the goal of improving understanding of their underlying mechanisms, refining treatment approaches,

and developing new preventive measures. While electrical burns remain a significant challenge, continued advancements in research and clinical practice offer hope for better outcomes and quality of life for those affected by these injuries(5).

One promising area of research is the use of stem cell therapy for electrical burn wounds. Stem cells have the potential to promote tissue regeneration and reduce inflammation, which can help accelerate healing and reduce scarring(6).

Another promising approach is the use of virtual therapy for pain management in burn patients. This therapy involves using immersive virtual environments to distract patient from their pain and can be particularly useful for those with electrical burns, which tend to be associated with high levels of pain(4).

Ultimately the prevention and treatment of electrical burns requires a multidisciplinary approach that involves collaboration between healthcare professionals, researchers, and industry partners. By working together to develop new prevention strategies, treatment approaches, and technologies, we can help reduce the incidence and impact of electrical burns(7).

In terms of prevention, it is important to promote public education and awareness about electrical safety, including safe usage of electrical appliances and equipment, as well as the dangers of power lines and electrical substations. This can help reduce the number of accidents and injuries caused by electricity(8).

In addition, industry partners can play a crucial role in developing and implementing new safety technologies, such as improved electrical insulation materials and better protective gear for workers who are exposed to electrical hazards(9).

Overall, while electrical burns continue to pose a significant threat to public health and safety, on-going research and collaboration can help mitigate these risks and improve outcomes for those who are affected(10).

1.2 Statement of the problem

Electrical burns are serious and potentially life-threatening injuries that occur when the body is exposed to electric current. Despite being a preventable injury the prevalence and outcomes of electrical burn remain a major health concern. The lack of awareness, education, and training on electrical safety practices is a major contributing factor to the high rate of electrical burns.

Furthermore, individuals who work in high risk industries or are exposed to electrical hazards on a regular basis are at increases risk of suffering an electrical injury. Understanding the prevalence and outcomes of electrical burns is crucial identifying ways to reduce the number of cases and improve the management of this injury.

1.3 Rationale of the Study

The study of the prevalence and outcomes of the electrical burns is important for several reasons. Firstly, it provides insight into the frequency and severity of the injury, which is necessary for developing and implementing effective prevention and treatment strategies. Secondly, it highlights the risk factors associated with electrical burns and helps to identify high-risk populations, such as workers in certain industries. This information can be used to develop targeted safety education and training programs. Lastly, understanding the outcomes of electrical burns is important for improving the management of the injury, including early identification and treatment, and the prevention of secondary complications. Overall, the study of the prevalence and outcomes of electrical burns is crucial for reducing the incidence and improving the management of this serious and potentially life-threatening injury.

And all the results of this study will be communicated to department of Emergency and critical care medicine and all the concern bodies will be communicated with the outcome of this study, for the improvement of quality care.

CHAPTER TWO

1. Literature Review

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 classified 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(1).

Several studies have identified demographic risk factors associated with electrical burns, including age, gender and occupation, young males and adults are at increased risk of electrical burn, as are occupations that are associated with exposure to electrical current, such as construction workers and electricians(2).

People exposed to the electrical injuries are often admitted to hospital for observation. Current evidence suggested that patients who are a normal ECG on admission after a low- voltage injury, short contact with electrical source and with no loss of consciousness or initial cardiac arrest may be discharged home after a quick clinical assessment(3).

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(9).

According to retrospective study done in 2018, the prevalence of electrical burns was 6.1% out of total 819 patients. The highest incidence rate of electrical burns was seen in males aged 21-30 years. The majority of the patients sustained electrical burns at work or during leisure activities(4).

In the United States, approximately 4400 victims are significantly injured by electrical hazards and 400 people die of exposure to electricity annually(4).

Also in another 10- year retrospective analysis of 376 cases at burn centre in China done in China, to investigate the epidemiological profile of electrical burn and associated outcomes and the results were 217 were high voltage injuries and 157 were low voltage injuries and men are the one most affected(11).

A retrospective study was conducted in electrical burn in Brazil, it was a chart review study in patients who were admitted with burns, and it was aimed to identify types of burns and their outcomes, out of 538 patients admitted with burns, 10.4% was electrical burn, and it was associated with worst outcome(12).

There is also a retrospective study done at Shiraz University of Medical Sciences in Iran in 2002, on burn patients and out 1352 patients, 64 cases (4.73%) was found suffered electrical burns. And also in this study 62.5% of electrical burns occurred during work time of construction workers and electrical technicians(13).

The severity of electrical burns is determined by the amount of electrical energy that has been absorbed by the body, which influenced by factors such as the pathway of the current, the duration of the exposure, and the voltage of the electrical source. High voltage electrical burns are associated with higher morbidity and mortality rates due to deeper tissue damage, including muscle, nerve and bone. The two major cardiac complications are arrhythmias and cardiac tissue injury, and Arrhythmias are the most common cardiac complication of electric injury some of them have reported rates varying widely from a few percentage points to almost 40%, a recent larger study has recorded significant arrhythmias in only 3% of monitored patients(14). The most frequent arrhythmias are sinus tachycardia and premature ventricular contractions, but atrial fibrillation and ventricular tachycardia or fibrillation have been reported(15).

A retrospectives study in German analyses the outcome of electrical burns in both High voltages injures and low voltages injuries, of 4075 patients, 162 patients (3.9%) with electrical injury were analysed. A total of 82 patients (50.6%) were observed with HVI. These patients were younger, had considerably higher morbidity and

mortality, and required more extensive burn surgery and more complex burn intensive care than patients with LVI. Admission CK and myoglobin levels correlated significantly with HVI, burn size, ventilator days, surgical interventions, amputation, flap surgery, renal replacement therapy, sepsis, and mortality. The highest serum levels were observed at PID 1 (myoglobin) and PID 2 (CK). In 23 patients (14.2%), cardiac arrhythmias were observed; only 4 of these arrhythmias occurred after hospital admission. The independent predictors of mortality were ventilator days (OR 1.27, 95% CI 1.06–1.51, $p = 0.009$), number of surgical interventions (OR 0.47, 95% CI 0.27–0.834, $p = 0.010$) and limb amputations (OR 14.26, 95% CI 1.26–162.1, $p = 0.032$) (8).

Regionally or in Africa there is study conducted in Ghana in 2014, and the study was to investigate the trends and mortality risk factors of electrical burns, was retrospective study and the burns registry was used, out of total 487 admissions 2.7% electrical burns, and 11(84.6%) was males and 2 females (15.4%), and the mortality risk factors were high voltage electrical burns, older age ($P=0.0250$), and TBSA > 20% ($P=0.048$),(10).

Compare to above studies, in Ethiopia there is some studies done on burn injuries in general, one of these studies was conducted at AaBET Hospital 2 years cross sectional review, electrical burn was about 26.6%, was electrical burns and adult males was most affected by electrical burns(12).

The treatment of electrical burns is determined by the severity the injury which is assessed by the extent of the body surface area affected, the depth of the burn and the presence of associated injuries, initial management of electrical burns patients includes the assessment and stabilization of the patient's airway, breathing, and circulation. This is followed by debridement or removal of dead tissue, dressing changes, and wound care(16).

Outcome measures for electrical burns can vary depending on the study design and the severity of the injury. The most commonly reported outcomes include the length of hospital stay, complications such as infection and amputation, and mortality rate(15).

According to studies done in India to study the impact of electrical burns and its impact on quality of life on these patients, 103 patients were included in the study and about 41% were required amputation(10)

A retrospective study done at the burn centre in USA, There were 38 high-tension injuries and 91 low-tension injuries. The average age was 33.7 years (5 months to 63 years), with burn wounds ranging from 1 to 57 per cent total body surface area (mean 9.5 per cent). Ninety-four (72.9 per cent) of these injuries were work related, and most occurred in males (85 per cent). A total of 323 surgical procedures were performed on those 129 patients. An average of 0.48 surgical debridement per patient was necessary in the low-tension injury group and only three partial finger or Toe amputations

were necessary. In the high-tension group, 27 major limb amputations were performed after 2, 3 debridement per patient, resulting in an overall major limb amputation rate of 35 per cent. The average length of stay was 22 days (2).

In another retrospective review don in USA, on outcome of electrical burn injuries, 162 patients with electrical burn was includes, 55 patients suffered high- voltage injuries, 55 also suffered low voltage injures, and 52 unknown voltage injures, high voltage injuries were more likely male males (98.2% vs. 83.6% low voltage vs. 94.2% unknown voltage, $p = 0.015$), to experience loss of consciousness (69.1% vs. 23.6% vs. 33.3%, $p < 0.001$), cardiac arrest (20% vs. 3.6% vs. 13.4%, $p = 0.032$), and undergo amputation (23.6% vs. 5.5% vs. 8.2%, $p = 0.024$). No significant differences were observed in long-term neurological deficits. Twenty-seven patients (16.7%) were found to have neurological deficits on or after admission; 48.2% recovered, 33.3% persisted, 7.4% died, and 11.1% did not follow-up with our burn centre. Electrical injuries are associated with protean sequel. Immediate complications include cardiac, renal, and deep burns. Neurologic complications, while uncommon, can occur immediately or are delayed(14).

2.1 Conceptual Frame work

Outcome of burn injury is affected by different factors. These factors divided into four groups. The conceptual framework shown in figure below helps to summarize the relationship between outcomes of burn injury with its associated factor(16).

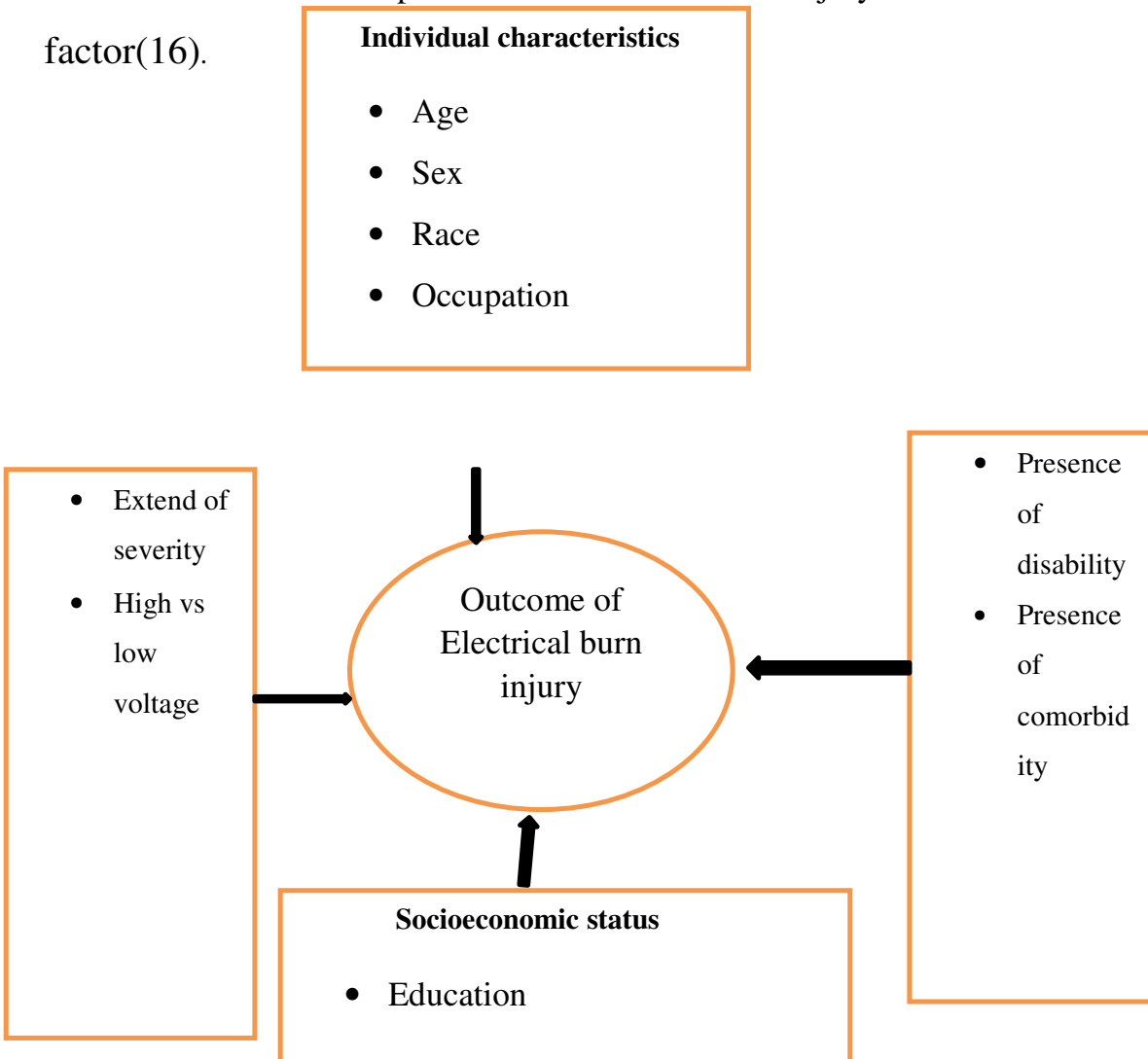


Figure 1 factors associated with outcome of burn injury

CHAPTER THREE

3.1 General Objective

The overall objectives of this study is to determine the prevalence of electrical burns and their outcomes at AaBET, Yakatit 12 and ALLERT hospital

3.2 Specific objectives

- 1- To assess prevalence of the electrical burn
- 2- To assess the outcomes of electrical burn patients who admitted to AaBET, Yakatit and Alert hospital
- 3- To investigate the outcomes of electrical burn victims, including the length of stay, and complications

CHARTER FOUR

4 Methods

4.1 Study Setting

This study was conducted at multicentre level, at AaBET, Yakatit 12 and Alert Hospital ED and burn centres in Addis Ababa/ Ethiopia

4.2 Study Period

The study period was 12 months from January 2022 to December 2022.

4.3 Study Design

A retrospective files review was conducted over the period of 12 months by reviewing the patient's charts

4.4 Study Population All patients who are admitted to AaBET, Yakatit 12 and Alert Hospital with electrical burn from January 2022 to December 2022

4.5 Inclusion and Exclusion criteria

4.5.1 Inclusion criteria:

- ✓ All patients who have been diagnosed with an electrical burn
- ✓ Patients who have sustained the injury due to contact with electricity, including exposure to electrical current, electrical discharge.

- ✓ participants who have received medical treatment for electrical burn
- ✓ Participants of all ages, genders and ethnicities.

4.5.2 Exclusion criteria:

- ✓ Participants who have not received medical treatment for electrical burn.

4.6 Sample Size

All patients that admitted to AaBET, Yakatit 12 and Alert Hospital, during the period of 2022 to December 2022

The minimal sample size will be calculated as follow:

Since the prevalence of the problem in the study is not well known in our setting, the P- value is taken as 50% (0.5) and 95% confidence interval will be used, with a 5% margin of error will be tolerated, the sample size was determined by using single population proportion formula.

$$n = \frac{(Z^{\alpha/2})^2 P(1-P)}{d^2} = \frac{(1.96)^2 \times 0.5(1-0.5)}{(0.05)^2} = \mathbf{384}$$

Where; n. required sample

Z. standard normal value at 95% CI which is 1.96

P-Estimated population proportion which is 0.5

d- Possible margin of error tolerated which is 0.05

Adding 10% non-response rate, the total sample size is **422** study subjects.

Sample size, $n = 384$. We deducted the sample size by finite population correction formula because our source of population is less than 10,000 patients admitted with electrical burn, and the calculated sample size was larger than 5% of the source population. Considering 10% incompleteness the corrected sample size is $n_o = 422$

$$n = n_o / (1 + n_o / N) = \frac{422}{1 + 422 \div 264} = \mathbf{162}$$

The sample from an infinite population $N = 264$, source population, number of Stroke patients seen within 8 months period in the previous year. Final sample size is **162** patients.

4.7 Sampling Procedures

simple random sampling technique was used, card number of electrical burns cases was used from AaBET, Yakatit 12 and Alert Hospital registration log book from the period of January 2022 to December 2022,

Then random numbers table was generated by a computer. From the generated random number, the first sample was marked by pencil anywhere in the table by looking away or closing eye. Subsequent sample was selected by going down the column and continuing on to the next column in the table until the 162 sample are obtained.

4.7.1 Data collection procedures

Data was collected from all eligible patient charts, and was collected from AaBET, Yakatit 12 and Alert Hospital registration log book, patients charts health information system, referral slip, death report, vital sign sheets, and medication sheets, then all the above data sources was reviewed for age, sex, whether high or low voltage and underlying diseases, occupations treatment given and outcome of the patients using structured questionnaire. The questionnaire was prepared from the articles in the literature reviews and based on the objectives relevant questionnaire component was added. The data collection tool was in English language and be filled. And data collectors were nurses.

4.8 Data management and analysis

Data was first checked manually for completeness and then entered and analysed using SPSS version 27. Bivariable and multivariable logistic regression analysis was used to identify prevalence and outcome of electrical burn injury. The Multivariable analysis was done to control (adjust) for possible confounding variable. During the analyses P-value < 0.05 with 95% confidence interval (CI) for OR (odds ratio) was used in judging the significance of the associations. Results were presented in text, tables, charts and graphs.

4.9 Study Variables

4.9.1 Dependent variable:

The prevalence and the outcomes from the electrical burn

4.9.2 Independent variable

- Age
- Sex
- Clinical presentation
- Extend of severity
- Presence of disability
- Presence of comorbidity

4.10 Operational Definitions

Conservative management: one of the burn patient's treatment options which includes fluid administration, wound care, administration of antibiotic, analgesics and tetanus toxoid only or in combination.

Outcome of burn injury: The end consequences of burn injury at the end of the treatment mentioned on patients card (complete recovery and recovery with scar or disfigurement).

Low voltage: is generally less than 600 V and found in the household current

High voltage: injuries, such as those caused by electrical power lines or occupational accidents,

4.11 Data Quality Control and Management

Preliminary test on 5% sample size outside of the study area was done. Training was given for data collectors and supervisors

The data was entered, cleaned, edited, and analysed using SPSS version 25.0 statistical software. To identify association between dependent and independent variables binary logistic regression was used with CI of 95%. P value < 0.05 was declared statistically significant association.

Multivariable logistic regression was done to analyses all independent variable with dependent variables

4.12 Ethical Consideration

Ethical clearance and approval to conduct the research was obtained from St. Paul Hospital Millennium Medical College and department of emergency medicine and critical care, Addis Ababa. Study holds no harm to study population and the confidentiality was guaranteed.

4.13 Dissemination of Results

The result was presented to department of emergency and critical care medicine as a defence. The copies of final results were submitted to St. Paul Hospital Millennium Medical Collage and were distributed to library, to postgraduate office and St. Paul Hospital administration office and Federal Ministry of health of Ethiopia. Lastly it will be presented on workshops, seminars and will be sent for international publication

5 RESULTS

5.1 Socio-demographic characteristics

A total of 162 electrical burn patients chart was reviewed and analysed on three study areas in this study. Among 162 patient's 144 (88.9%) patients are males and 18(11.1%) were females with a male to female ratio of 8:1. The age range of the patient was from 15 months to 75 years with a mean age of 38.73(SD 16.165) years. Age 26 to 35 are the most affected group 45(27.8%) followed by 15 to 25 age group 37(22.8%) 36 to 45 with 30 (18.5%) are next affected age group and elderly (age greater than 56 years) accounts 25(15.4%). Most of the patients are from urban areas 106(65.4%) and 56(33.6%) from rural area. From those the majority 43(26.3%) are from oromia region followed by Addis Ababa on 33(20.4%).

Table 1 Socio demographic character of electrical burn patients at Yekatit 12, AaBET and ALERT Hospitals, Addis Ababa, Ethiopia.

Variable	Category	Frequency	Percent (%)
Age	15-25	37	22.8
	26-35	45	27.8
	36-45	30	18.5
	46-55	25	15.4
	>56	25	15.4
Sex	Male	144	88.9
	Female	18	11.1
Residence	Rural	106	65.4
	Urban	56	33.6

Region	Oromia	43	26.5
	Addis Ababa	33	20.4
	SNNP	32	19.8
	Amhara	27	16.7
	Others	27	16.7

5.2 Clinical characteristics

About clinical presentation of electrical burn patients 37(22.8%) were had stable vital sign followed by shock at presentation 34(21%), 27(16.7%) of patients had arrhythmias, 26 (16%) of patients present with loss of consciousness, 25(15.4%) of patients had compromised air way and 13(8%) of patients died at presentation.

In this study, out of 162 patients 52(32.1%) of patients presented <6 hours of the injury this accounts the majority of the victims 37(22.8%) of patients presented to hospital within 6-12 hours of injury and the other 37(22.8%) of patients present within 12-24 hours of the injury happened but 36(22.2%) of patients present delayed or >24 hours of injury.

There were 15(9.3%) patients with preexisting medical history the others had no any medical history. From those who had preexisting medical history 8(4.9%) of patients had epilepsy followed by 4(2.5%) diabetes mellitus, 3(1.9%) hypertensive and HIV/AIDS and psychiatric patients accounts 1.2% .

About vital signs at presentation systolic blood pressure (SBP) on 77(47.5%) had<90 mmHg and 33 (23.5%) had 90-120 mmHg of SBP, 47(29.0%) of patients had >120mmHg of SBP. Pulse rate was

<100 on 100(61.7%) patients and >100 on 62(38.3%) injured, 62(38.3%) of patients had <10 g/dl of initial Hgb 52(32.1%) of patients had 10-13 g/dl and 48(29.6%) of patients had >13 g/dl Hgb. 21(13%) of patients were needed of oxygen support at presentation.

Table 2 clinical characteristics of electrical burn patients at Yekatit 12, AaBET and ALLERT Hospitals, and Addis Ababa, Ethiopia

Variable	Category	Frequency	Percent (%)
Clinical presentation	Stable	37	22.8
	Shock	34	21
	arrhythmias	27	16.7
	LOC	26	16
	Air way compromised	25	15.4
	Died	13	8
Duration of hours before presentation(hours)	<6	52	32.1
	6-12	37	22.8
	12-24	37	22.8
	>24	36	22.2
Pre-existing medical history	Epilepsy	8	4.9
	DM	4	2.5
	HTN	3	1.9
	HIV/AIDS	1	0.6
	Psychiatry	1	0.6

SBP(mmHg)	<90	77	47.5
	90-120	38	23.5
	>120	47	29.0
P/R (b/m)	<100	100	61.7
	>100	62	38.3
O2 support	Yes	21	13.0
	No	141	87.0
Initial Hg(g/dl)	<10	62	38.3
	10-13	52	32.1
	>13	48	29.6

About 90(55.6%) of electrical burn injury was happened at home, followed by work place 59(36.4%) school and street are also other place of burn with 10(6.2%), 3(1.9%) respectively. Of 162 victims 80(49.4%) was work related and 82(50.6%) was not work related and from those 8(4.9%) was intentional.

Most mechanism of electrical burn 51(31.5%) injury origin was domestic line repair followed by electronic equipment's by 45(27.5%) and construction site by 33(20.4%) and welding by 14(8.6%) other causes like live wire in field, live wire in factory and transformer are a list cause for electrical burn by 14(8.6%), 3(1.9%), 2(1.2%), respectively.

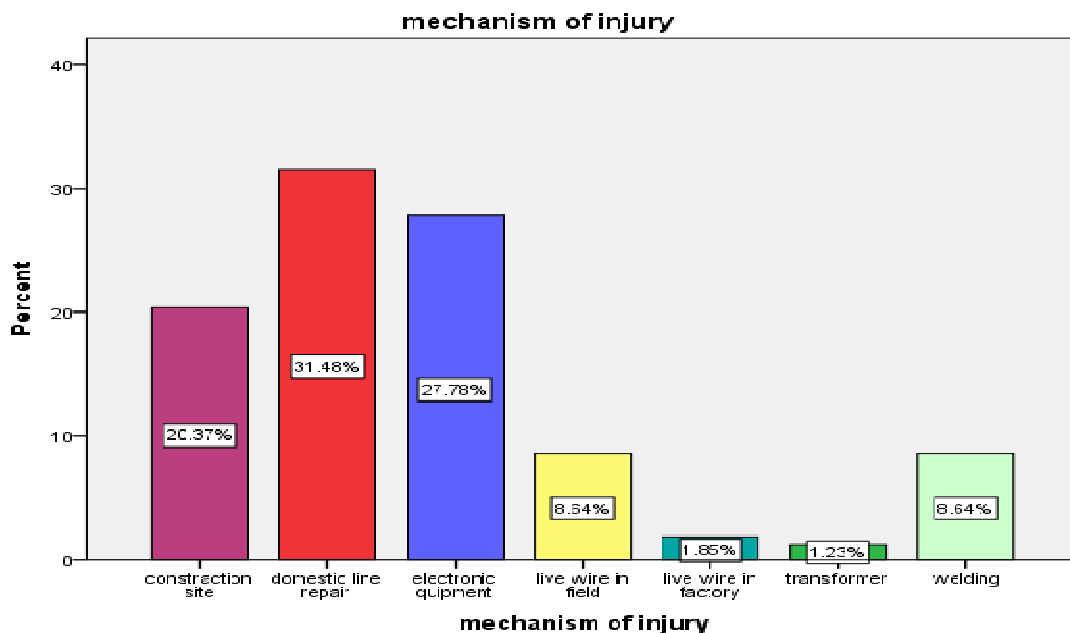


Figure 2 mechanism of injury of electrical burn patients at Yekatit 12, AaBET, and ALLERT Hospitals, Addis Ababa, Ethiopia.

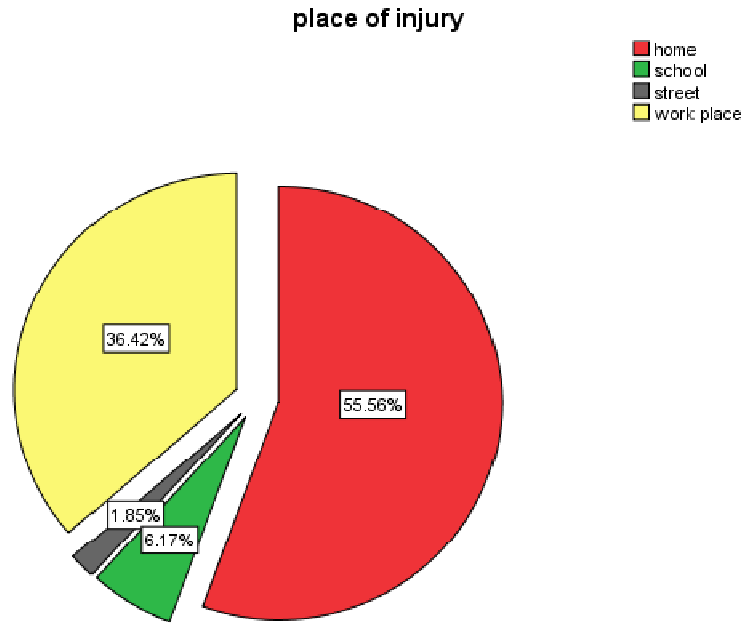


Figure 3 place of electrical burn injury of patients presented at Yekatit 12, AaBET, and ALLERT Hospitals, Addis Ababa, Ethiopia.

5.3 Anatomic locations of burn injuries

The upper extremity is the most affected body part and is involved in 85(52.5%) of followed by anterior trunk 27 (16.7%), the Lower extremity 26 (16.0%), posterior trunk 15 (9.3%), Head 5 (3.1%) and perineum 4 (2.5%).

The TBSA of the burns ranged from 1% to 36%. The mean area was 11.8% with a standard deviation of 4.79%. The 25th percentile was 9%, 50th percentile was 9%, and the 75th percentile was 18%.

Of the 162 patients, 125(77.2%) patients exposed for superficial/first degree burn , 28(17.3%) partial thickness/second degree burn and 9(5.6%) of patients were exposed for full thickness/third degree burn.

Patients with electrical burns are likely to have progressive necrosis and hence may need multiple surgeries. The patients usually required two debridements with a debridement in the first 24 h after resuscitation and a relook debridement after another 48 h. The maximum number of surgeries in a single patient was 4 .

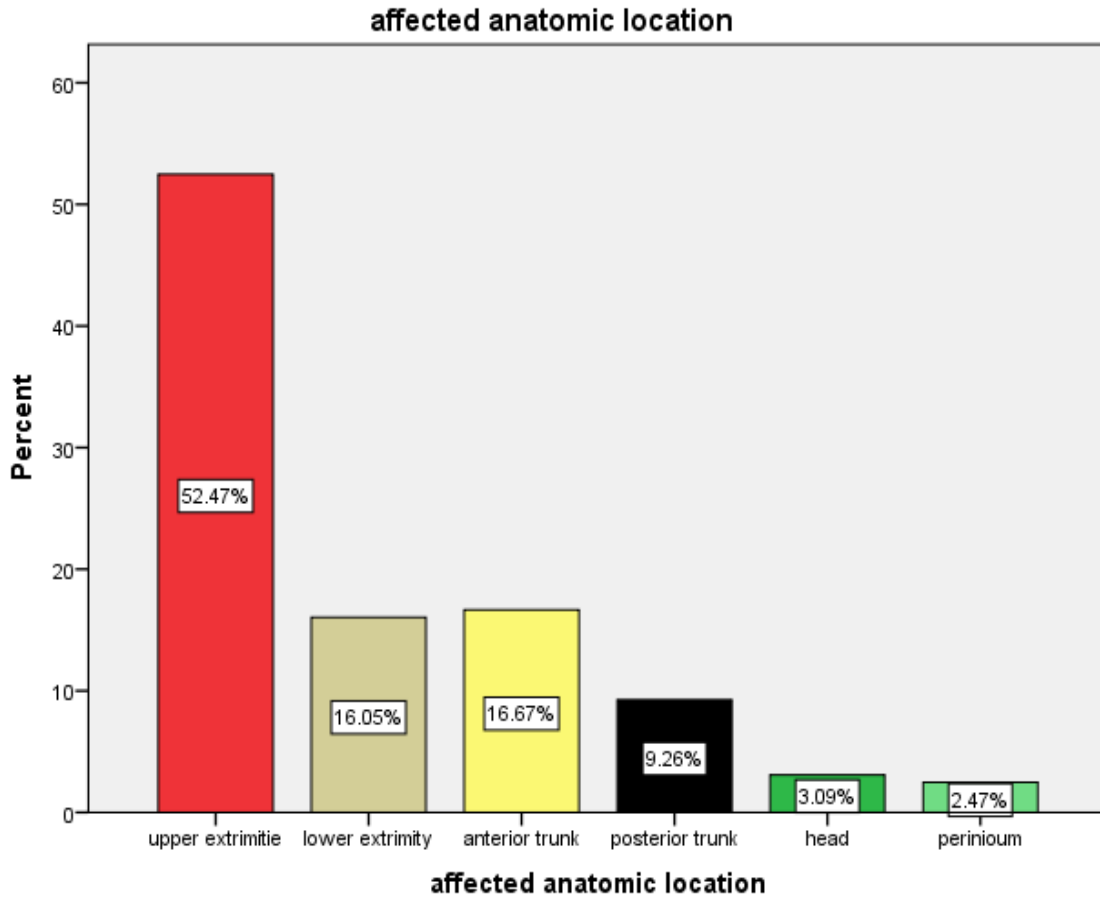


Figure 4 affected anatomical locations on patients presented with electrical burn at Yrkatit12, AaBET, and ALLERT hospitals, Addis Ababa, Ethiopia.

5.4 Management and outcome

Out of 162 patients 49(30.2%) were needed surgical intervention from those who needed surgery skin graft and skin flap are most frequent procedures done with 13(8%) each followed by contracture release on 12(7.4%), debridement 8(4.9%), fasciotomy 7(4.3%), and escharotomie accounts 3(1.9%) of electrical burn patients.

About 98.9 % of the patient took analgesia and wound care. Other care given includes fluid resuscitation for about 28(17.3%), TAT for 26(16%), burn wound management 23(14.2%), wound debridement for 8(4.9%), and IV antibiotics for 24(14.8%) of patients are given.

141(87.0%) of patients discharged from hospital and from those 58(35.8%) of patients needed an on-going medical care, 49(30.2%) had presence scarring or disfigurement during discharge and 34(21%) of patients led to work related disabilities. Twenty one patients died from those 9(5.6%) of patients died due to cardiac arrhythmia, 7(4.3%) due to acute renal failure and 4(2.5%) sepsis due to extensive exposed area. The mean length of hospital stay of the patient was 20.06 days with minimum disposal within one day and a maximum stay of 47 days.

5.5 Factors associated to outcome of electrical burn injury

Initially, cross tabulation were done for all variables to see existence of association between dependent and independent variables. Then, bi-variable and multivariable analyses were done to determine factors associated with outcome among electrical burn injury patients.

In a bivariate analysis of age, sex, burn TBSA% , delayed >24 before arrival to the hospital, early complication while in hospital stay, need for oxygen support during admission, affected anatomical location, depth of injury and length of stay are significantly associated with p-value <0.2. When the multivariable analysis was done age >56, sex, delayed >24, SBP<90, need for oxygen support, affected anatomical location anterior trunk, depth of injury 3rd degree burn were the only variable associated with a p-value of < 0.05. In multivariate analysis variables such as age >56 is 1.3 times more likely to cause death, AOR: 1.3(95%CI: 0.2, 2.43), delayed presentation to hospital >24 hours is 2.01 times more likely to cause death, AOR: 2.01(95%CI:

0.21, 2.18), affected anatomical location, being injured on anterior trunk 1.3 times more likely to cause death, AOR: 1.3(95%CI: 0.01,12.18), depth of burn, full thickness/3rd degree burn was 4.3 times more likely to cause death, AOR: 4.3(95%CI: 0.96, 19.3), . The above four variables were significantly associated with treatment outcome of electrical burn injury at the p-value of 0.05 with 95% CI.

Table 3 bi-variable and multivariable binary logistic regression analysis for outcomes, and associated factors of electrical burn Injury at Yekatit 12, AaBET, ALLERT Hospital, Addis Ababa, Ethiopia, (n=162)

Variables	Categories	Outcome of electrical burn patients		COR (95% CI)	p-value	AOR (95% CI)
		improved	Dead			
Sex	Male	126(87.5%)	18(12.5%)	1		
	Female	15(83.3%)	3(16.7%)	1.4	0.00	1.4(0.3-5.31)
Age	15-25	32(85.5%)	5(13.5%)	1		
	26-35	38(84.4%)	7(15.5%)	1.17	0.79	1.79(0.34-4.07)
	36-45	25(83.3%)	5(16.7)	1.28	0.71	1.8(0.33-4.9)
	46-55	22(88.0%)	3(12.0%)	0.87	0.8	0.1(0.1-2.4)

	>56	24(96.0%)	1(4.0%)	0.06	0.00	1.3(0.2-2.43)
Residence	Urban	90(84.9%)	16(15.1%)	1		
	Rural	51(91.1%)	5(8.9%)	0.55	0.00	0.17(0.19-1.59)
Place of injury	Home	80(88.9%)	10(11.1%)	1		
	School	9(90.0%)	1(10.0%)	0.8	0.9	0.14(0.03-0.54)
	Street	2(66.7%)	1(33.3%)	4	0.27	0.88(0.33-48.18)
	Work place	50(84.7%)	9(15.3%)	1.44	0.4	1.4(0.54-3.7)
Region	Addis Ababa	28(84.9%)	5(15.2%)	1		
	Oromia	38(88.4%)	5(11.6%)	0.73	0.65	0.58(0.19-2.79)
	SNNP	26(81.3%)	6(18.8%)	1.29	0.3	0.7(0.1-3.23)
	Amhara	24(88.9%)	3(11.1%)	0.7	0.08	0.88(0.1-2.5)
	Other	25(92.6%)	2(7.4%)	0.44	0.71	1.6(0.76-2.44)
Is work related	Yes	74(92.5%)	6(7.5%)	1		
	No	67(81.7%)	15(18.3%)	2.76	0.047	1.2(1.01-7.52)
Duration from time of accident-arrival(Hrs)	<6	42(80.8%)	10(19.2%)	1		
	6-12	35(94.6%)	2(5.4%)	0.24	0.07	0.31(0.04-1.16)
	12-24	33(89.2%)	4(10.8%)	0.5	0.288	5(0.14-

						1.77)
	>24	31(86.1%)	5(13.9%)	0.67	0.014	2.01(0.21-2.182)
SBP at ED (mmHg)	<90	60(77.9%)	17(22.1%)	1		
	90-120	37(97.4%)	1(2.6%)	0.09	0.02	0.9(0.01-0.7)
	>120	44(93.6%)	3(6.4%)	0.24	0.03	0.6(0.06-0.87)
HR at ED (b/m)	<100	84(84.0%)	16(16.0%)	1		
	>100	57(91.9%)	5(8.1%)	0.46	0.15	0.19(0.16-1.32)
O2 support	Yes	18(85.7%)	3(14.3%)	1		
	No	123(87.2%)	18(12.8%)	0.87	0.04	0.16(0.23-3.2)
Presentation	Stable	37(100%)	0(0.00%)	1		
	Shock	30(88.2%)	4(11.8%)	0.00		
	Arrhythmia	25(92.6%)	2(7.4%)	0.00		
	LOC	26(100%)	0(0.00%)	0.00		
	Air way compromised	22(88.0%)	3(12.0%)	0.00		
	Died	1(7.7%)	12(92.3%)	0.00		
Affected anatomical location	Upper extremity	77(90.6%)	8(9.4%)	1		
	Lower extremity	23(88.5%)	3(11.5%)	1.25	0.7	
	Anterior trunk	19(70.4%)	8(29.6%)	4	0.01	1.3(0.01-12.18)
	Posterior trunk	13(86.7%)	2(13.3%)	1.4	0.64	0.1(0.28-7.7)
	Head	5(100%)	0(0.00%)	0.00		

	Perineum	4(100%)	0(0.00%)	0.00		
Mechanism of injury	Construction site	29(87.9%)	4(12.1%)	1		
	Domestic line repair	46(90.2%)	5(9.8%)	0.78	0.73	0.788(0.1-3.17)
	Electronic equipment	38(84.4%)	7(15.6%)	1.33	0.66	3(0.35-5.49)
	Live wire in field	11(78.6%)	3(21.4%)	1.9	0.41	1.22(0.38-10.2)
	Live wire in factory	2(66.7%)	1(33.3%)	3.6	0.33	3(0.26-49.7)
	Transformer	2(100%)	0(0.00%)	0.00		
	Welding	13(92.9%)	1(7.1%)	0.5	0.61	6(0.057-5.49)
Baseline hemoglobin	<10	48(77.4%)	14(22.6%)	1		
	10-13	47(90.4%)	5(9.6%)	0.36	0.07	0.6(0.122-1.09)
	>13	46(95.8%)	2(4.2%)	0.14	0.015	0.1(0.32-0.69)
Depth of injury	Superficial/1 st degree	112(89.6%)	13(10.4%)	1		
	Partial thickness/2 nd degree	23(82.1%)	5(17.9%)	1.87	0.27	0.2(0.6-5.76)
	Full thickness/3 rd degree	6(66.7%)	3(33.3%)	4.3	0.05	4.3(0.96-19.3)
Pre-existing medical history	Yes	12(80.0%)	3(20.0%)	1		
	No	129(87.8%)	18(12.2)	0.55	0.4	0.25(0.14-2.1)
Interventions provided	Fluid replacement	26(92.9%)	2(7.1%)	1		

during hospitalization	Burn wound management	21(91.3%)	2(8.7%)	1.23	0.83	0.11(0.16-9
	Antibiotics	22(91.7%)	2(8.3%)	1.18	0.87	0.76(0.15-9.09)
	Pain management	21(100%)	0(0.00%)	0.00		
	TAT	25(96.2%)	1(3.8%)	0.52	0.99	
	Surgery	26(92.9%)	2(7.1%)	1.0	0.04	1.17(0.13-7
Is surgical intervention needed	Yes	45(91.8%)	4(8.2%)	1		
	No	96(85.0%)	17(15.0%)	1.99	0.23	0.89(0.63-6.26)
Type surgical procedure done	Fasciotomy	7(100%)	0(0.00%)	1		
	Escharotomy	3(100%)	0(0.00%)	0.00		
	Skin graft	13(100%)	0(0.00%)	0.00		
	Skin flap	13(100%)	0(0.00%)	0.00		
	Contracture release	12(100%)	0(0.00%)	0.00		
	Debridement	5(100%)	0(0.00%)	0.00		
Discharge status	Presence of scar/disfiguration	49(100%)	0(0.00%)	0.00		
	Need for on-going medical care	58(100%)	0(0.00%)	0.00		
	Work related disability	34(100%)	0(0.00%)	0.00		
	Died	0(0.00%)	21(100%)	0.00		

*P value less than 0.05 were significant, 1 reference group

6. Discussion

Electrical burn is still an important and challenging problem in burn centres with a higher incidence in developing countries. It has an admission rate of 21–27% in developing countries versus 3–5% in developed ones(3). The increasing incidence of electrical burns is due to the increasing use of electric current in everyday life and an increasing population. In this study, 88.9% of the patients with electrical burn were men with a male-to-female ratio of 8:1, and this is also comparable with other studies done in our setting(12). Similar findings have been reported in various studies. This may be due to the adventurous nature of males and their greater desire to be active compared to females. In a study in Turkey, 95% of such patients were men(17). In a study conducted in Taiwan, 92.5% of patients with electrical burn were men(18).

The upper extremity is the most affected body part and is involved in 85(52.5%) of followed by the anterior trunk 27 (16.7%), the Lower extremity 26 (16.0%), posterior trunk 15 (9.3%), Head 5 (3.1%) and perineum 4 (2.5%). In 73% of the case, there is the involvement of two or more body parts involvement. This is higher but consistent in part involved from a study done in another region of Ethiopia like 43.3% in a study of Frehiwot Girma, Bahirdar, Ethiopia (19) and 45.4% in a study Sielu Alemayehu, Ayder, Mekele, Ethiopia(12).

Most of the patients come to all study area hospitals by out of Addis Ababa. Among them, 98.9% of patients received some sort of treatment which include, Resuscitation fluid, analgesia, wound care,

oxygen administration, fasciotomy, or a combination of them. Gaps are observed in handling the patient, starting available appropriate treatment, and documentation as well as delays in the referral system. This could affect most unstable patients in getting definite management. A similar problem is faced in other countries like Indonesia (according to Aditya Wardhana study), in which, patients wait for a longer time to get a referral to a territory center where the subspecialists are available (20). This is due to the scarcity of facilities as well as equipment and manpower faced by most developing countries

affected anatomical location, being injured on anterior trunk 1.3 times more likely to cause death, AOR: 1.3(95%CI: 0.01,12.18), depth of burn, full thickness/3rd degree burn was 4.3 times more likely to cause death, AOR: 4.3(95%CI: 0.96, 19.3), . The above four variables were significantly associated with treatment outcome of electrical burn injury at the p-value of 0.05 with 95% CI. This study is consistent with the study done in South Gondar zone government hospitals(21), and Bahir Dar, Ethiopia (21). This is supported by the scientific evidence of those who have a larger body surface area of burn are prone to complex fluid shifts, including system-wide extravasation of fluids into unburned tissues. This results in resultant intravascular hypervolemia which can produce ischemia to body organs, lactic acidosis, and eventual cardiovascular collapse, which increases the risk of mortality and complications(22).

In this study, delayed presence to hospital after injury, depth of injury, affected anatomical location was the leading cause of death which is in comparable with other studies(8) .

In this study, the reported mortality was 11.4%, which is slightly higher than several studies. In other studies, a mortality rate of 2.8–6% was reported(4). However, with more severe injury in electrical burns, studies have shown that the quality of life in patients with electrical burn is similar to other burns (23). As early skin graft is recommended as an effective method in electrical burns, so, decision

making on delayed debridement, amputation and skin graft is important. The findings of the present study and similar ones showed that the electrical injuries have occurred more in 20–40 years old men while working with repairing domestic equipment's. We showed that 48.9% of electrical burns occurred in home setting, which may be due to unskilled electrical repairing or unsafe electronics equipment use. Although hospital mortality caused by this type of burn seems less than non- electrical burns, a high mortality caused by high voltage electric shock occur on the accident site. In developing countries, the incidence of electrical burns is high due to nearness of electrical posts to houses, presence of unskilled persons in electrical fields and lack of public educational programs. Regarding the increasing growth of electricity distribution and use in developing countries, and ignorance of labor standards, electrical burn can be considered as one of the most important health problems in our country. Public educational programs for the people and those working in electrical fields and for those who try repair electrical equipment's at home setting can be beneficial to reduce the incidence of electrical burns

Strengths and limitations of the study

Strength

Since there was no published study on electrical burn specifically, this study will give information about the overall electrical burn patient outcome. Furthermore, it will help to identify gaps and give a solution for them.

Limitation

- The study was a retrospective documentary review, there were challenges like incomplete documentation at all sites of care(like subsequent day-to-day progress of the patients), an inconsistent subsequent clinical feature of the patient, ineligible handwriting, and no or unclear information for some variables(type of analgesia, amount and dosage of fluid taken at pre-hospital levels).
- Due to the nature of the study, information gathered by taking history, doing a physical examination, or simple observations are missed (like socioeconomic status, housing condition, circumstance while the event occurs
- The study was not blinded, which could have introduced bias into the results.
- The study did not collect data on all potential confounders, which could have resulted in residual confounding.
- We can't differentiate whether the electrical burn injury happen by high voltage or low voltage since it's not stated on the chart

7. Conclusion and Recommendation

7.1 conclusion

The present study was conducted to assess the outcomes of electrical burn injury in Yekatit 12, AaBET, and ALLERT hospital in Ethiopia. The results showed that males were highly exposed to electrical burn injury, with a mean age of 38 years which is a working or productive age. The majority of the injuries occurred at home or during domestic electrical repairing. The overall mortality rate was 11.4%. The most common risk factors for electrical burn injury were male sex, age >56 years, and depth of burn.

The findings of this study suggest that electrical burn injury is a significant public health problem in Ethiopia. Targeted interventions are needed to reduce the incidence and mortality of electrical burn injury in this country. Therefore, timely identification and monitoring of burn injury should be necessary to prevent the mortality of burn victims, and it is highly recommended to give priority to preventive measures and improve prehospital care service.

7.2 Recommendation

Based on the findings of this study, the following recommendations are made:

- Electrical burn injury is a significant public health problem in Ethiopia. Targeted interventions are needed to reduce the incidence and mortality of electrical burn injury in this country.
- The government should develop and implement a national strategy to prevent electrical burn injury. This strategy should

include public awareness campaigns, education programs for electrical workers, and regulations to improve the safety of electrical equipment.

- Hospitals should develop and implement protocols for the management of electrical burn injury. These protocols should include guidelines for triage, resuscitation, wound care, and pain management.
- Research is needed to identify new and improved methods for the prevention and treatment of electrical burn injury. This research should focus on developing safer electrical equipment, improving the training of electrical workers, and developing new treatments for electrical burn injury.

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7. ANNEX

Assurance of Principal Investigator

I the undersigned agree to accept all responsibilities for the scientific and ethical conduct of the research project. I will provide timely progress report to my advisor and seek the necessary advice and approval from my primary advisors

in the course of the research. I will communicate timely to my advisors all stakeholders involved in the study including any source of funding for this research.

Name of the student: _____

Signature: _____

Date: _____

Approval of the Primary Advisor

Name of the primary advisor: _____

Signature: _____

Date: _____

Approval of the Co-Advisor

Name of the primary advisor: _____

Signature: _____

Date: _____

Questionnaire

1, Patient information

MRN:

Age: -----

2. Sex 1. male 2. Female

3, Residence 1 urban 2 Rural

4. Region

1. Addis Ababa

2. Oromia

3. SNNP

4. Amhara

5. other

5 Place of injury

1. Home

2. School

3. Street

4. Work place

4. Others (specify)

6, Affected anatomic location/s of the burn

1. Upper extremities

2. Lower extremities

3. Anterior trunk

4. Posterior trunk

5. Head

6. Perineum

7. Face and neck

7. Depth of burn injury

1. Superficial/first degree burn

2. Partial thickness/second degree burn

3. Full thickness/third degree burn

8. Extent of burn injury (% of total burn surface area burned) _____

9. was the injury intentional

1. Yes

2.NO

10. Any preexisting medical condition

1. yes

2. no

11. If yes for Q9 what is the diagnosis

1. HTN

2. HIV/AIDS

3. Diabetes mellitus

4. Malnutrition

5. Epilepsy

6. Psychiatry disorder

7. Others (specify)_____

12. Clinical presentation at the time of admission

1. Stable

2. Shock
3. Arrhythmia
4. Loss of consciousness
5. Airway compromise
6. Died
- 13.** Duration of time in home before getting medical attention after burn injury (in hours)
 1. <6
 2. 6-12
 3. 12-24
 4. >24
- 14.** Length of hospital stays _____
- 15.** What was the Intervention provided during hospitalization,
 1. Fluid replacement
 2. Burn wound management
 3. Antibiotic
 4. Pain management
 5. Tetanus toxiod
 6. Surgery
 7. Other (specify)_____
- 16.** Does the surgical procedure done 1. Yes 2. No
- 17.** If the surgery was done ,what type of surgery performed
 1. Fascioctomy
 2. Escharotomie
 3. Skin graft
 4. Skin flap
 5. Contracture release
 6. Debridement
 7. Other_____
- 18.** How many surgeries are done for a patient
- 19,** is the injury work related 1. Yes 2. No
- 20,** Systolic BP 1. <90mmhg 2. 90-120 mmgh 3. >120mmhg
- 21,** PR1. <100b/m 2. > 100b/m

22, does the patient needs O2 support at presentation 1. Yes 2. No

23, Hg at presentation

1. <10 2. 10-13 3. >13

24. Mechanism of injury

1. Construction site
2. Domestic line repair
3. Electrical equipment
4. Live wire in field
5. Live wire in factory
6. Transformer

17. Welding

25. Discharge statuses

1. Presence of scarring or disfigurement
2. Need for ongoing medical care
3. Work related disability
4. Mortality (if applicable)

26. Cause of death 1. Acute renal failure 2. Cardiac arrhythmia 3. Sepsis

27. Final outcome 1. Discharged 2. Died