“AN OBSERVATIONAL EPIDEMIOLOGICAL ANALYSIS OF PATIENTS ADMITTED WITH ELECTRICAL BURN INJURIES OVER LAST 6 YEARS”

A research report submitted to the Department of Plastic Surgery, M.G.R University, Chennai, Tamil Nadu for the partial fulfilment of the requirements for the degree of M.Ch. in Plastic Surgery.

CHRISTIAN MEDICAL COLLEGE, VELLORE 2015

CERTIFICATE

This is to certify that the work presented in this dissertation entitled **"AN OBSERVATIONAL EPIDEMIOLOGICAL ANALYSIS OF PATIENTS ADMITTED WITH ELECTRICAL BURN INJURIES OVER LAST 6 YEARS"** is a bonafide work done by Dr. Gohil Amish Jayantilal, Christian Medical College, Vellore, Tamil Nadu done towards the partial fulfillment of the requirements of the Tamil Nadu **Dr. M.G.R Medical University, Chennai** for degree of M.Ch. Plastic Surgery under my guidance and supervision.

Dr. ASHISH KUMAR GUPTA
Guide, Professor and Head,
Department of Plastic Surgery,
Christian Medical College, Vellore.
Dated:

Dr. ALFRED JOB DANIEL
Principal
Christian Medical College,
Vellore.
Dated:

CANDIDATE'S DECLARATION

I, Dr. GOHIL AMISH JAYANTILAL, declare that this report is my own work. It is being submitted for the degree of Master of Chirurgical in Plastic Surgery, MGR University, Chennai, Tamil Nadu. It has not been submitted before for any degree or examination at this or any other university.

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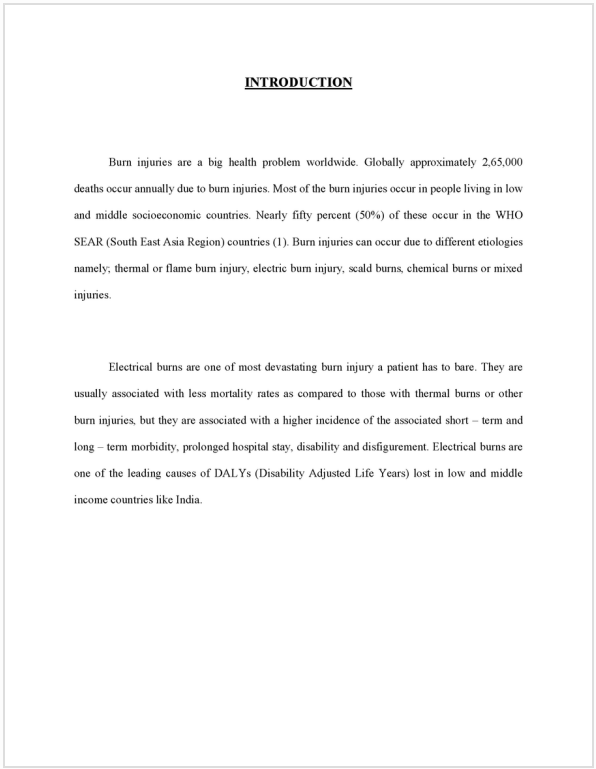

INTRODUCTION

Burn injuries are a big health problem worldwide. Globally approximately 2,65,000 deaths occur annually due to burn injuries. Most of the burn injuries occur in people living in low and middle socioeconomic countries. Nearly fifty percent (50%) of these occur in the WHO SEAR (South East Asia Region) countries (1). Burn injuries can occur due to different etiologies namely; thermal or flame burn injury, electric burn injury, scald burns, chemical burns or mixed injuries.

Electrical burns are one of most devastating burn injury a patient has to bare. They are usually associated with less mortality rates as compared to those with thermal burns or other burn injuries, but they are associated with a higher incidence of the associated short – term and long – term morbidity, prolonged hospital stay, disability and disfigurement. Electrical burns are one of the leading causes of DALYs (Disability Adjusted Life Years) lost in low and middle income countries like India.

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Director, Christian Counseling Center,
Chairperson, Ethics Committee.

Dr. Alfred Job Daniel, D Ortho, MS Ortho, DNB Ortho
Chairperson, Research Committee & Principal

Dr. Nihal Thomas,
MD., MNAMS., DNB (Endo), FRACP (Endo), FRCP (Edin), FRCP (Glasg)
Deputy Chairperson
Secretary, Ethics Committee, IRB
Additional Vice Principal (Research)

February 11, 2015

Dr. Gohil Amish Jayantilal
Sr. PG Registrar
Department of Plastic Surgery
Christian Medical College, Vellore 632 004

Sub: **Fluid Research Grant Project:**
An observational epidemiological analysis of patients admitted with electrical burn injuries over last 6 years.
Dr. Gohil Amish Jayantilal, Plastic Surgery, Dr. Ashish Kumar Gupta, Plastic Surgery, CMC, Vellore.

Ref: IRB Min No: 9259 [OBSERVE] dated 12.01.2015

Dear Dr. Gohil Amish Jayantilal,

The Institutional Review Board (Blue, Research and Ethics Committee) of the Christian Medical College, Vellore, reviewed and discussed your project entitled "An observational epidemiological analysis of patients admitted with electrical burn injuries over last 6 years." on January 12th 2015.

The Committees reviewed the following documents:

1. IRB Application format
2. Curriculum Vitae' of Drs. Gohil Amish Jayantilal, Ashish Kumar Gupta
3. Proforma
4. No of documents 1 – 3

The following Institutional Review Board (Blue, Research & Ethics Committee) members were present at the meeting held on January 12th 2015 in the CREST/SACN Conference Room, Christian Medical College, Bagayam, Vellore 632002.

Name	Qualification	Designation	Other Affiliations
Dr. Inian Samarasam	MS, FRCS, FRACS	Professor,Surgery, CMC	Internal, Clinician

Ethics Committee Blue, Office of Research, 1st Floor, Carman Block, Christian Medical College, Vellore, Tamil Nadu 632 002.
Tel : 0416 - 2284294, 2284202 Fax : 0416 - 2262788, 2284481 E-mail : research@cmcvellore.ac.in

Dr. B.J. Prashantham, M.A., M.A., Dr. Min (Clinical)
Director, Christian Counseling Center,
Chairperson, Ethics Committee.

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MD., MNAMS., DNB (Endo), FRACP (Endo), FRCP (Edin), FRCP (Glasg)
Deputy Chairperson
Secretary, Ethics Committee, IRB
Additional Vice Principal (Research)

Dr. Anuradha Rose	MBBS, MD	Assistant Professor, Community Health, CMC	Internal, Clinician
Mrs. Emily Daniel	MSc Nursing	Professor, Medical Surgical Nursing, CMC	Internal, Nurse
Mr. C. Sampath	BSc, BL	Legal Expert, Vellore	External, Legal Expert
Rev. Joseph Devaraj	B. Sc, BD	Chaplaincy Department, CMC	Internal, Social Scientist
Dr. Nihal Thomas	MD, MNAMS, DNB(Endo), FRACP(Endo) FRCP(Edin) FRCP (Glasg)	Professor & Head, Endocrinology. Additional Vice Principal (Research), Deputy Chairperson, IRB, Member Secretary (Ethics Committee), IRB	Internal, Clinician

We approve the project to be conducted as presented.

The Institutional Ethics Committee expects to be informed about the progress of the project, any **adverse events** occurring in the course of the project, any **amendments in the protocol and the patient information / informed consent**. On completion of t`he study you are expected to submit a copy of the **final report**. Respective forms can be downloaded from the following link: http://172.16.11.136/Research/IRB_Polices.html in the CMC Intranet and in the CMC website link address: http://www.cmch-vellore.edu/static/research/Index.html.

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MD., MNAMS., DNB (Endo), FRACP (Endo), FRCP (Edin), FRCP (Glasg)
Deputy Chairperson
Secretary, Ethics Committee, IRB
Additional Vice Principal (Research)

Fluid Grant Allocation:

A sum of 7,000/- INR (Rupees Six Thousand only) will be granted for 6 months.

Yours sincerely

Dr. Nihal Thomas
Secretary (Ethics Committee)
Institutional Review Board

Dr. NIHAL THOMAS
MD.,MNAMS.,DNB(Endo),FRACP(Endo),FRCP(Edin),FRCP(Glasg)
SECRETARY - (ETHICS COMMITTEE)
Institutional Review Board,
Christian Medical College, Vellore - 632 002.

Cc: Dr. Ashish Kumar Gupta, Plastic Surgery, CMC, Vellore.

IRB Min No: 9259 [OBSERVE] dated 12.01.2015

Ethics Committee Blue, Office of Research, 1st Floor, Carman Block, Christian Medical College, Vellore, Tamil Nadu 632 002.
Tel : 0416 - 2284294, 2284202 Fax : 0416 - 2262788, 2284481 E-mail : research@cmcvellore.ac.in

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I am indebted to my patients whose data records helped me to carry out this work. I would express my profound and sincere gratefulness to all the authors whose work helped me throughout this task.

I would like to express my profound and sincere love to my parents and wife for their constant inspiration with love and affection throughout my life.

Before concluding, this is my heartily prayer to 'THE ALMIGHTY' for well being of those who helped me to complete this work.

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INTRODUCTION

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Burn injuries are a big health problem worldwide. Globally approximately 2,65,000 deaths occur annually due to burn injuries. Most of the burn injuries occur in people living in low and middle socioeconomic countries. Nearly fifty percent (50%) of these occur in the WHO SEAR (South East Asia Region) countries (1). Burn injuries can occur due to different etiologies namely; thermal or flame burn injury, electric burn injury, scald burns, chemical burns or mixed injuries.

Electrical burns are one of most devastating burn injury a patient has to bare. They are usually associated with less mortality rates as compared to those with thermal burns or other burn injuries, but they are associated with a higher incidence of the associated short – term and long – term morbidity, prolonged hospital stay, disability and disfigurement. Electrical burns are one of the leading causes of DALYs (Disability Adjusted Life Years) lost in low and middle income countries like India.

APPLIED ANATOMY

The skin is the largest organ of the body containing many important structures. Histologically, the skin has two main layers namely; the epidermis and the dermis. The epidermis is the outermost layer of skin and made up of five layers:

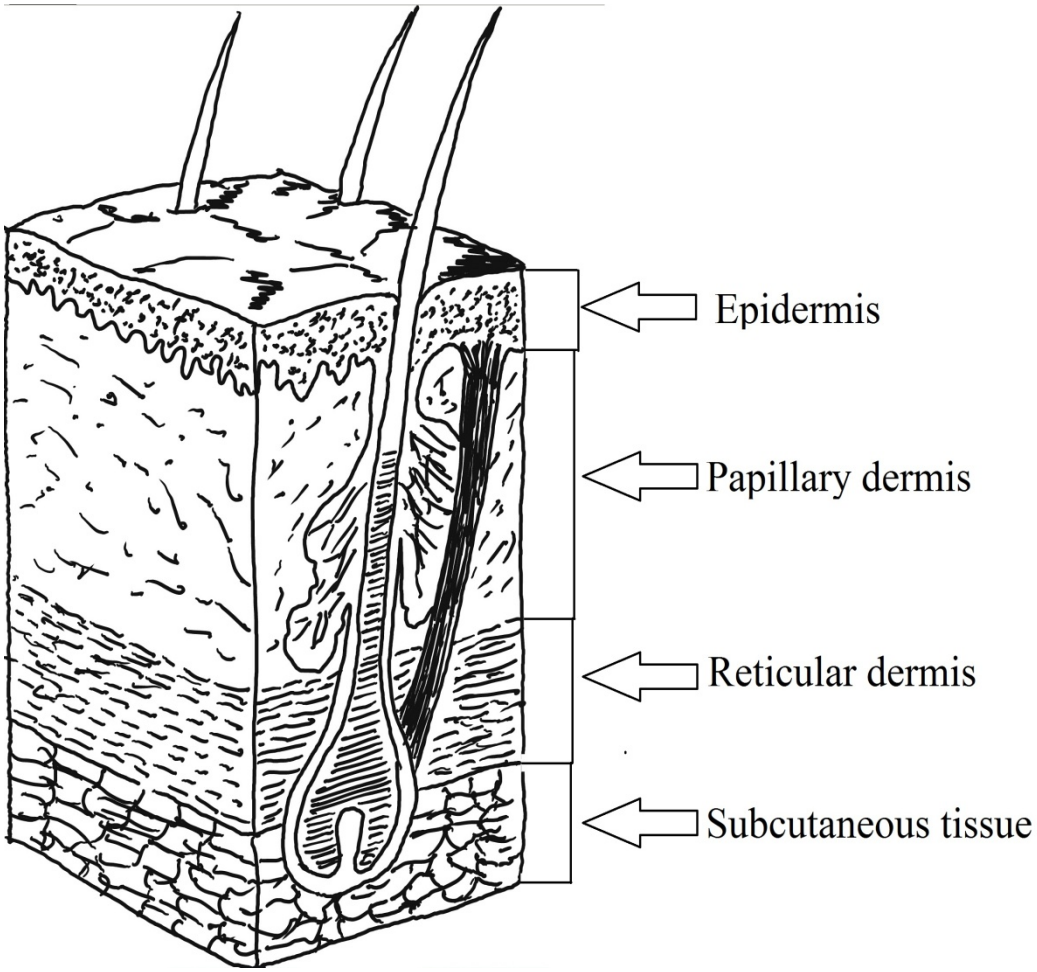
1. Stratum corneum (Cornified layer)
2. Stratum lucidum (Clear/translucent layer)
3. Stratum granulosum (Granular layer)
4. Stratum spinosum (Spinous layer)
5. Stratum basale/germinativum (Basal/Germinal layer).

The dermis is the deeper layer immediate below the epidermis. It is separated from the epidermis by a thin layer of basement membrane. The dermis is divided into two regions:

1. Papillary dermis, which consists of areolar connective tissue.
2. Reticular dermis, which consists of irregular dense connective tissue made of collagen fibres and elastin. This layer provides the skin its strength.

Below the dermis lies the subcutaneous tissue. The dermis consistes of mamy vitals structures like capillary blood vessels, lymphatic channels, sensory nerve endings like tactile receptors, pacinian corpuscles, meissener's corpuscles, sweat glands, sebaceous glands, hair and its follicles and arrector pili muscles attached to the hair follicle.

Diagram of skin



Degree of burns	Depth of skin involved
First degree	Only epidermis
Second degree (Superficial)	Epidermis and part of dermis (papillary)
Second degree (Deep)	Epidermis and dermis (papillary & reticular)
Third degree	Up to subcutaneous tissue

PATHOPHYSIOLOGY OF BURNS

The seriousness of electrical burn injury is established by the voltage, amperage, type, route of flow of current, contact duration and it varies from one person to person based on one's vulnerability. In most injuries, the affected person is aware of the voltage of the electric current but not about the amount of current (in amperes).

The relation between the current flow and voltage is given by Ohm's law, which can be mathematically put as:

Current (I) = Voltage (V) / Resistance (R).

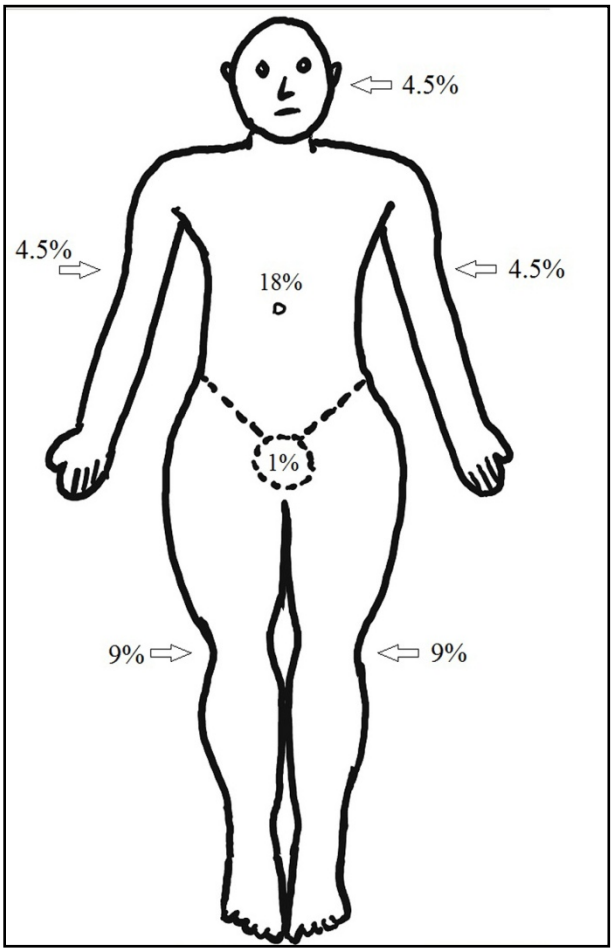
The type of current involved can be either alternating current (AC) or direct current (DC). Alternating current causes continuous jerky contractions of the muscles, often throwing the patients away from the point of contact or sometimes it can cause a continuous contact. Drowsiness, unexplained irritability, unconsciousness are all signs reported in patients with high tension injuries or where patients had a prolonged contact with the current source.

Resistance at the point of contact is different in various situations. It is low if the hands a sweaty and higher in dry skin during the winters. Whenever electric current flows through any tissue, it generates heat. The amount of heat generated can be known if the resistance through the tissue is known. As per Joule's law, the amount of power or heat generated in a tissue when electric current passes through it is given by the formula:

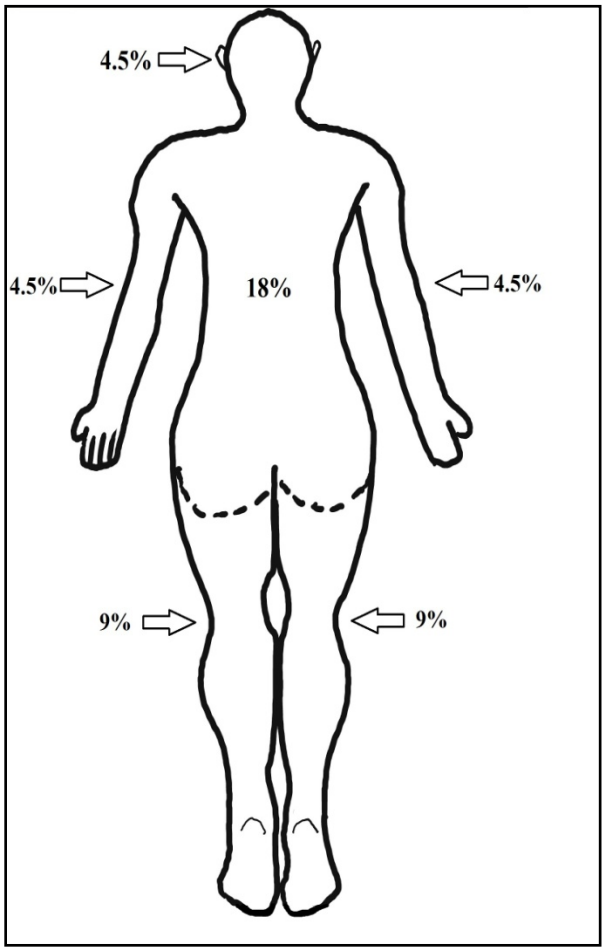
$$\text{Power (J-Joule)} = I^2 \text{ (Current)} \times R \text{ (Resistance)}$$

Resistance to the flow of electric current varies from tissue to tissue. The highest resistance is provided by the bones, followed by fat, tendon, skin, muscle, arteries and veins and finally the nerves, for which resistance to flow of current is the least. Thus, as per Joule's law, hypothetically, the tissues that have higher resistance would generate more amounts of heat and vice-versa. But in reality, this is not always true. The deeper tissues, especially the bones, tend to hold heat such that the surrounding tissues sustain a more severe injury as compared to the superficial tissues. The vascular damage that occurs during this period is instant and practically irreversible. The cells of the tissues involved are both directly and indirectly damaged in the process, for example the damage that occurs to the brain cells which is not totally explained by peri-cranial heat. One of mechanisms by which this damage can occur is by obliteration of the cell membranes by disruption of the Na-K-ATPase pump due to the high tension current.

CALCULATION OF BURNS PERCENTAGE



ANTERIOR ASPECT



POSTERIOR ASPECT

The percentage of total body surface area burnt is commonly done by Wallace's rule of nine. There are many other methods describes like Lund-Browder chart and area of palm of each patient which is approximately 1% of the body surface area.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Burn injuries constitute to as an enormous health problem worldwide. Internationally approximately 2,65,000 deaths occur annually due to burn injuries. Most of the burn injuries occur in people living in low and middle socioeconomic strata or developing countries. Nearly fifty percent (50%) of these occur in the WHO SEAR (South East Asia Region) countries (1).

Burn injuries can occur due to different etiologies namely; thermal or flame burn injury, electric burn injury, scald burns, chemical burns or mixed injuries. Electrical burns are one of most devastating burn injury a patient bears. They are usually associated with less mortality rates as compared to those with thermal burns or other burn injuries, but they are associated with a higher incidence of the associated short – term and long – term morbidity, prolonged hospital stay, disability and disfigurement. Electrical burns are one of the leading causes of DALYs (Disability Adjusted Life Years) lost in low and middle income countries like India. According to WHO factsheet, more than 10,00,000 people suffer from moderate to severe burn injuries in India (1).

Electrical burn injuries result from sudden transfer of current from the source, through the human body or externally via the skin, to the ground. En-route the current conducts heat in different quantity to the subjacent structures, changing the “milieu interior” of an organ or entire body, for a transient phase or permanently. The course of injury for the surviving patients can be unsightly, ugly scars, stiffness of the involved joints, other systemic complications which can be

transient or can be life-long, and finally loss of part of a limb or multiple limbs leading to permanent dependence on others partly or for all activities.

Electrical burns can be classified, according to the voltage of the current, into either low voltage (or low tension) burns or high voltage (or high tension) burns. Low voltage burns are those burns that result due to presence of less than 1000V of electric current. High voltage burns are those in which the voltage of current is 1000V or more than 1000V. They usually result as a consequence of occupational hazards or due accidental contact with live wires.

Electrical burns can also be described according to the type of incident into four different types namely; electrical contact burns, electrical flash burns, arc burns and mixed burns. Contact burns are burns occurring over the exact site of contact between the electrical source and a part of the body. The part of the body which comes in direct contact with electric source through which the current passes is termed as the entry wound. They may result in less involvement of the skin but cause immense damage to the underlying structures because of the large quantity of heat energy produced in the tissues lying in the vicinity of the path of electric current. Flash burns result from the flame produced by the electrical arcs leading to enormous heat production and subsequently injuring the skin. These burns usually present similar to a case of thermal burns with large area of skin burns in varying depth, but the tissues underlying like the muscles and bones are usually unaffected. Arc burns result when the electrical arcs produced from the source pass through one's body through the path of least resistance. The current passes or jumps from point of high resistance to point of low resistance affecting the involved areas, thus resulting in patches of burnt skin in varying depths with the intervening tissues totally unaffected. Mixed

type of electrical burns is a combination of any of the above mentioned three types in varying percentages.

Majority of the electrical burns are associated with a low case fatality or mortality rate, but they are more damaging in nature. The most common part of the body affected is the upper extremity due to the fact that majority of the electrical injuries occur at workplace and while handling or working near electrical wires. Electrical burn injuries are more critical due to high risk of developing compartment syndrome in the affected limb(s). Early examination, diagnosis and management of the patient can help in preventing the involved limb from developing ischemia and finally gangrene. Electrical burn injuries are often associated with multiple metabolic derangements which may require aggressive treatment modalities, neurological damage including spinal disorders, peripheral nerve involvement (2), cardiac abnormalities like arrhythmias (3), cardiac failure, ocular involvement (4,5) like visual impairment due to either direct injury to the globe or due to later manifestation of cataract, upper and/or lower limb fractures, spine fractures either due to fall from height or violent contractions of the muscle when the patient is getting injured by the electric current, dislocations and amputation (of single or multiple limbs depending on the severity)(4–8).

In 2014, A. Pittrowski et. al. (4), from France published a study in “Burns” journal. They published a report of 311 cases by a retrospective analysis of the outcome of electrical injuries from 1996 to 2005 in workers of a French electric company. They surveyed all employees in order to know what they felt about the safety procedures provided by the company and how to

improve the medical facilities for the management of these occupation associates injuries. The purpose of their study was to analyze and publish the changing trend of the incidence as well as the severity of these incidents. They also examined the clinical features, immediate and late sequelae that developed in these patients. They recorded information of each injury using numerous data like age of the patient, gender, type of work, voltage of current, day of injury, mode of injury, percentage of body surface area burnt, areas of the body involved, burn sequelae, associated cardio – respiratory effects, neurological and neurosurgical effects, aesthetic appearance, psychiatric effects, sick leaves and the disability rates. The data collected was tabulated in different sets and analyzed statistically using Statistical Analysis System (SAS) version 9.2. The company had 403 incidents of electrical injuries. Data about 92 of them could not be completes and thus they were excluded from the study. Remaining 311 cases were included in the study. The year-wise incidence was found to an average of 31 incidents. All the injured workers were males except one female. The mean age of the injured workers was found to be 36.7 years ranging from 19 years to 59 years. Most of the burn injuries were found to be secondary to arc burns accounting to 70% of the victims. Contact or electro-thermal burns were found in 20.2% cases and 9% of the workers had mixed burns (including features of electro-thermal burns and arc burns). Out of 311 incidents, 10 incidents were fatal accounting to 3.2%. Nine deaths were immediate due to ventricular fibrillation following passage of electric current through their body. One death occurred late in the course of the treatment due to deep mixed burns. Out of the ten deaths, six incidents were due to high voltage burns and four incidents were due to low voltage burns. Among all patients, nearly 80% of the patients showed involvement of the head, neck, hands and wrists. Most of the victims (66%) suffered arcs burns, from low voltage current, involving 1 – 10% of the TBSA (Total Body Surface Area). Sixteen patients

required surgical treatment, out of which three required fasciotomies and four required amputations. All amputations (left below elbow, left little finger, left metacarpal, left middle finger and right thumb) were required in patients who suffered injury due to high voltage current. In their study, they found 98 patients (32.5%) with permanent functional sequelae among 301 workers who got injured and 95 patients (34.4%) out of 276 patients who sustained burn injuries. They classified the sequelae into three types namely those caused by the burns itself, neurological and psychological sequelae and those affecting the nervous system especially the peripheral nervous system. The sequelae related to the burn injuries were mainly unsightly scars, pain, tightness of involved areas, stiffness of the involved joints and/ or amputation involving a single limb or multiple limbs. Ocular involvements were found in 5 patients, leading to either unilateral or bilateral cataract, retinal damage. One patient suffered from loss of vision in both eyes. Auditory sequelae were present in eight patients, five of them developing hearing loss and three cases had tinnitus. Majority of the survivors (195, 73%) had no sequelae, 73 patients (25%) had minimal sequelae and remaining six accounting to 2% had suffered from serious injuries.

Another similar study was published in the “Burns” journal in 2014 by Ayten Saracoglu et. al.(6), from Istanbul, Turkey. They published a series of 101 patients admitted under their regional burn centre from January 2009 till May 2012 which were reviewed and analyzed in a retrospective manner. On admission of each patient, the Parkland Formula was used to calculate the volume of intravenous fluids required for resuscitation. Baseline blood investigations including blood counts, serum electrolytes, serum proteins, serum creatinine, blood urea, routine X-rays and electrocardiograms were performed routinely. All patients were administered prophylaxis for tetanus. Daily urine output was monitored. Ringer’s lactate solution was

administered to all patients as the initial fluid. Blood, wound and urine cultures were done and as per the positive cultures reports antibiotic therapy was given to each patient. Prophylactic antibiotics were not administered to any patient. Use of topical sulfonamide creams was done for each burn patient. Whenever required, surgical interventions such as escharotomy, fasciotomy, debridement and skin grafting or amputation(s) were performed. Limb amputations were performed when there was a clear line of demarcation between the healthy and necrosed part. All data was obtained from the medical records. Data collected was segregated into age, gender, percentage of body surface area burnt, degree of burns, type of surgery done, total number of surgeries performed, voltage of current to which the patient was exposed, place of burn injury, whether admission to ICU (Intensive Care Unit) was required, duration of hospital stay and the mortality rates. Patients who were followed up on outpatient basis after initial assessment in emergency were excluded from the study. SPSS (Statistical Package for Social Sciences) for Windows version 20 software was used for the statistical analysis of the collected data. This study included 101 patients out of which one was female and remaining 100 were males. Twenty seven male patients with an average age of 35.6 years expired. The survivors had a mean age of 32.7 years. Majority of the patients who suffered electrical injuries had injuries related to their work and involved alternating current. The serum CPK levels, CK-MB mass, percentage of body surface area burnt, need for ICU admission, need for hemodialysis and duration of ICU stay were significantly higher in patient who expired. The average urine output of all patients was 0.4 – 0.6 ml/kg/hr during the first 48 hours. The average percentage of total body surface area burnt was found to be 42.5% among the patients who expired and 26.5% among the survivors. All patients who expired were intubated, had a prolonged ICU stay and finally expired in the ICU. Most common associated injury among all patients was renal injury. Among the patients who expired

(27), eleven patients (40%) required hemodialysis. Among the survivors, eleven patients (5.4%) required hemodialysis. The amputation rates and number of surgical interventions did not show any statistically significant difference between the patients who expired and those who survived. Eighteen patients (66.7%) out of 27 who expired were operated and 2 of them required limb amputations. Similarly, 40 survivors (54.1%) required surgical procedures and limb amputations were performed in 5 of them. None of the patients admitted in the wards expired. Mortality rate was lesser in patients had suffered low-voltage burn injury as compared to those who suffered high-voltage burn injury. The age of the patients, serum CPK levels, CK-MB levels, duration of ICU stay, duration of ward stay, number of surgical procedures and limb amputation rates had no statistical difference between patients who sustained high-voltage burn injuries and those with low-voltage burn injuries. As compared to the patients with high-voltage burn injuries, those with low-voltage burn injuries were found to have lower percentage of body surface area involved and lower rate of hemodialysis. The percentage of body surface area burnt had a significant impact on the mortality rate. Patients with more than 25% TBSA burnt had 2.79 times higher risk of mortality and those with more than 50% TBSA burnt had 18.85 times higher risk of mortality. Higher the duration of stay in ICU, higher was the risk of mortality. Similarly need for hemodialysis increased the risk of dying 12.03 times.

In 2013, A. Tarim and A. Ezer (7) from Turkey published an article in “Burns” journal including 1144 patients hospitalized between January 2000 and June 2011. Their aim was to study the demographic profile, etiology and final result of the patients who underwent amputations in the study. Out of 1144 patients, 44 patients, accounting to 3.8%, underwent amputation of the digits or below elbow in upper limb or below knee in lower limb. They were

divided into two groups, one who underwent amputations and other group who did not undergo amputation. Demographic profile, etiology of the burns, severity of burns and duration of stay in the hospital were recorded and compared between the two groups. Out of the total 1144 patients, 214 patients had sustained electrical burn injuries. These patients were further divided into two groups, one without amputations that included 181 patients, while other group included remaining 33 patients who underwent amputation(s). The same clinic-epidemiological profile of these patients was also recorded as the other patients included in this study. The data obtained was expressed as standard error of mean and various statistical tests and methods were used to analyze the data using SPSS (Statistical Package for Social Sciences) for Windows version 16.0 software. The results were noted and it was found that with respect to the age, mortality and duration before admission, there was no statistically significant difference between patients who underwent amputation and those who did not undergo amputation. The average age of patients undergoing amputation was 22.90 years. Amputations were more common in males. The average duration of hospital stay was also found to be higher in patients undergoing amputation (36.21 days) as compared to those who did not undergo amputation (19.54 days). On comparing the percentage of body surface area burnt, there was no statistically significant difference between the two groups. Also the average volumes of plasma and albumin transfused in both groups was not statistically significant. Among all patients who underwent amputations (44), digital amputations were the most common (43%, 19 patients) amputations noted. Most of the patients with amputations had sustained injury due to high voltage current. Five patients had succumbed to burns in this study with a survival rate of 88.6%. The average time at which amputations were performed was 16.81 days (range 6 to 36 days). None of the patients in the amputation group had associated fractures of the underlying bones. The conclusion of their study was that the

amputation rate was higher in patients sustaining electrical burns. Majority of the patients were adult males. Though patients who sustain electrical burn injuries have a lower mortality rate, they suffer from permanent functional consequences such a loss of a limb (or a part), neuropsychiatric consequences, prolonged rehabilitation. Involving the prosthetic team regularly and in the early phase should be done to aid in rehabilitation and early mobilization. Education, awareness, compliance of people along with adequate safety measures and common sense with respect to handling electrical devices are necessary to curtail these incidences.

In 2014, S.B. Duci et. al.(8), published a report in European journal of trauma and emergency surgery. They published a retrospective study of 246 patients who sustained electrical burn injuries and received treatment from 2005 to 2010 at the University Clinical Center of Kosovo. The data were collected and processing and analysis was done using the statistical package InStat3. They included only those patients who presented within 24 hours of injury to the hospital. Patients less than 1 year and more than 65 years were excluded from this study. Other exclusion criterion was involvement of less than 5% of total body surface area. Out of the total 246 patients, 231 (93.9%) patients were males and remaining 15 (6%) were females. Majority of the patients (n=180, 73.1%) had sustained low-tension injury, while remaining (n=66, 26.8%) had sustained high tension electrical burn injuries. The mean age of the affected patients was 33.6 years (range 1 to 64 years). Majority of the patients (n=115, 46.7%) were between the age groups 20-29 years (n=66, 26.8%) and 30-39 years (n=54, 22%). The mean duration of hospital stay was found to be 14.9 days, ranging from 1 to 111 days. The maximum number of patients (n=48, 19.5%) were admitted during 2008, followed by 2006 (n=47, 19.1%), 2007 (n=46, 18.6%), 2005 (n= 43, 17.4%), 2009 (n=32, 13%) and 2010 (n=30, 12.1%). High

tension injuries occurred mainly during the summer season with 38 patients accounting for 15.4%, while low tension injuries were found to be more common during the winter season with 77 patients accounting for 31.3%. Overall seasonal trend was noted and maximum number of patients (n=91, 36.9%) sustained electrical injuries during the winter period, followed by summer period (n=70, 28.4%), spring season (n=46, 18.6%) and least during autumn (n=39, 15.8%). Out of 246 patients, 180 patients had sustained low-tension injuries, while only 66 patients had sustained high tension electrical injuries. Majority of the low tension injuries (n=101, 56.1%) occurred at the victims residence due to accidental burns, while remaining 79 patients (43.9%) sustained injuries at work as occupational hazard. The majority of the patients sustaining low tension injuries showed involvement of the face and hands (n=146, 59.3%). Of these, only thirteen patients (nine of these sustained deep second degree burns over the hands and four sustained deep second burns over the face) required surgical procedures like early tangential excision and split thickness skin graft cover. There was no mortality recorded in patients sustaining low tension electrical injuries. Among patients sustaining high tension injuries (n=66), majority (n=39, 59.1%) occurred at work and remaining (n=20, 30.3%) occurred at home which included children (n=16), students (n=3) and one elder person. Out of these 66 patients, 3 patients had sustained other injuries also like subarachnoid hemorrhage, polytrauma, and spinal cord injury. All patients that sustained high tension injuries required surgical procedures, of which 16 patients needed urgent fasciotomy due to development of compartment syndrome, 40 patients underwent early tangential excision of the burnt areas and immediate split thickness skin graft cover, 11 patients required abdominal flap cover as the underlying tendons and joints got exposed after debridement, while only eight patients with involvement of the fingers underwent cross-finger flap cover. Sixteen cases (6.5%) with high tension injuries needed amputation, out

of which thirteen needed amputation of digit(s), and remaining three patients underwent below elbow amputations. Seven cases with high tension injury were referred to higher centre for further management. There were six deaths recorded in this study and all deaths occurred in patients who sustained high tension electrical injuries.

In 2012, Chao-Feng Sun et. al.(9), published an article in the “Burns” journal. It was a retrospective study including 383 patients admitted in the Burns unit of Tangdu Hospital, Shaanxi, China between January 2000 and December 2009 with a diagnosis of electrical burns. The data were collected from the medical records and reviewed for multiple criteria including age, gender, occupation of the patients, duration of hospital stay, total number of surgeries performed, characteristics of burn injury, associated complications, voltage, etc. The collected data was segregated and statistically analyzed using SPSS (Statistical Package for Social Sciences) for Windows software (version 17.0). The results were obtained. The patients were randomly distributed in this time period, but there was an increasing incidence noted from the year 2005. The total number of patients admitted with electrical injuries in the year 2009 was 53, which was the maximum number on a yearly basis. Majority of the patients (n=346, 90.3%) were males and rest were females (n=37, 9.7%). The mean age was 35.4 years (range 9 – 62 years). Out of these, 307 patients were between the age of 19 to 60 years, 72 patients were between the age of 7 to 18 years and only 4 patients were aged more than 60 years. Majority of the patients were working as electricians or helpers, accounting for 78.4%, followed by residents among the locality, accounting for 12.2% and students (9.4%). There were total 6 deaths out of 383 patients with an overall mortality rate of 1.6%. The percentage of total body surface area involved ranged from 1 to 30%. There were a total of 429 entry wounds, of which majority were in the upper

limbs (n=324, 75.5%). Among upper limb entry wounds, 227 were through the hands. Other entry wounds from the lower limbs (n=42, 9.8%) or through other sites. Most of the injuries (n=300, 78.3%) were occupational injuries occurring at the workplace. Incidental electrical contact (n=71, 18.5%) was the next most common cause of electrical injury. In one percent patients (n=5) the injury occurred as a consequence of suicide. Based on the pattern of injury, majority of the burns were due to electro-thermal heat (n=256, 66.8%), followed by arc burns (n=102, 26.6%) and direct contact burns (n=25, 6.5%). Out of all patients, 201 patients sustained injuries due to a voltage of 220V to 10KV, while remaining 182 patients sustained injuries due to voltage more than 10KV. The incidence of fourth degree injury was only 20% in patients sustaining burns due to current of less than 10KV, while in the patients resulting from voltage more than 10KV; the incidence was quite high, up to 70%. Of the total cases, 116 patients (30.3%) suffered from cardiac effects, including 47 patients (40.5%) with an abnormal ECG and 91 patients (78.4%) with raised serum CPK levels and CK-MB levels. The association between severity of injuries and voltage was analyzed. There was a statistically significant difference between patients who sustained injury due to less than 10KV and those who sustained injuries with more than 10 KV ($p<0.05$). Thus, their data showed a positive correlation between the severity of injuries and the voltage of current. The higher the voltage of injury, longer was the duration of hospital stay, increasing from 18 days for 380V (N=70) to 31.1 days for <10KV (n=131) and 60.5 days for >10KV (n=182). Meanwhile, the average number of surgeries performed in each group was 0.45, 0.84, and 2.59 times respectively. Coma was the most common complication associated with the injuries, found in 272 patients (71%). Acute renal failure occurred in 20 cases (5.2%) and required prolonged treatment and eventually longer stay

in the hospital. They concluded with the statement that, public education, awareness of safety measures and methods of preventions of these injuries should be emphasized.

In 2012, S.R.Mashreky et. al.(10), published a report of a community based national survey from Bangladesh to look at the social and economic impact of non – fatal electric injuries over a period of one year, from January 2003 to December 2003. The survey included a total of 604 patients who sustained non – fatal electrical injuries. The patients were divided into two groups based on the age of the patients. First group had patients with age less than eighteen years that included 272 patients (45%), while the second group included remaining 332 patients (55%) that were more than eighteen years old. In this study, three patients (all males more than eighteen years old) had developed permanent disability due to electrical burn injury. Majority of the injuries occurred at home (n=321, 53.14%). Majority of the patients were from a low socio-economic background and on daily wages. Among the total 604 patients, 282 patients (46.7%) had developed temporary disabilities, with about 63% suffering the disability for less than 7 days, about 29% suffering for more than 7 days but less than 30 days, around 7% suffering from 30 days to 90 days and around 1% suffering for more than 90 days. Out of the total 604 patients, 172 patients (28.47%) were students. Out of these patients, 139 patients (80.8%) missed their school for several days. More than 66.67% were absent from school for less than 7 days. About 28% remained absent for up to 30 days. Around 6% missed school for up to 90 days. The average days of missing school was 9.72 days. Out of total 604 patients, only 318 patients (52.64%) were employed. Among them about 71% could not work for less than 7 days. Around 22% could not work for up to 30 days. Around 6% could not work for up to 90 days. The mean duration of loss of work was around 10.5 days. Of the total, 236 patients (39%) were contributors

to the family income and 345 patients (57%) were the main income earner of the family. Out of the total 604 patients included in this survey, 27 patients needed hospital admission for their treatment.

In 2011, Shagun Aggarwal et. al.(11); reported their experience of electrical flash burns in New South Wales occurring due to switchboard explosions over a 9 year period. The study included 119 patients who were admitted with a diagnosis of electrical injury between January 2000 and December 2008. The data of each patient was recorded and separated in different headings such as age, gender, type of work, type of electric injury, site of injury, percentage of body surface area involved, whether there was need for ICU admission, surgical intervention needed, associated complications, duration of hospital stay and final outcome. Out of the 119 patients, 107 patients were males (90.0%) and remaining 12 patients were females (10.0%). Out of these, 20 patients (17%) had sustained high tension injury, of which 15 patients (75%) had direct contact with high tension wires. Remaining 99 patients (83%) sustained low tension injury. Out of these 99 patients, 54 patients (55%) sustained injury either at their workplace or at residence. Thirty-seven of these (37%) were flash burns associated with the explosion of electrical switchboards, accounting for 31% of all patients of electrical burn injuries. All 37 of low tension flash burns occurred in males who worked as qualified electricians. Twenty-one patients of these 37 patients (57%) required admission to hospital, while 16 patients (43%) sustained minor flash burns only and were treated on outpatient basis. The commonest site of burns in all patients was upper extremity (81%), involving one or both hands or forearms, followed by involvement of the face (67%). Only one patient suffered injury over the trunk. Lower extremity was not involved in any patient. There were no bony injuries. The mean age of

admitted patients was 32.7 years (range 21–55 years). The mean percentage of total body surface area burnt was 8.76% (range2–30%). The average duration of hospital stay was 9.95 days (1–27 days). Six patients required admission to ICU for further ventilation, monitoring and treatment. Of which three patients required intubation. There were abnormal findings noted on ECG for any of these patients. Seven patients (33%) required surgical procedure with early tangential excision and split thickness skin grafting. Six patients suffered from PTSD (Post Traumatic Stress Disorder). Eight patients had associated eye injuries and two patients had associated oropharyngeal burns. The patients who were treated on OPD basis (16 patients) had an average age of 41.13 years and the average percentage of body surface area burnt was 2%. Four of these patients had associated eye injuries. None of these patients required surgical intervention.

In 2008, M. Kingsly Paul, Prema Dhanraj, Ashish Gupta(2) published a report of 3 cases who developed spinal cord injury following high voltage electric burns over a span of 5 years. During the 5 year period, 253 patients were admitted with burn injuries. Forty one patients (16.2%) of them had sustained high voltage electrical burn injuries. However, only 3 patients, accounting to 7.3% had spinal cord injury. All three patients were males with an average age of 41.47 years (range 30 – 50 years). All patients had sustained burns involving less than 20% of the total body surface area. At the time of admission all patients were able to move all four limbs normally with no loss of sensation. However, within a span of an average 3.67 days (range 2 – 6 days), all patients developed sudden weakness of both lower limbs with loss of sensation and control over the bladder and bowel. In one patient, the weakness progressed in the upper limbs also. Radiological examinations did not show any bony injury in any patient. Nerve conduction studies were done for all patients, but they were also found to be normal in two patients. Only in

one patient, nerve conduction study showed increased latency in the left dorsal and right cervical spine and was diagnosed as spinal cord syndrome with associated transverse myelopathy and incomplete tetraplegia at C4 level. All patients were started on physiotherapy with passive range of motion for both lower limbs and active exercises for the upper limbs. Regular change of posture was all done for all patients to prevent formation of pressure sores. After discharge the patients were regularly followed. Two of them regained full power and complete control of bladder and bowel within 6 months. One patient regained full control in bladder and bowel but had lower limb power of 4/5 only. He was continued on active and passive exercises. On literature review, they found the possible diagnosis of spinal atrophic paralysis in all patients. The reasons or mechanism of injury for these symptoms can be due to direct trauma or due to thermal damage or vascular damage or because of the electrostatic force that leads to sudden expansile effects on the body tissues eventually causing rupture of the affected tissues. In their study, they could not find the exact etiology for the paralytic features in the three cases reported. Thus, they concluded that all patients with electrical burn injury should be examined thoroughly and repeatedly for any neurological symptom and sign. If required, MRI of the brain and spine along with nerve conduction studies should be done. Aggressive approach with prompt and early physiotherapy can hasten the recovery and final outcome in these patients.

In 1998, I. Ferreiro et. al.(5), published a study to understand the Factors influencing the sequelae of high tension electrical injuries. This study was a retrospective study involving patients who suffered high voltage electrical burn injuries during eleven years from 1986 to 1996. During this period, total 1,557 patients with history of burns, including thermal, electric, scald and others were treated in their hospital. Of these, fifty-nine patients had sustained high

voltage electrical burns, accounting to 3.7% of the total burns treated in our hospital. Forty seven patients (80%) out of these were males, with an average age of 32 years. Majority of the injuries occurred at the workplace (75%). Voltage of current ranged from 3KV to 50KV. Twenty four patients (40%) sustained flash burns and sixteen patients (27%) had associated bone fractures. In patients with contact burns, the average percentage of total body surface area burnt was 9%. The most common site of entry was in the upper limb and site of exit was from the lower limbs. Lactated Ringer's solution was the initial fluid administered on the day of admission. In patients with electrical burn injuries, there was muscle necrosis and damage to the RBCs, often leading to myoglobinuria and eventually resulting in acute renal failure. The end point of initial fluid resuscitation is maintaining adequate urine output almost in the range of 1.5ml – 2ml/kg/hr. Despite this treatment two patients (3%) developed features of acute renal failure that required hemofiltration. All patients were monitored for any symptoms or signs of compartment syndrome. Urgent escharotomies and fasciotomies were performed in patients suspected to have compartment syndrome. All patients underwent surgical debridement of the dead tissues during the first week of injury. Four patients (7%) developed cardiac arrhythmia, while one developed ventricular fibrillation requiring immediate treatment. Majority of the patients developed keratitis or conjunctivitis during the early phase of the course of treatment, which was treated with traditional treatment. Three patients (3%) developed cataract as a late complication. In their study, 20 patients (34%) had history of unconsciousness immediately after the electric injury. Eighteen patients (30%) developed peripheral neuropathies, of which the most commonly involved nerves were median nerve and ulnar nerve. Nine patients (15%) developed paresthesias and nine patients (15%) developed permanent motor neuropathy. Out of all patients (59), seven patients (11%) underwent amputations. Forty nine patients (83%) underwent surgical procedures.

The average number of surgical procedure per patient was 2.3 (0 to 7). The case fatality rate was 12% (7 patients). The patients in this series had an average duration of hospital stay of 23 days. In their series, patients had sustained injury due to high tension did not have a higher severity or a higher incidence of associated consequences. The percentage of limb amputations in the multiple trauma patients is lower (15%) than in patients who only have a high tension injury (39%). The presence of cardiac arrhythmia, neurologic injury, compartment syndrome, amputations or ocular effects had no relation to the severity and degree of associated burns. Those patients who underwent early fasciotomy had a lesser incidence of the amputations. Thus, timing of early intervention, especially when compartment syndrome is impending or suspected can be limb saving for the patients.

In 1997, Arrowsmith et. al.(3), from UK published an article where they retrospectively reviewed the patient records of those who were admitted with diagnosis of electrical burns to the Welsh Burns Unit over a period of five years (from 1991 to 1996). Their main aim of the study was to assess the cardiac complications associated with those patients and the time after which the complication resulted following the electrical injury. They studied a total of 145 patients out of which 128 patients sustained low tension injuries and 17 patients sustained high tension injuries. ECGs (electrocardiograms) were recorded for 114 patients (78.62%). Remaining 31 patients (22.96%), for who did not have their ECGs recorded on the day of presentation, had suffered from low tension injuries. ECGs were recorded for 104 patients within 24 hours of sustaining the electrical injury, with the mean time from sustaining the injury to the recording of ECG being 2 hours. Ten patients had their ECGs recorded more than 24 hours after sustaining the electrical burn injury as they presented late to the hospital. Out of 104 patients who presented

within first 24 hours of the electrical injury, 73 patients (70.19%) were observed and monitored regularly for up to 24 hours. A repeat ECG (12-lead) was recorded for 25 patients. Serum levels of cardiac enzyme were measured for 17 patients. The results of all samples were found to be within the normal range. Twenty-one patients (20.19%) out of 104 patients were discharged on the next day with no further treatment need. Another ten patients (9.61%) were discharged after 48 hours on conservative treatment. History of unconsciousness immediately after electrical injury was given by 15 (14.42%) of the 104 patients. Of these 15, eight patients suffered from high tension electric injury and seven patients suffered low tension injury. Out of these 15 patients, two patients had associated cardiac abnormalities on ECG. Abnormal ECG findings were recorded in four patients. All were present on the first ECG. The first patient was a 7 year old boy who had suffered low tension injury over bilateral hands. His initial ECG was suggestive of atria1 ectopic beats. Cardiac enzymes were found to be within the normal range. He was kept for overnight observation and monitoring and an ECG was repeated the next day which did not show any abnormal findings. The second patient was a 38 year old lady who also suffered low tension electrical injury while doing household work over her right hand. She had ventricular ectopic beats on the first ECG with normal cardiac enzymes. Her ECG showed normal rhythm within 4.8 hours without any medication. The third patient was a 36 year old man who suffered high tension injury resulting in 7 per cent full thickness burns involving his head, trunk and legs. His initial ECG showed atria1 ectopic beats with normal cardiac enzymes. His cardiac rhythm also recovered without any medication within 5.6 hours. The fourth patient was a 29 year old man who sustained high tension electrical burns to his right hand and both feet. He had atrial fibrillation on his initial ECG, which settled after intravenous infusion of digitalis. No further atrial fibrillation was recorded during monitoring and his serial ECGs and cardiac enzymes were

normal. They concluded their study with the opinion that if the initial ECG was normal and there was no associated history or episode of unconsciousness, then there was rarely a risk of development of serious cardiac abnormalities. Therefore, it is not necessary to admit the patient with history of sustaining low tension or high tension electrical injury only for 24 hour cardiac monitoring.

AIMS

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OBJECTIVES

AIMS AND OBJECTIVES

1. To find out the incidence, demographic profile and pattern of electrical burn injury.

2. To study the associated complications, treatment methods required and final outcome of the patients sustaining electrical burn injuries.

3. To audit and improve the treatment protocols for future admissions.

MATERIALS

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METHODS

MATERIALS AND METHODS

Ethical Clearance

The project was put forward to the Institutional Research Board Committee for Ethics Clearance and the project was cleared and accepted by the Institutional Research Board, Christian Medical College, Vellore.

Inclusion Criteria

All patients (total 98 patients) admitted under the Department of Plastic & Reconstructive Surgery, Christian Medical College, Vellore with a diagnosis of electrical burn injury from January 2008 till December 2014 were included in this study.

Exclusion Criteria

Patients who presented to the Accident and Emergency department with alleged history of sustaining electric injury without any obvious skin involvement were not included in this study.

Clinical Study

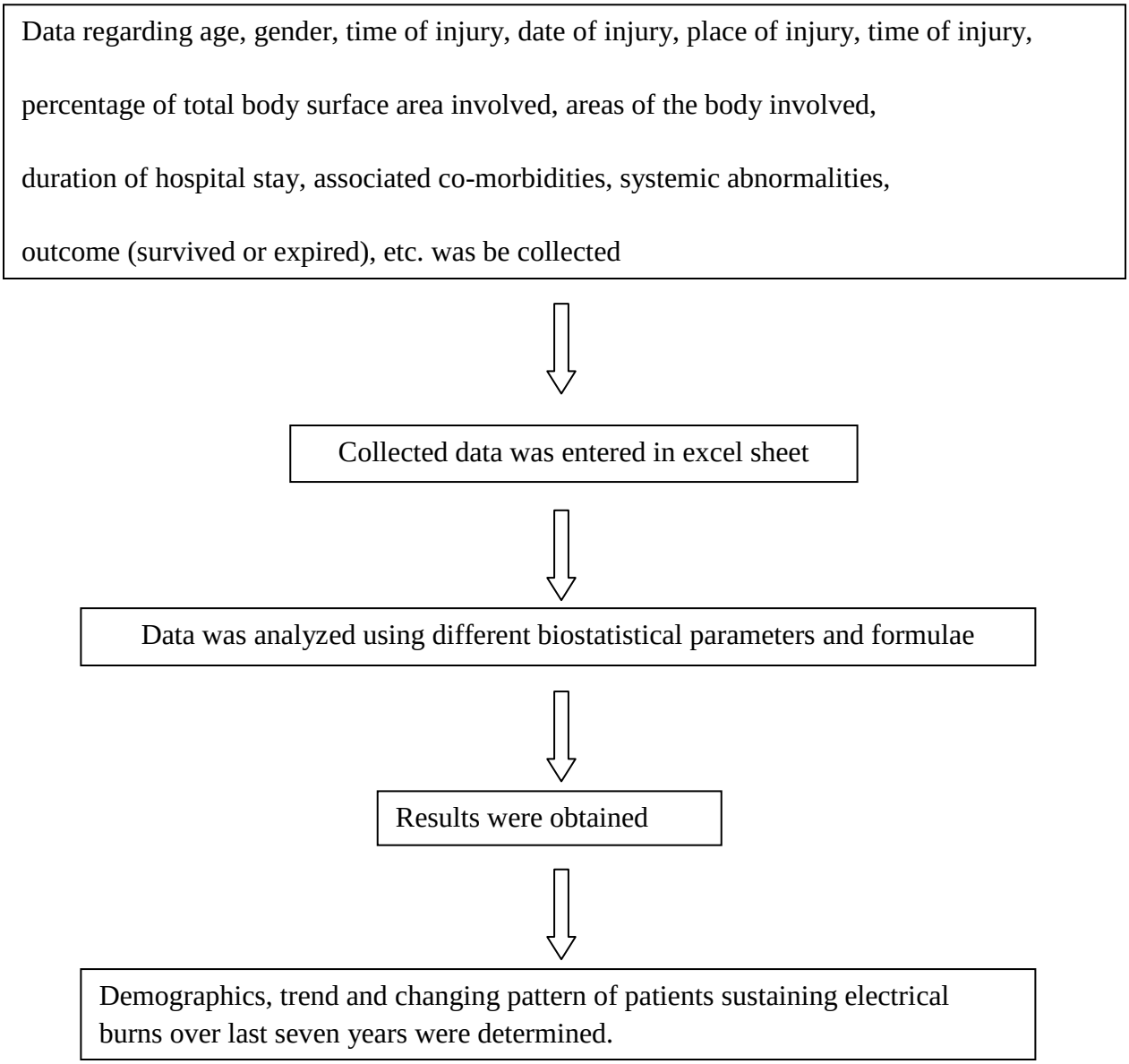
This study was done in a retrospective manner by chart analysis and data collection of all patients admitted under Department of Plastic Surgery with a diagnosis of electrical burn injuries from January 2008 till December 2014.

Total 98 patients sustaining electrical burns were included in this study.

The data recorded included age of the patient, gender, residence, place of injury, occupation of the patient, day of injury, month of injury, year of injury, time of reporting to hospital after injury, delay in reporting to out institute, voltage of the current(high or low), type of electrical injury (contact burns/ flash burns/ arc burns/ mixed burns), percentage of total body surface area involved, fall from height, history of head injury, unconsciousness, history of pre-existing co-morbid conditions, ocular involvement, spine injury, intra-abdominal or intra-thoracic injury, upper limb fractures, lower limb fractures, cardiac abnormalities, serum CPK and creatinine levels (increased or normal) on the day of admission, within normal range/ increased, urine myoglobin, treatment done, time interval between day of admission and first surgery, number of surgeries performed, total units of plasma transfused, total units of blood transfusions, whether patient required ICU admission, final outcome at discharge survived/ expired, total duration of hospital (in days).

The collected data were analyzed using statistical tests and results were tabulated.

Algorithm of the study



Statistical methods used

1. Frequencies and percentages were used to describe for demographic data.

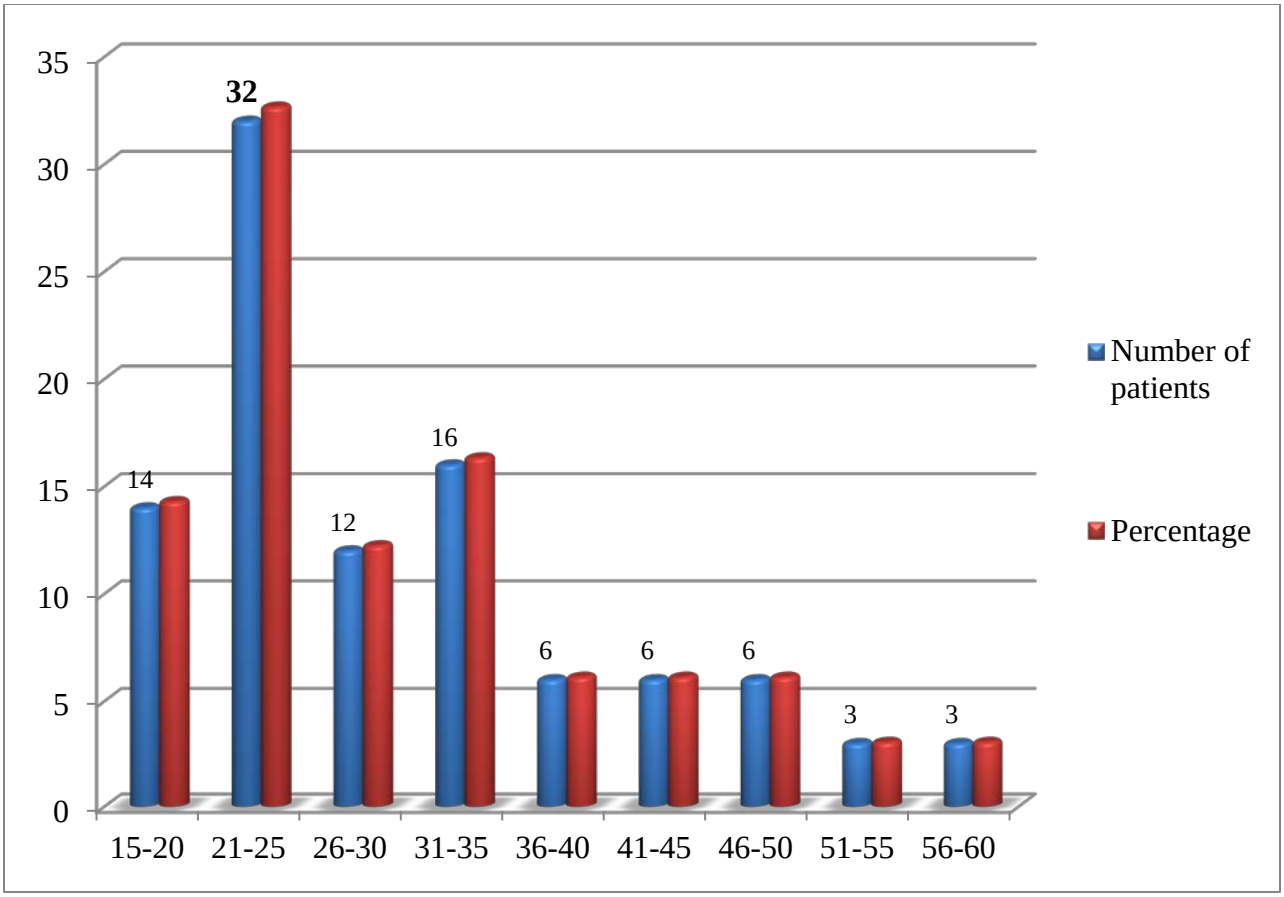
2. Categorical values were compared using Chi-Square test.

3. For continuous variables, mean with standard deviation and compared using independent sample t-test, if normal and Mann-Whitney U test if not normal.

RESULTS

RESULTS

AGE

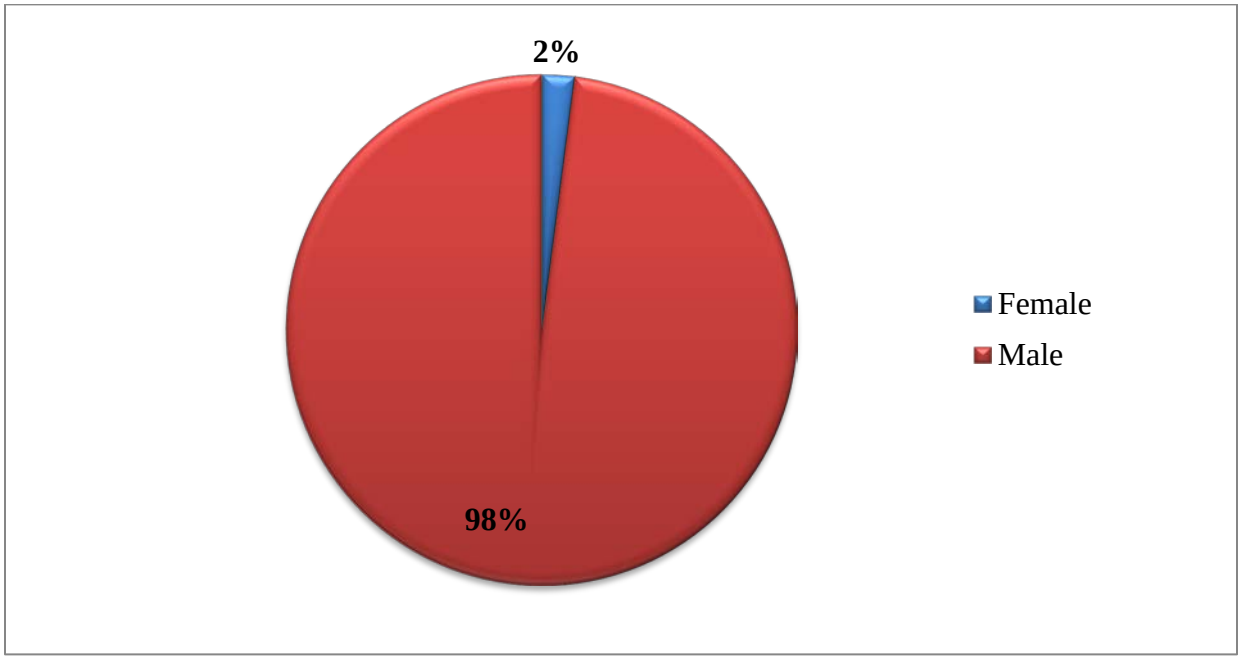


The mean age of all patients was 30.44 years with a minimum age being 15 years and maximum age being 60 years.

Maximum patients (32) were between 21 to 25 years accounting to 32.65%.

Out of 98 patients in the study, 60 patients were among the age range of 21-35 years, accounting to 61.63%.

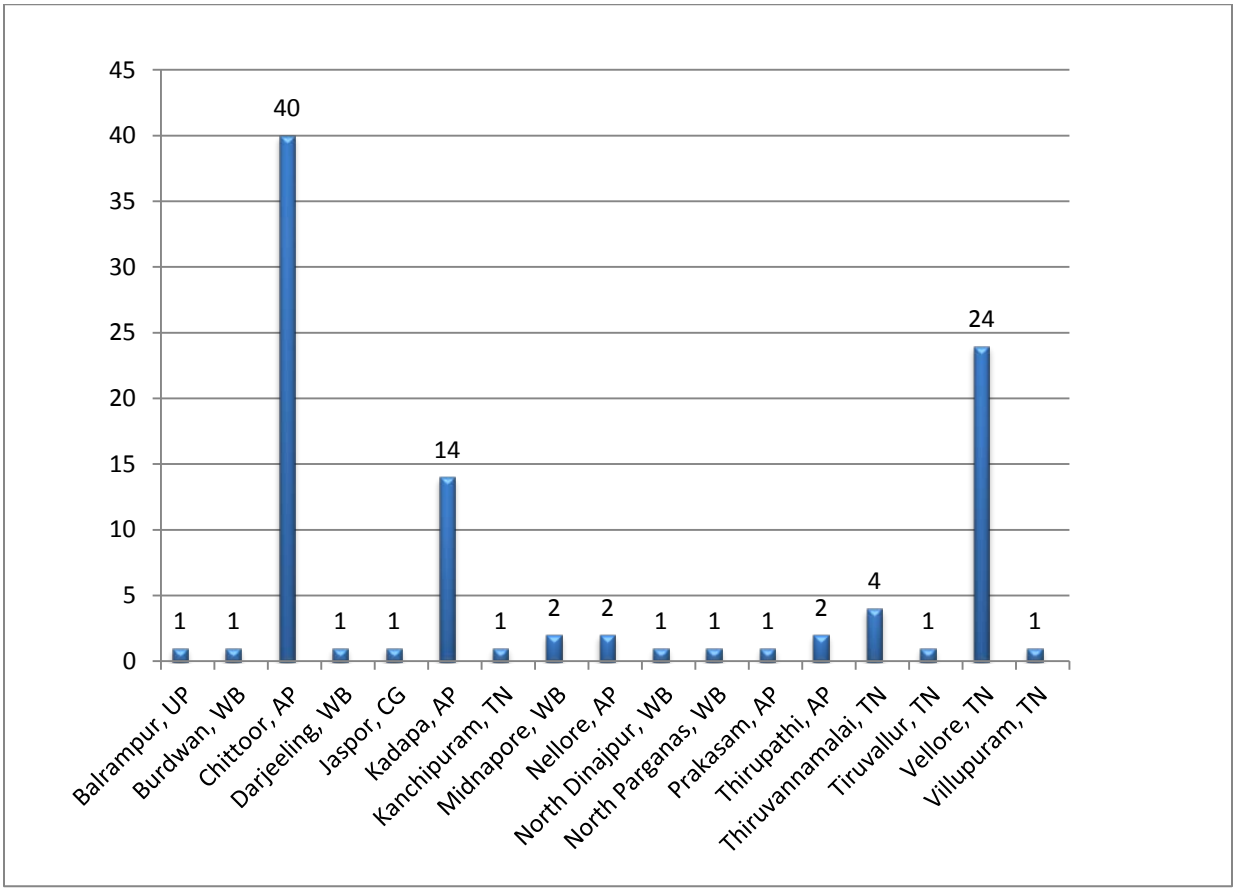
SEX



Out of 98 total patients, only 2(2%) were females and remaining 96(98%) were males.

Males are more commonly affected either due to their occupation (electrician) or due to accidental injury while at work (construction workers and labourers).

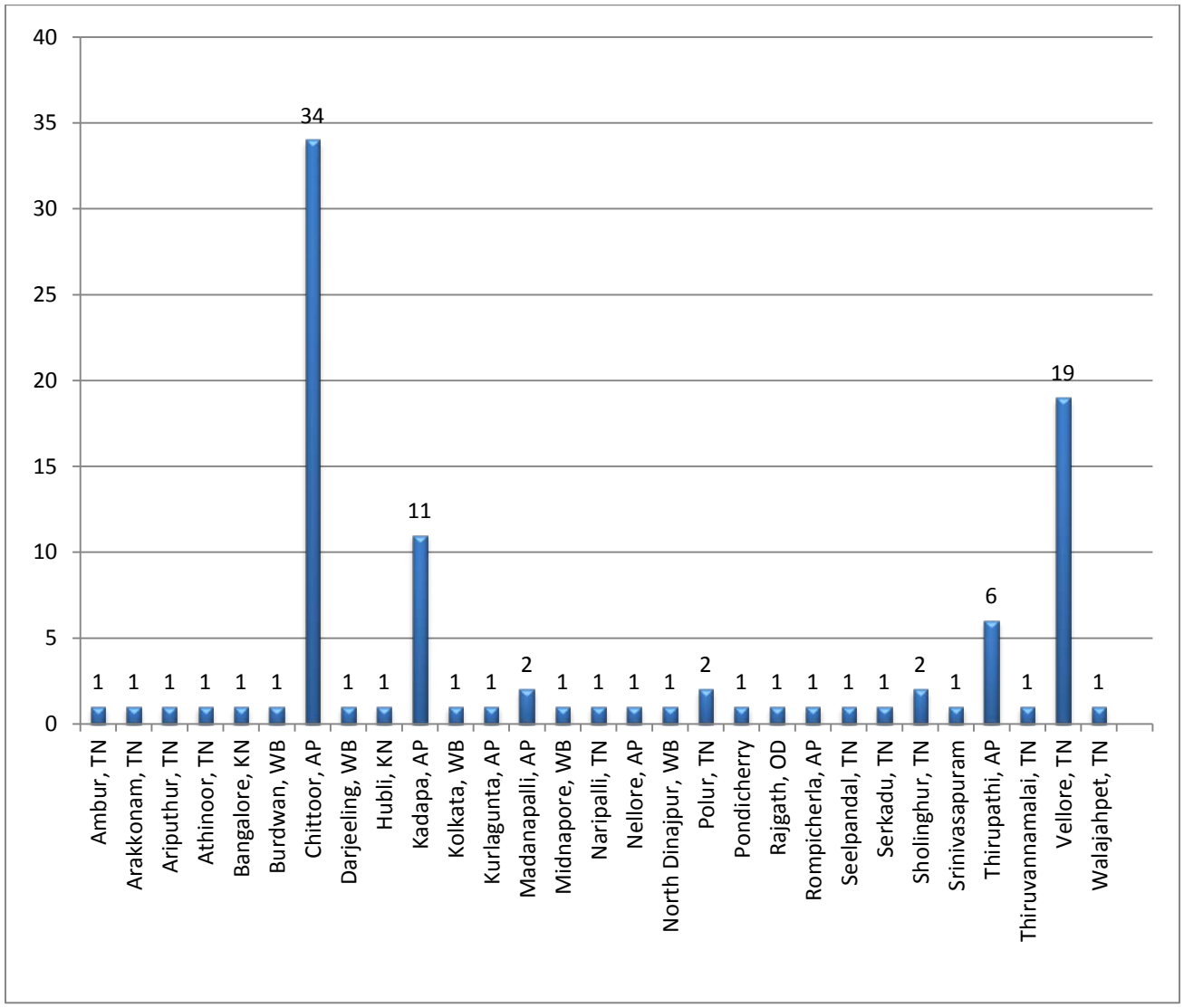
RESIDENCE



Among all patients, majority of the patients were residing at Chittoor, AP (40.8%) followed by Vellore, TN (24.5%) and Kadapa, AP (14.3), accounting to 79.6% of all patients.

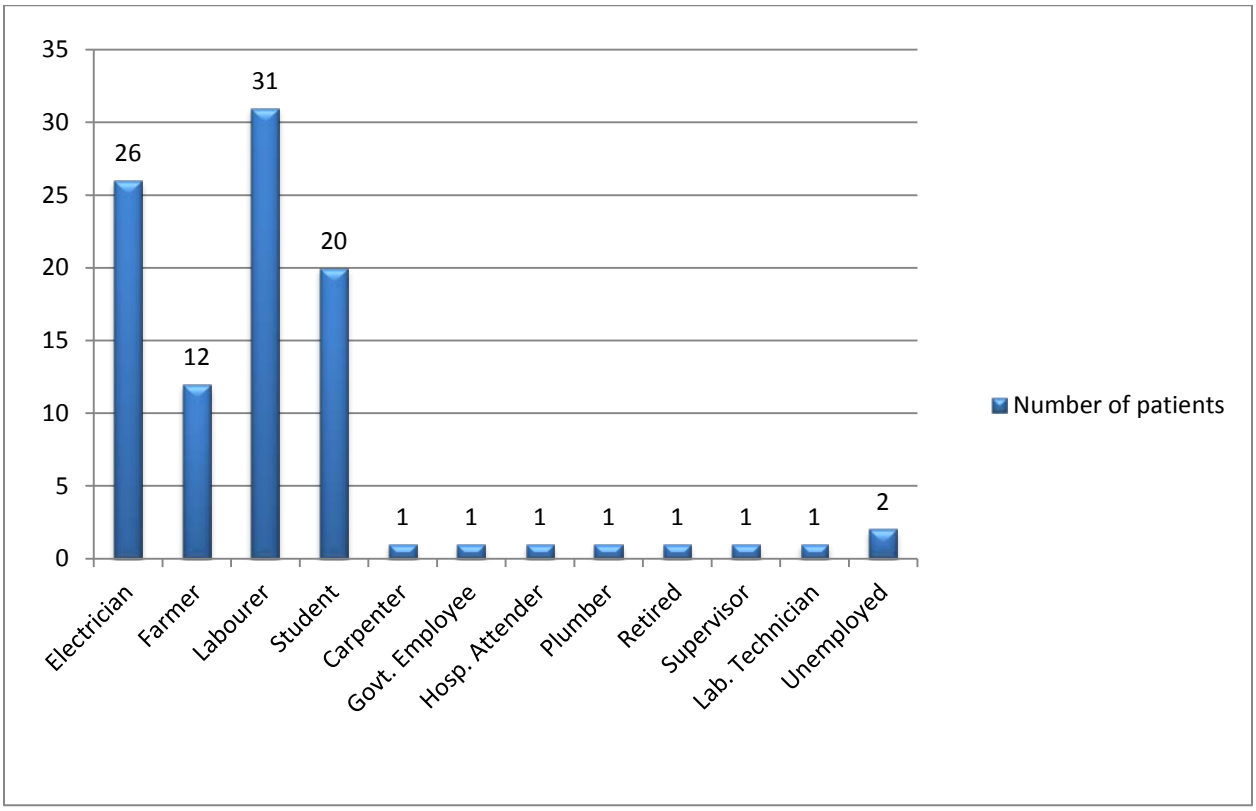
The above chart shows that majority of the patients were residing in the nearby district of our institute.

PLACE OF INJURY



Majority of the patients suffered the electrical injury at Chittoor, AP (34.7%), followed by Vellore, TN (19.4%) and Kadapa, AP (11.2%) which is usually near their residence. Few patients sustained the electrical injury while at work away from their residence at a remote place.

OCCUPATION



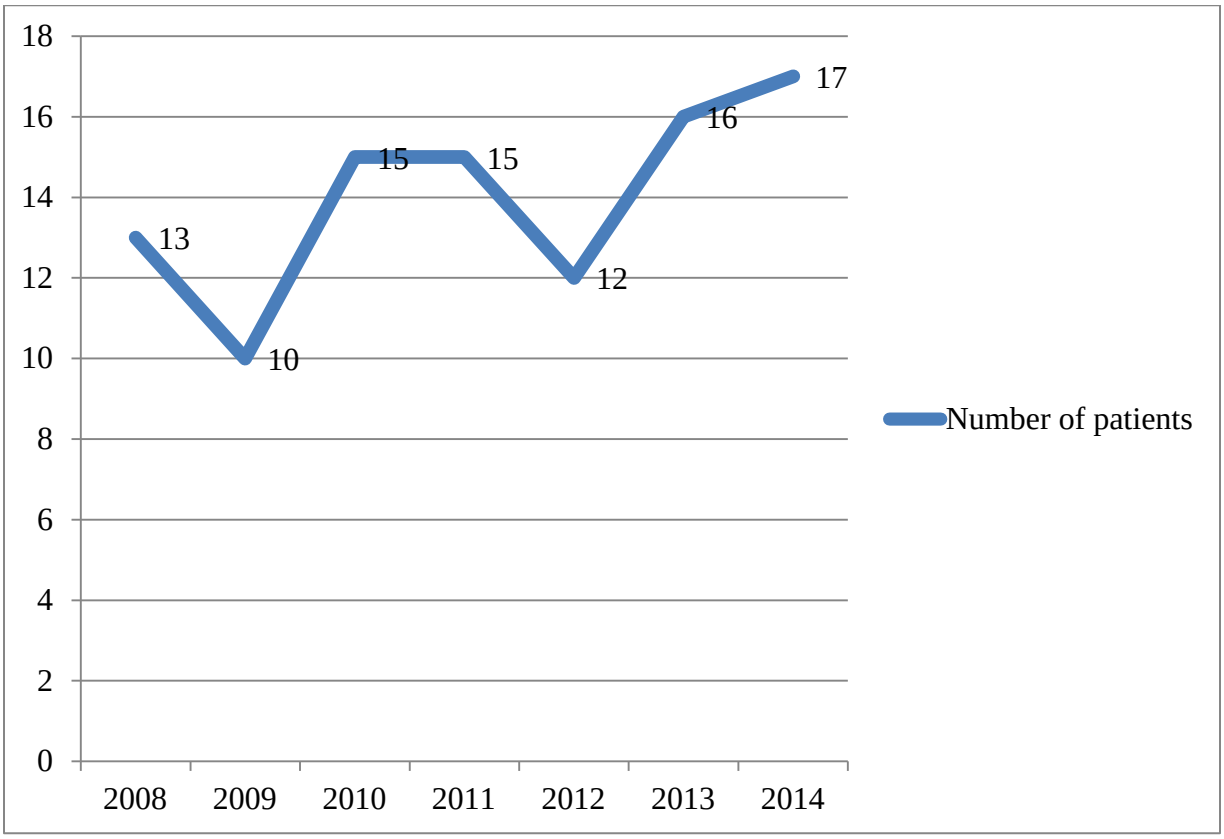
Amongst all patients, majority of the patients were labourers (31.6%), followed by electricians (26.5%), students (20.4%) and farmers (12.2%).

Most of the labourers used to work as construction site workers where they were in close vicinity to overhead wires.

Electricians are also the most vulnerable people to sustain electrical burn injuries. It is a well known occupational hazard for them.

Farmers sustain electrical injuries by accidental contact with a loose or broken live wire lying in the field. While at work these farmers are often unaware of these live wires and they step on them and sustain electrical burns.

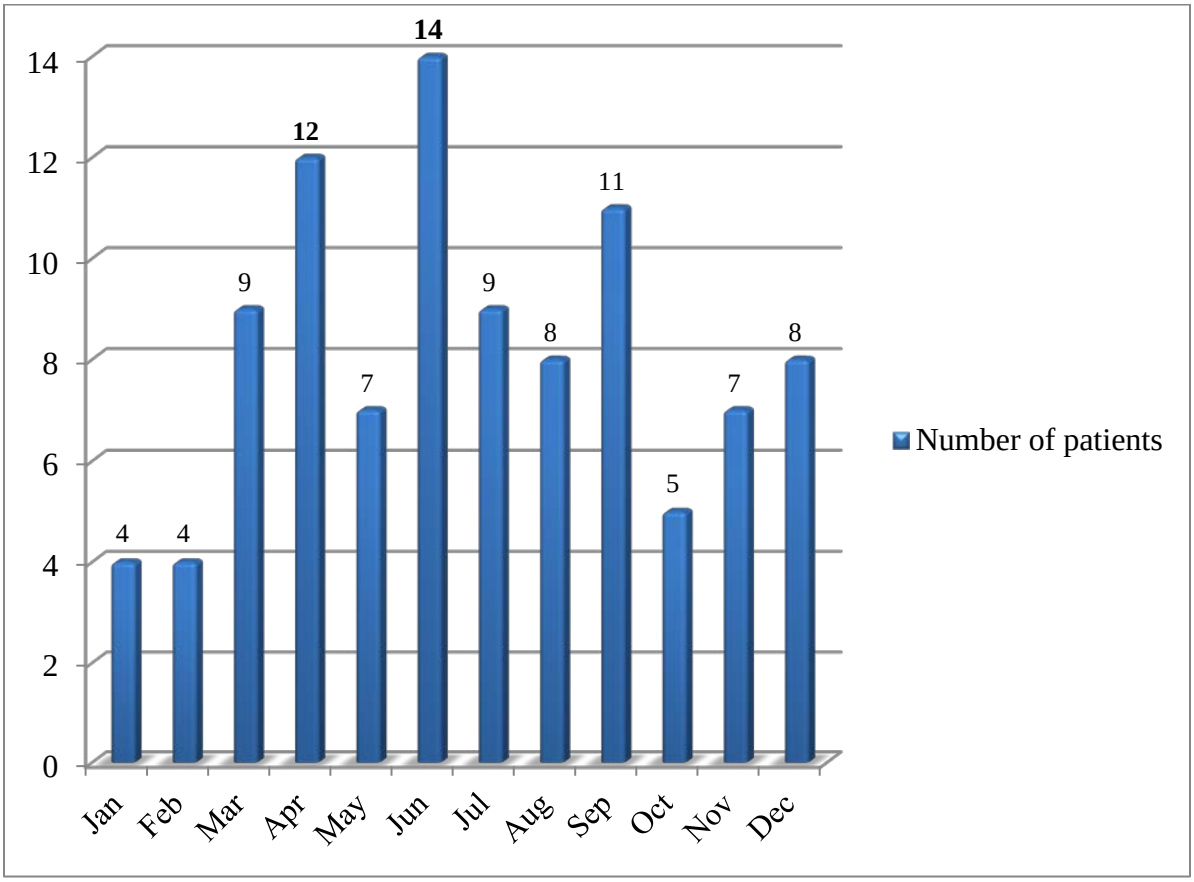
YEAR-WISE TREND



Although there is no statistical significant difference in the yearly incidence of patients admitted with electrical burn injuries, over the last three years the trend is on the increasing curve, with the maximum number of patients in a year (17 patients in 2014).

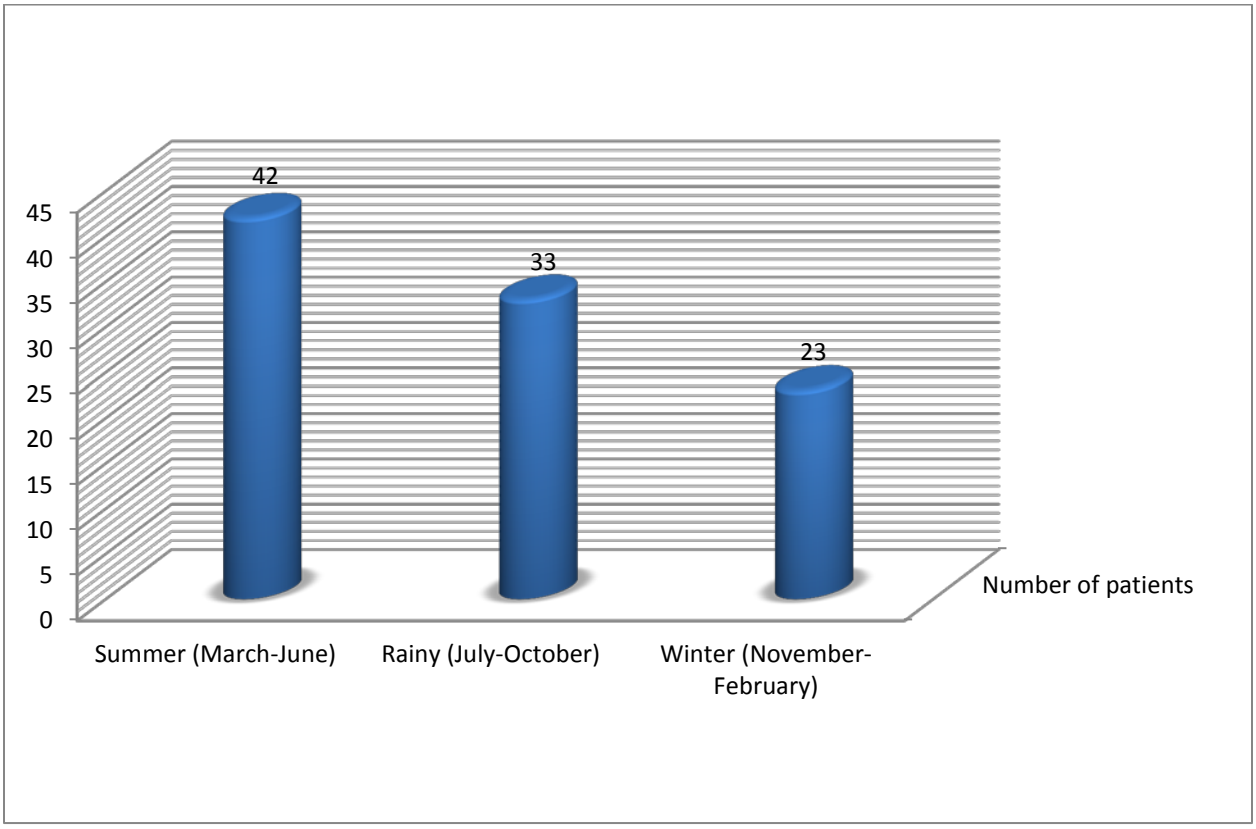
MONTH-WISE TREND

OVERALL TREND



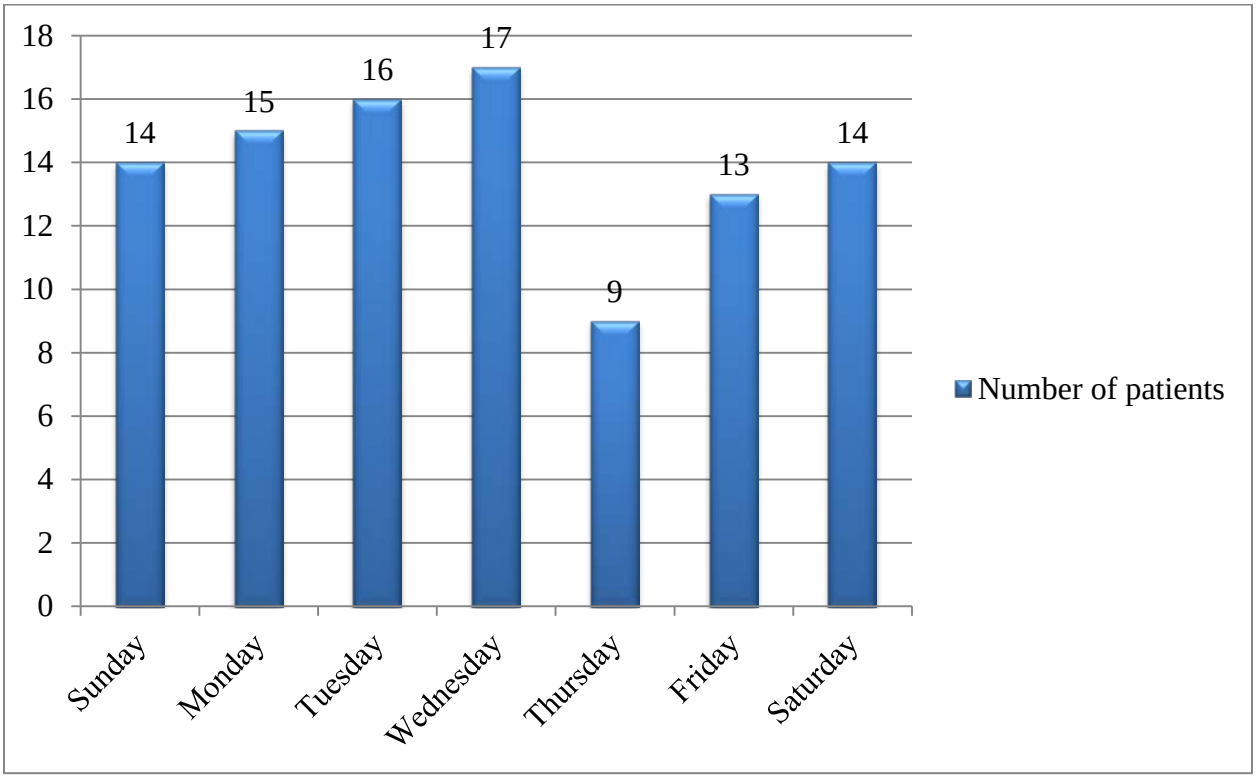
Overall, the maximum incidence of electrical burn injuries was found to occur during the months of June, followed by April that fall during the summer season.

SEASONAL-TREND



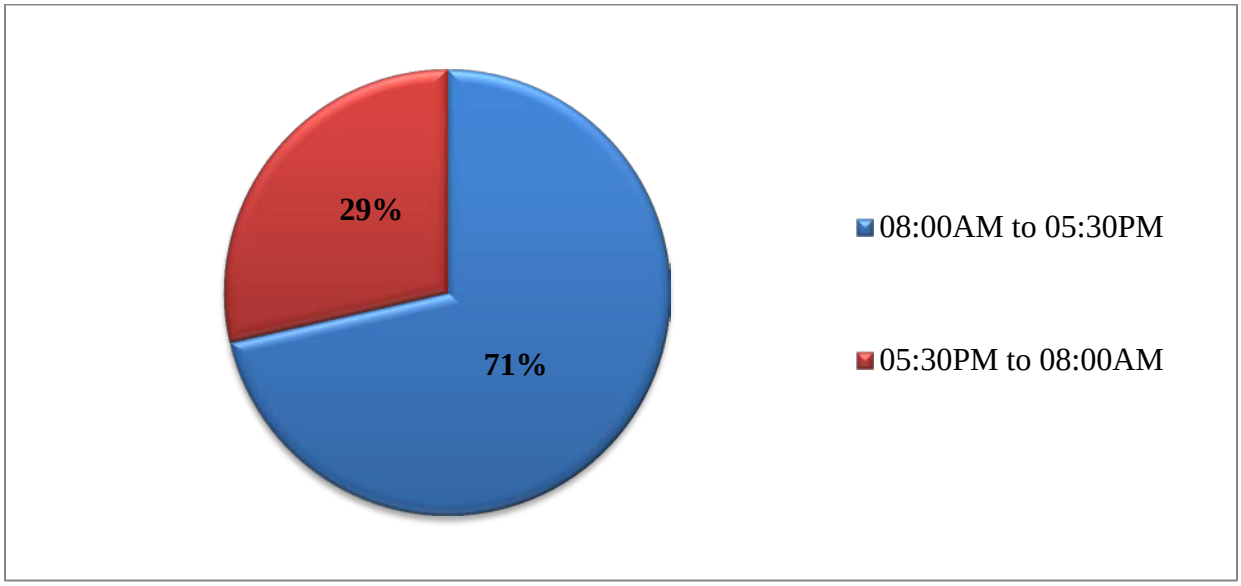
From January 2008 till December 2014, the maximum number of patients (42.85%) sustaining electrical injuries was found to occur during the summer season between March to June. The probable reason for the higher incidence during summer season could be due to patients trying to work with live-wires to steal electricity or they may be working near the live-wires due to frequent power cuts in the districts like Vellore, Chittoor and Kadapa.

DAY-WISE VARIATION



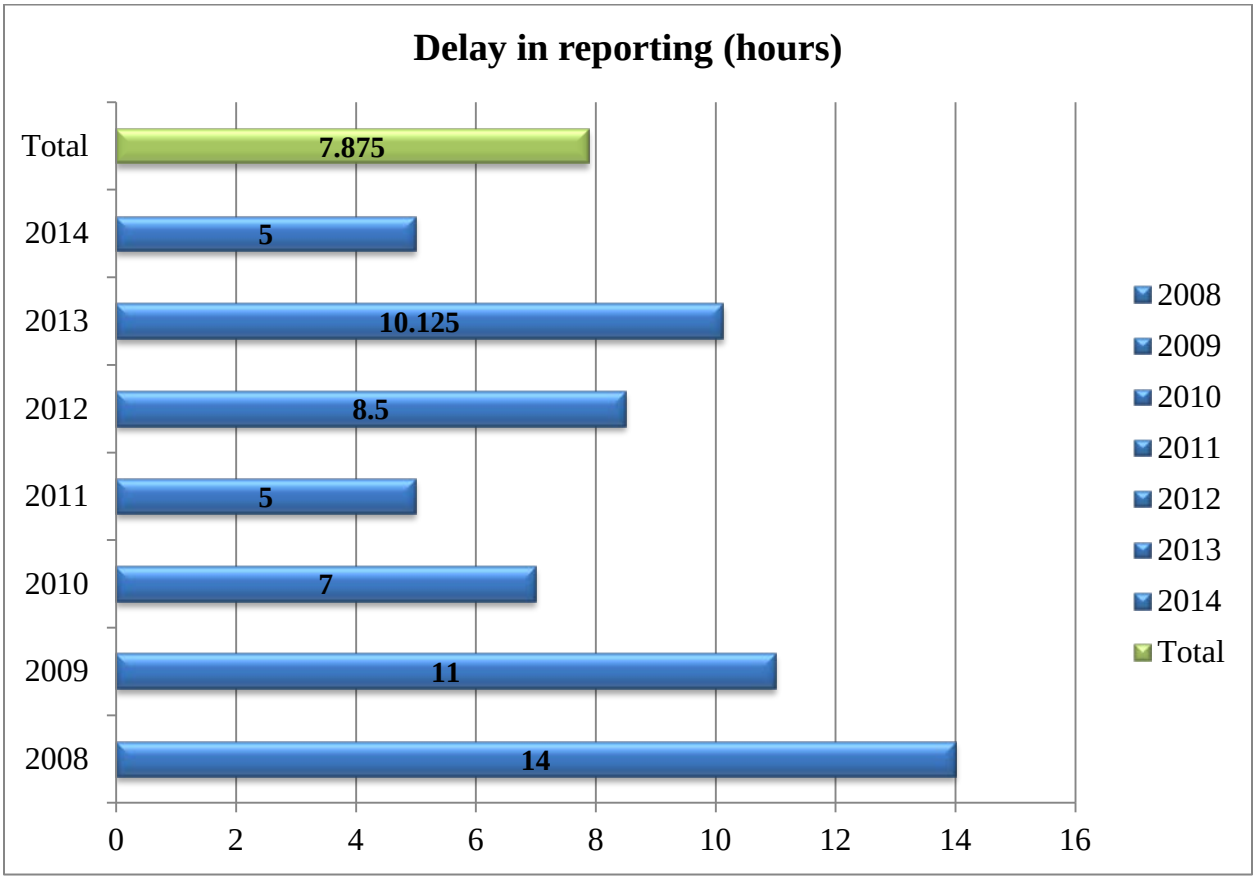
Overall, out of the seven days of the week, there was no particular day during which the incidence of sustaining electrical burns was higher than other days.

TIME OF INJURY



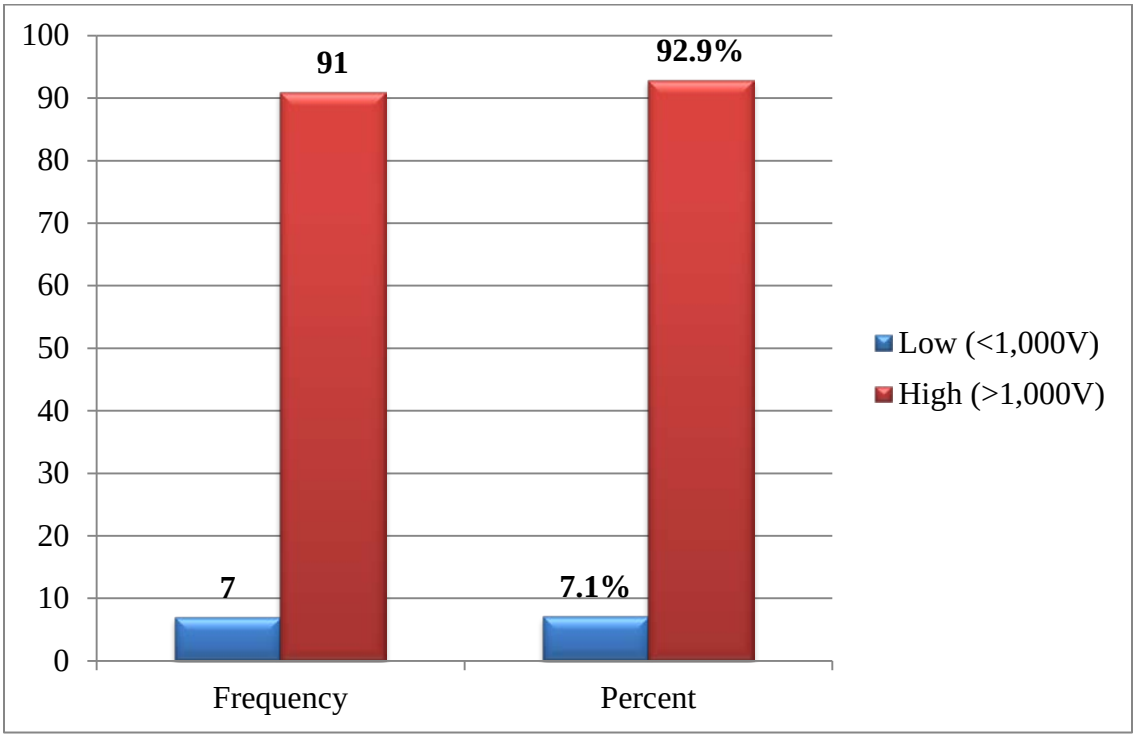
Majority of the patients (70 out of 98) sustained electrical burn injury during the daytime between 8 AM to 5:30 PM which is the usual working time in most of the places.

DELAY (IN HOURS) IN REPORTING TO CMCH AFTER INJURY



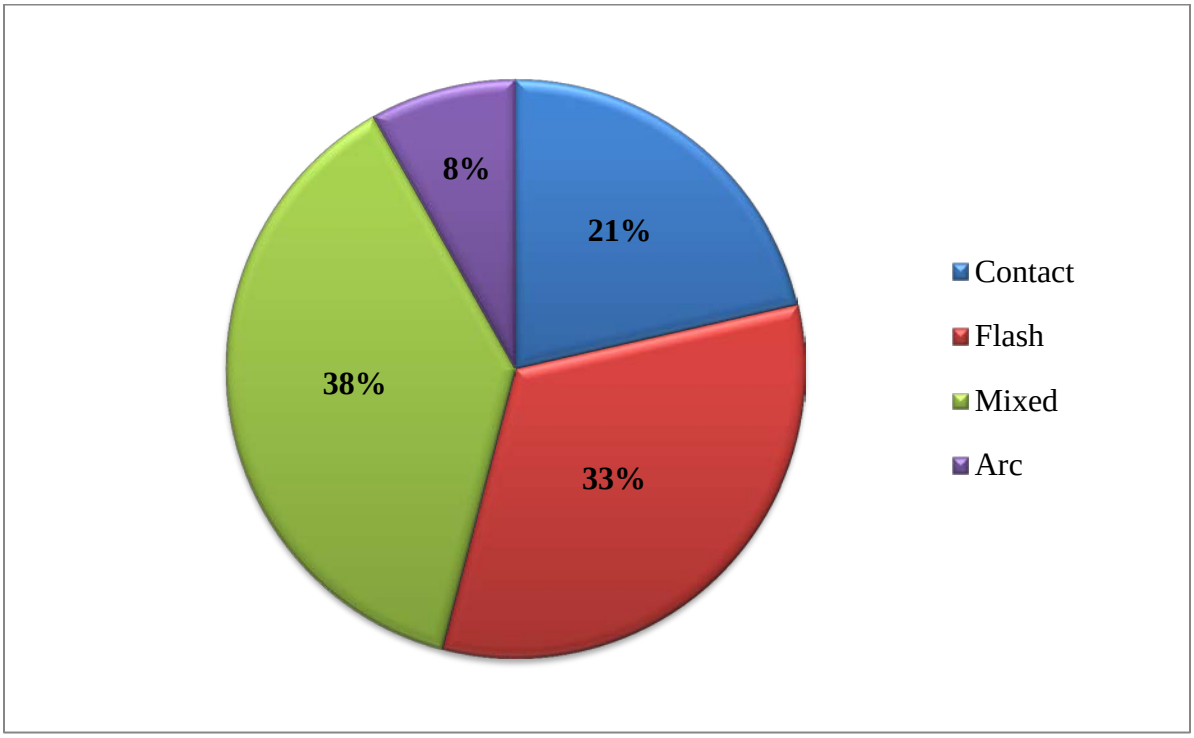
The median time delay in reporting to our institute after the burn injury was 7.875 hours.

VOLTAGE



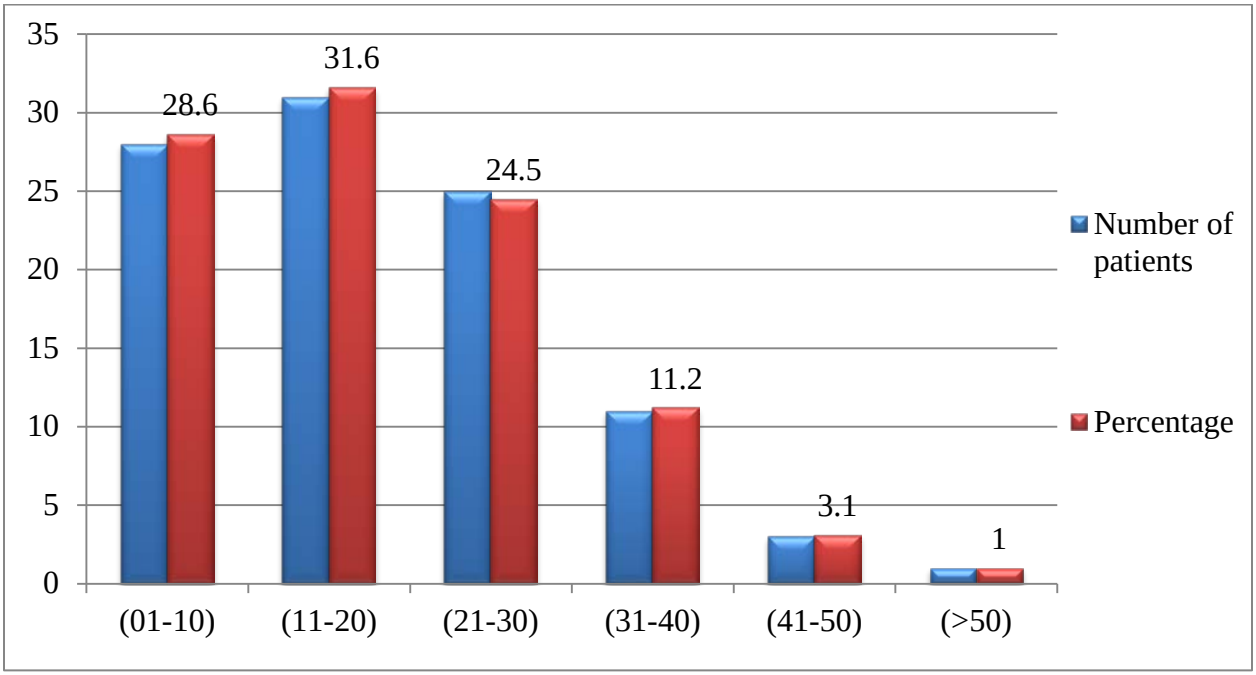
Majority of the burn injuries (92.9%) occurred due to handling or passage of high voltage (>1,000 V) current through the patient's body.

TYPE OF BURN INJURY



Majority of the patients (38%) had sustained mixed electrical burns (combination of two or more types), followed by flash burns, contact burns and finally arc burns.

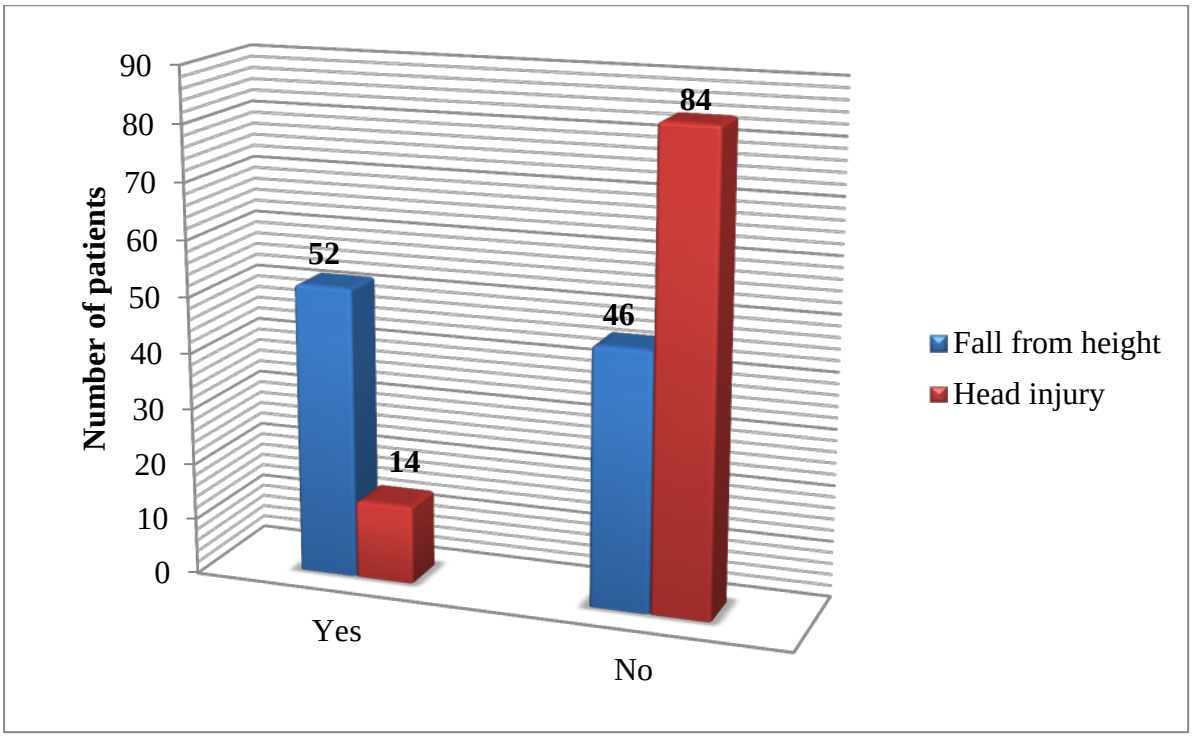
PERCENTAGE OF TOTAL BODY SURFACE AREA BURNT



84.6% patients sustained burn injuries involving less than 30% total body surface area (TBSA).

60.2% patients sustained burn injuries involving less than 20% total body surface area (TBSA).

ASSOCIATED FALL FROM HEIGHT AND PRESENCE OF HEAD INJURY

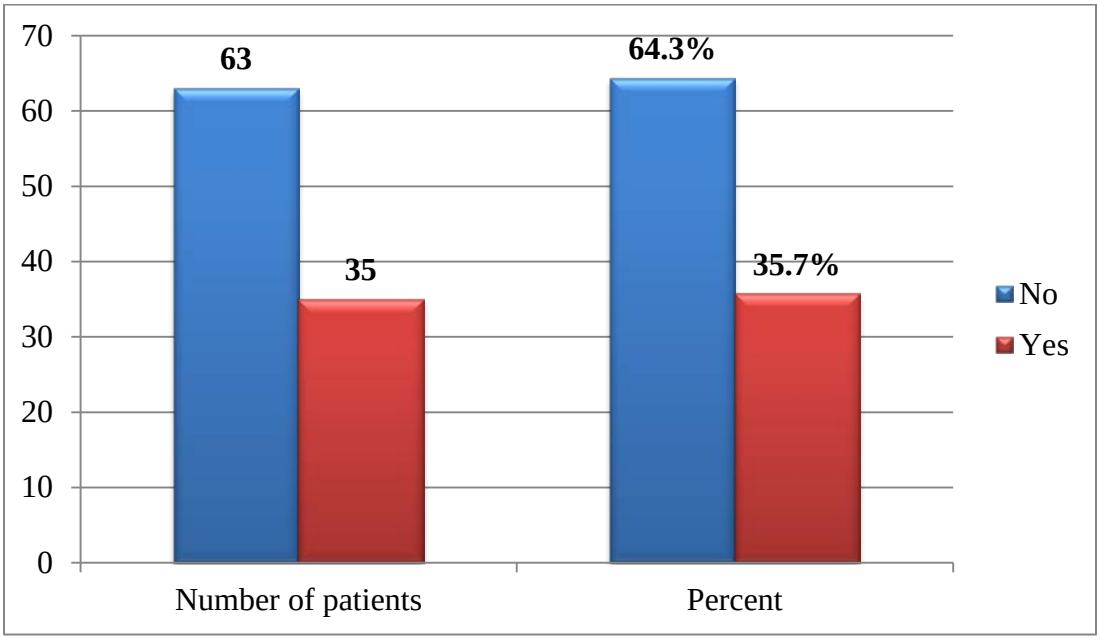


Out of 98 patients, 52 patients gave history of fall height at the time of electric shock, of which fourteen of them had associated head injury.

Out of the 14 patients who had associated head injuries, 2 patients had depressed frontal bone fracture, one patient had fracture of the mandible, one patient had frontal contusion and remaining patients had scalp defect requiring flap cover.

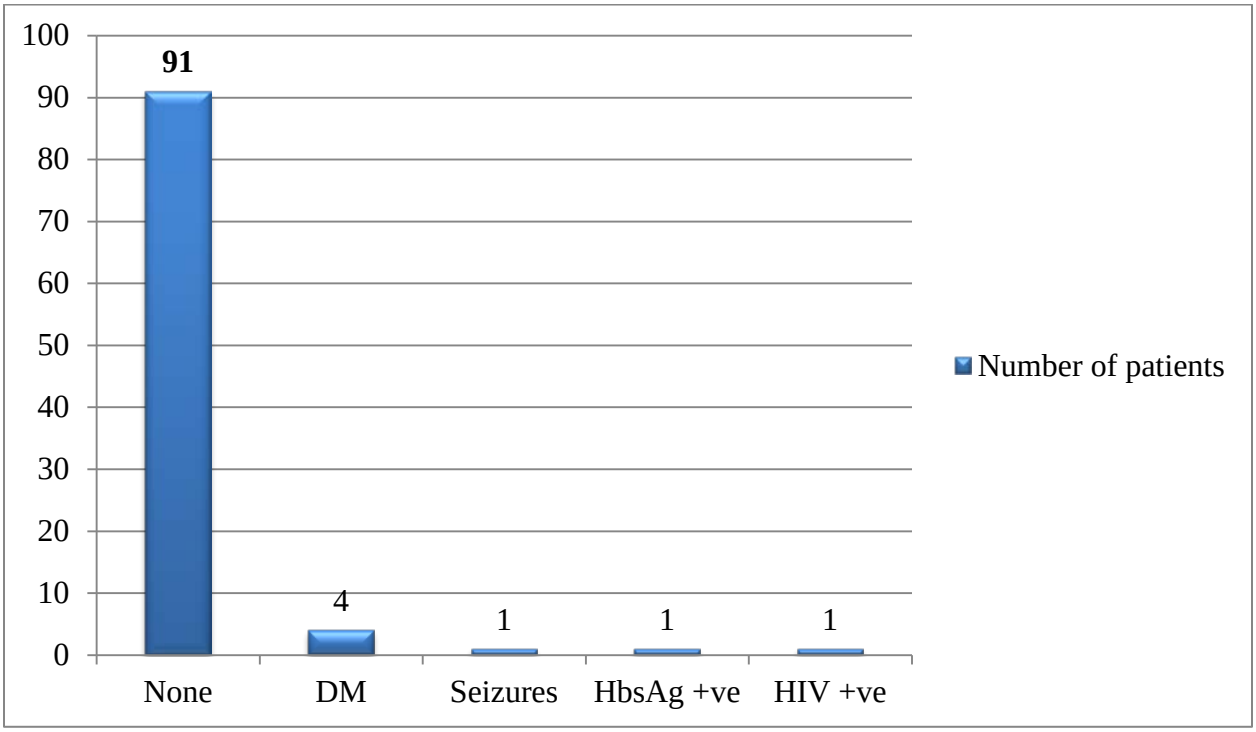
Patients with depressed frontal bone fracture and frontal contusion were evaluated by neurosurgeons and managed conservatively. One of the patients with depressed frontal bone fracture had low GCS score and had eventually expired.

HISTORY OF UNCONSCIOUSNESS



Out of all patients, 64.3% patients had no history of associated unconsciousness.

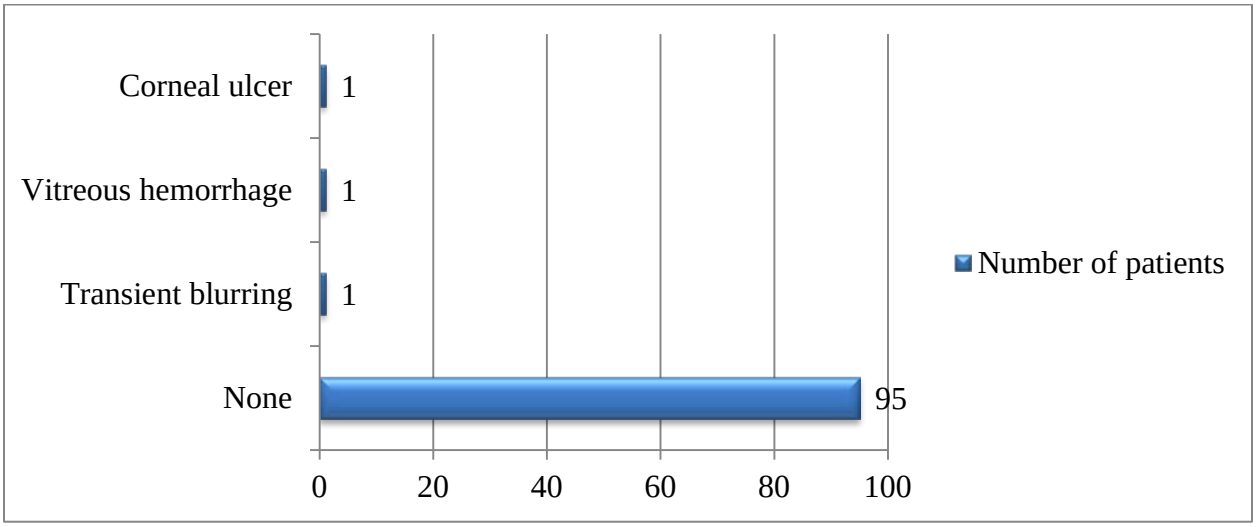
ASSOCIATED COMORBIDITIES



Out of 98 patients, 91 patients (92.86%) had no associated pre-existing comorbidties.

Four patients were diabetic, one patient was a known case of seizure disorder, one patient had tested positive for HbsAg and one for HIV antibody.

ASSOCIATED OCULAR INVOLVEMENT



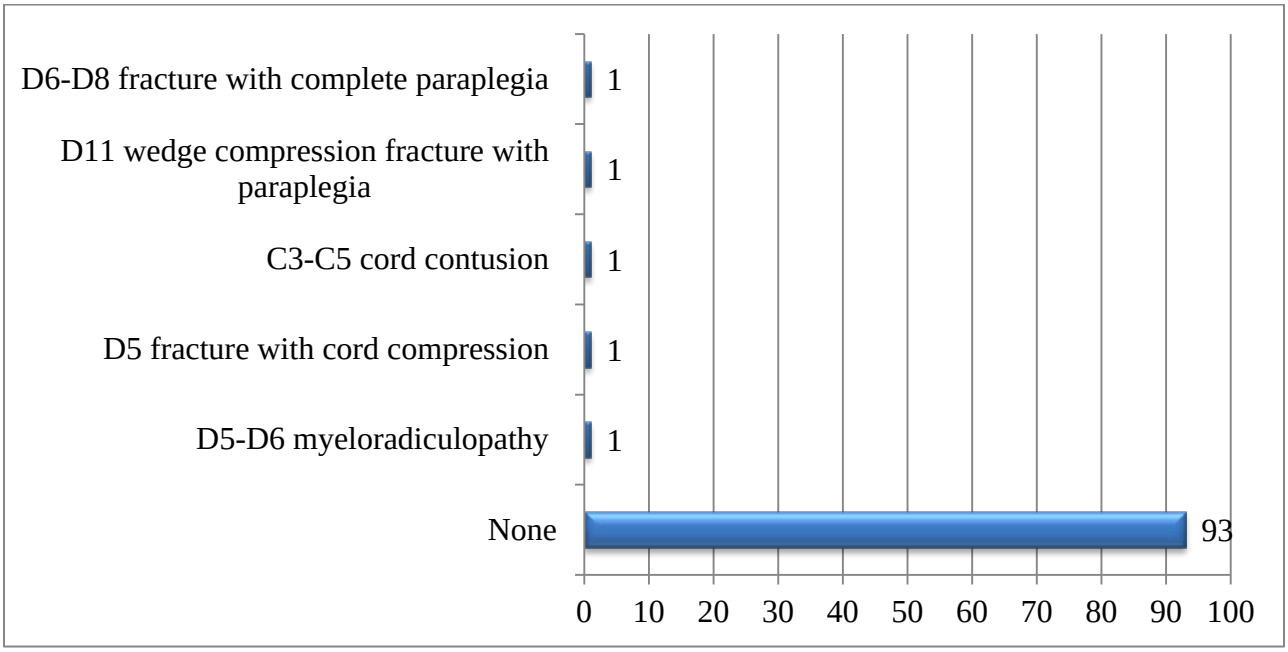
More than 95% patient had no associated immediate or late ocular complaints.

One of patients complained of immediate blurring of vision which was transient and has recovered over the course of treatment.

One of the patients had developed right eye vitreous hemorrhage and decreased vision.

One of the patients developed corneal ulcer due to exposure keratitis due to lower and upper eyelid ectropion due to contraction of the skin grafts applied for facial burns.

ASSOCIATED SPINE INJURY



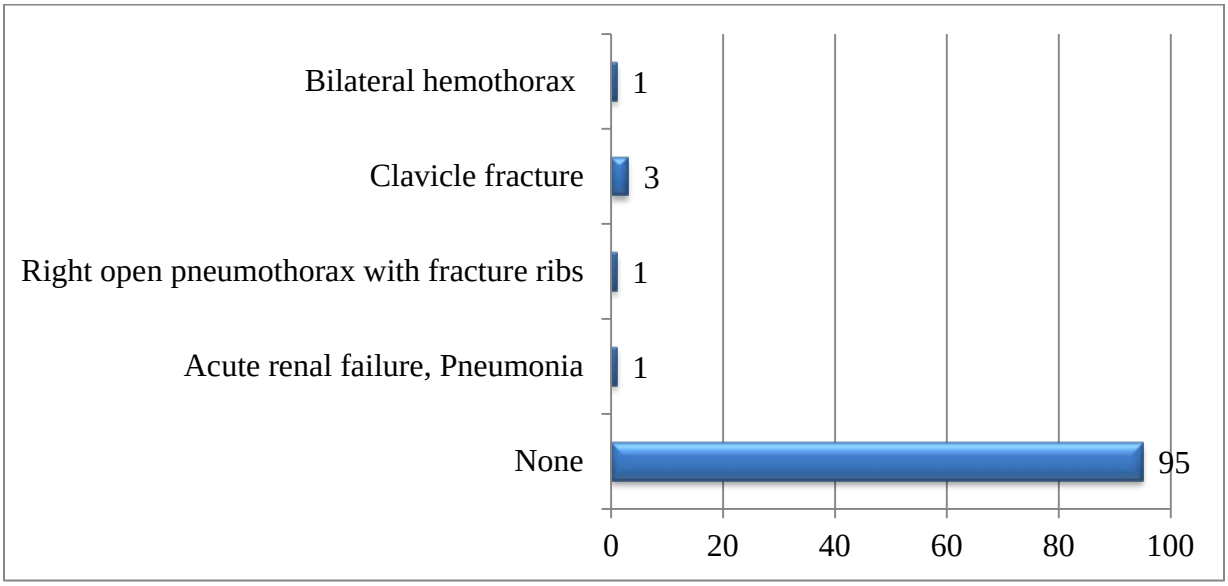
Out of the 98 patients included in the study, 93 patients had no spine injury.

As observed, out of 98 patients, 52 patients had associated fall from height. Out of these 52 patients, only 5 of them had associated spine injury.

Of the 5 patients, 4 of them had injury of the thoracic spine and one patient had cervical spine injury with cord contusion.

Of the 4 patients with thoracic spine injury, 3 were treated conservatively. Only one patient was operated with fixation and stabilization of the D6 – D8 fracture.

ASSOCIATED INTRATHORACIC AND INTRABDOMINAL INJURY



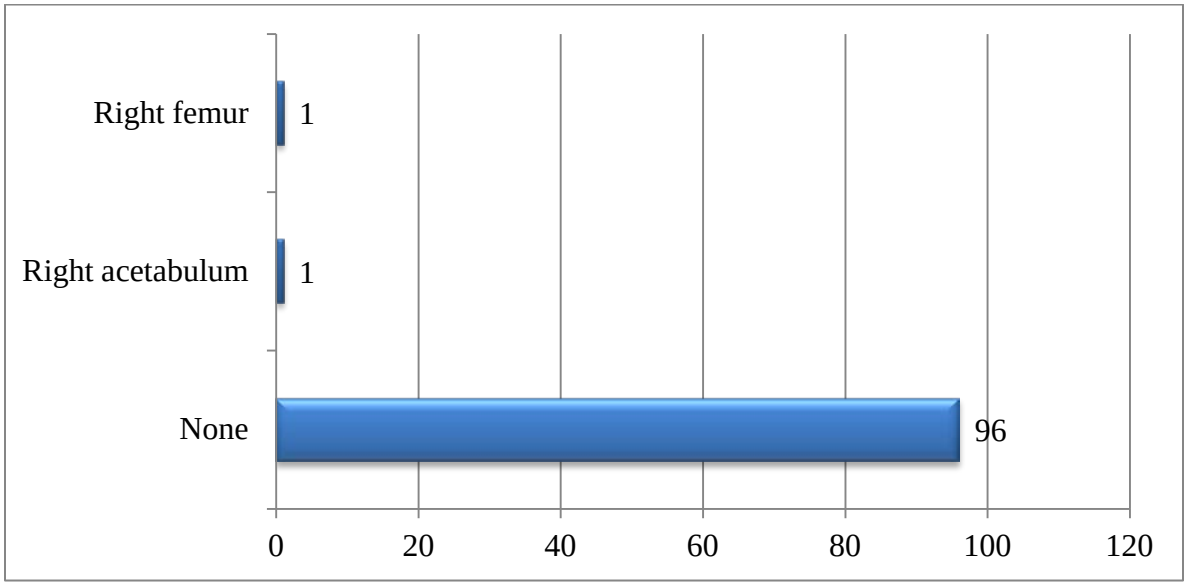
Five patients had associated intrathoracic injuries:

One of them had bilateral hemothorax for which the patient was transferred under cardiothoracic surgery and was managed with immediate insertion of intercostals chest drainage tubes.

One patient had fracture of the 3rd to 5th ribs with open pneumothorax.

Three patients had closed fracture of unilateral clavicle with no intraparenchymal lung injury or pleural injury. The fractures were managed conservatively.

ASSOCIATED LIMB FRACTURES

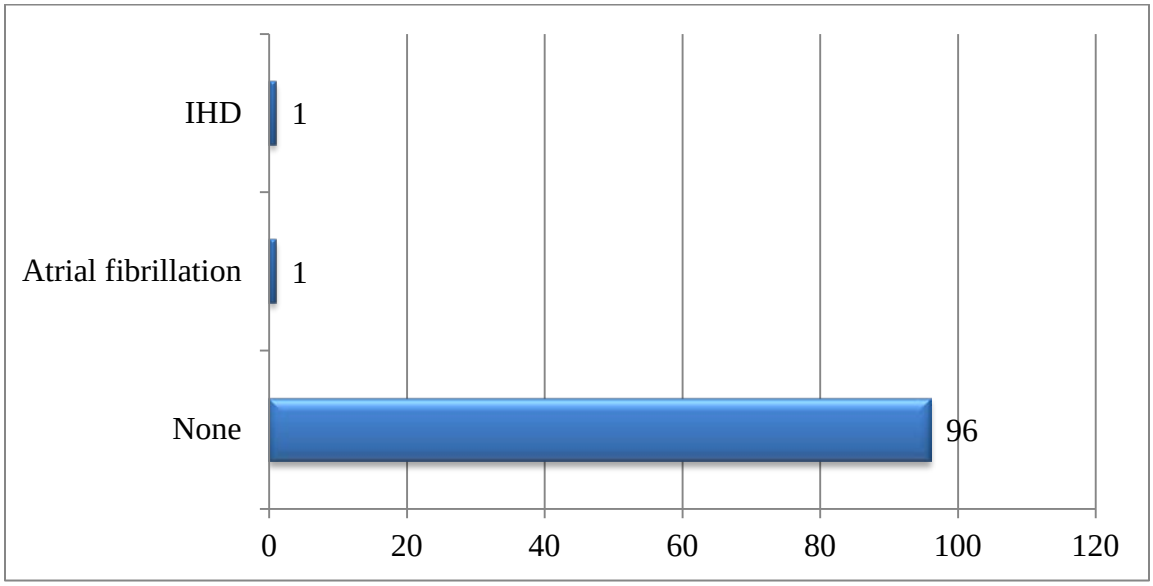


Out of 98 patients included in this study, only two patients had associated limb fractures.

One of them had closed fracture of right acetabulum which was managed conservatively, other patient had closed fracture of right femur shaft for which IM nailing was done once the burnt areas had healed by conservative measures.

None of the patients had any upper limb fractures.

ASSOCIATED CARDIAC ABNORMALITIES

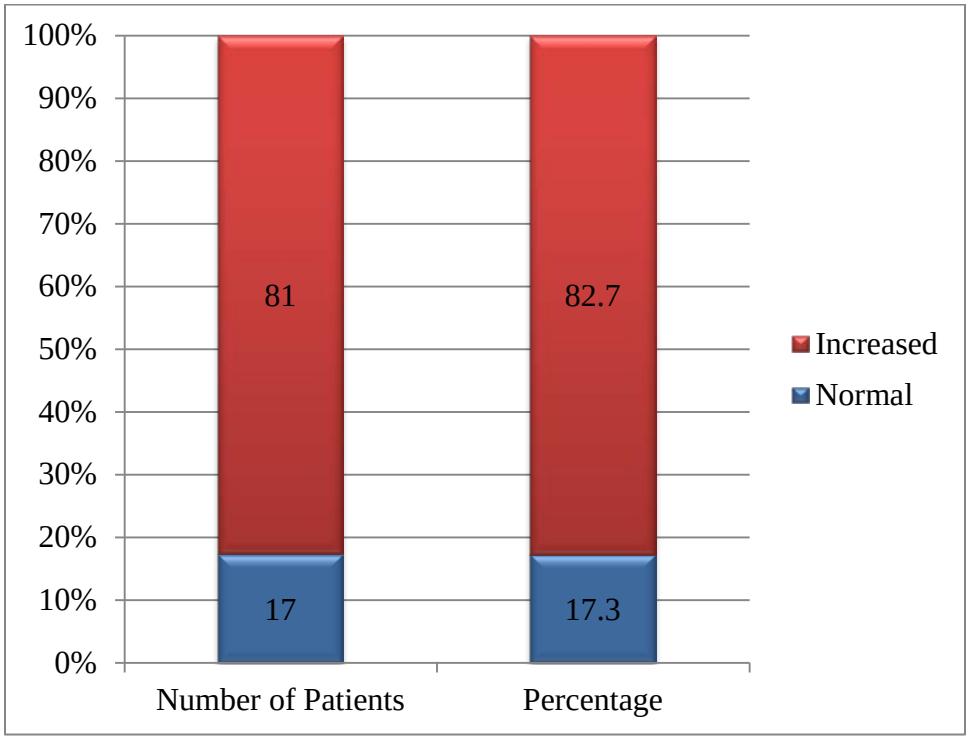


Only two patients out of 98 included in the study had cardiac abnormalities detected on ECG.

One patient had features of atrial fibrillation on initial ECG for which Tab.Metoprolol was initiated and patient was observed and repeat ECG were taken. The changes had reverted back and the patient did not require any further management as per the cardiologist advice.

Other patient had features suggestive of ischemic heart disease (IHD) for which he was started on Tab.Deplatt A 75mg OD, Tab.Aztor 10mg OD and Tab.Metoprolol 25mg OD.

SERUM CPK LEVELS ON DAY OF ADMISSION

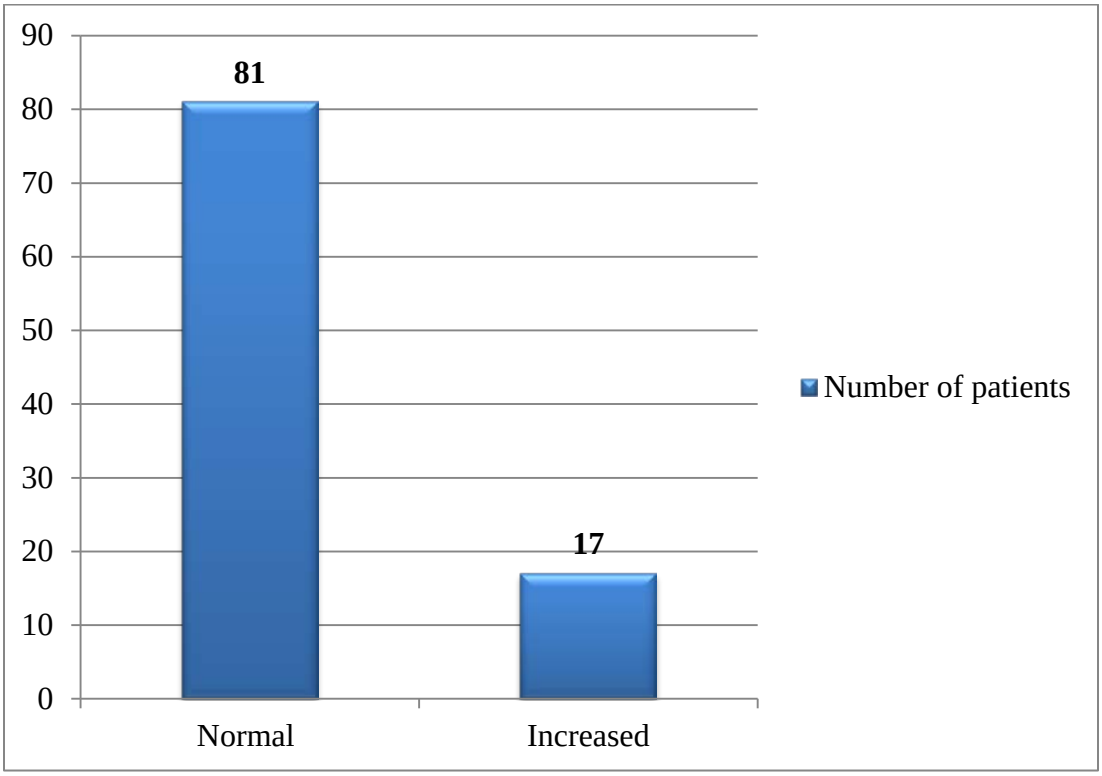


Serum CPK levels were done for all patients on the day of admission.

Increased levels of serum CPK were found in 81 (82.7%) patients whereas normal values were present in 17 (17.3%) patients.

Normal levels were found in majority of the patients who reported after 72 hours of injury and in few patients who had electric flash burns.

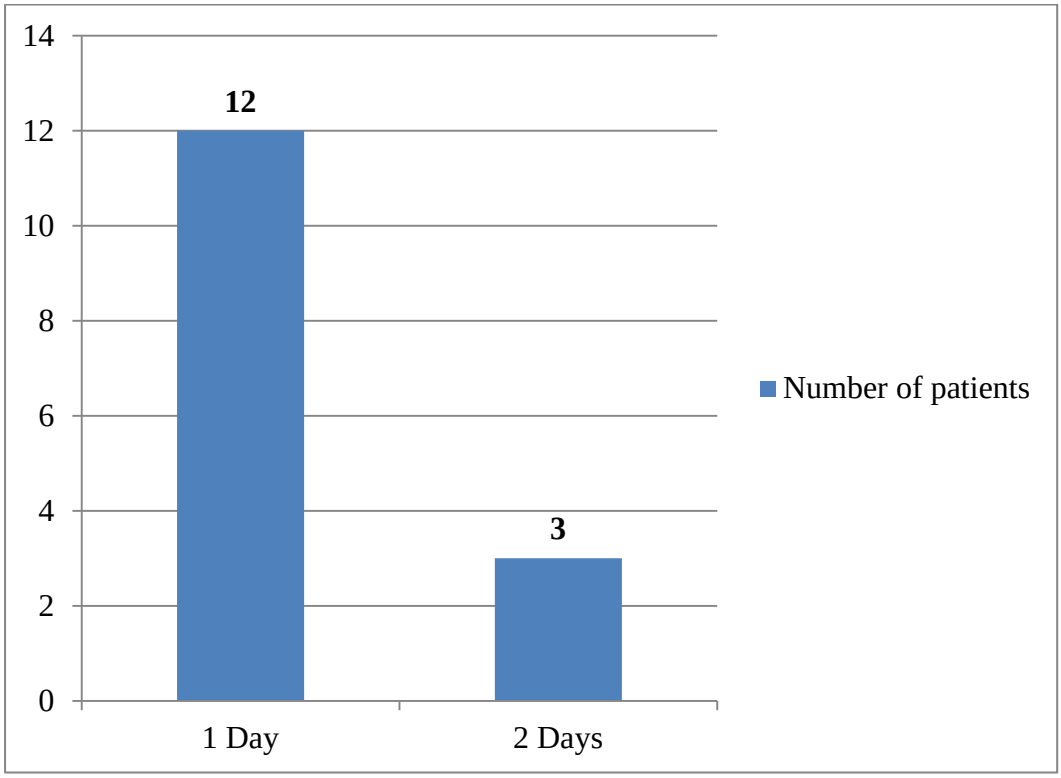
SERUM CREATININE LEVELS ON DAY OF ADMISSION



Serum creatinine levels were done for all patients on the day of presentation at our institute.

Out of 98 patients, 81 patients (82.65%) had normal serum creatinine levels and 17 patients (17.35%) had increased serum creatinine levels at the time of presentation to our institute.

SERUM CREATININE LEVELS BECAME NORMAL AFTER _ DAYS



Out of the 17 patients who had increased serum creatinine levels on day of admission, the serum creatinine levels became normal in 15 patients. In majority (12) of the patients (80%), serum creatinine levels became normal after 1 day and in 3 patients (20%).

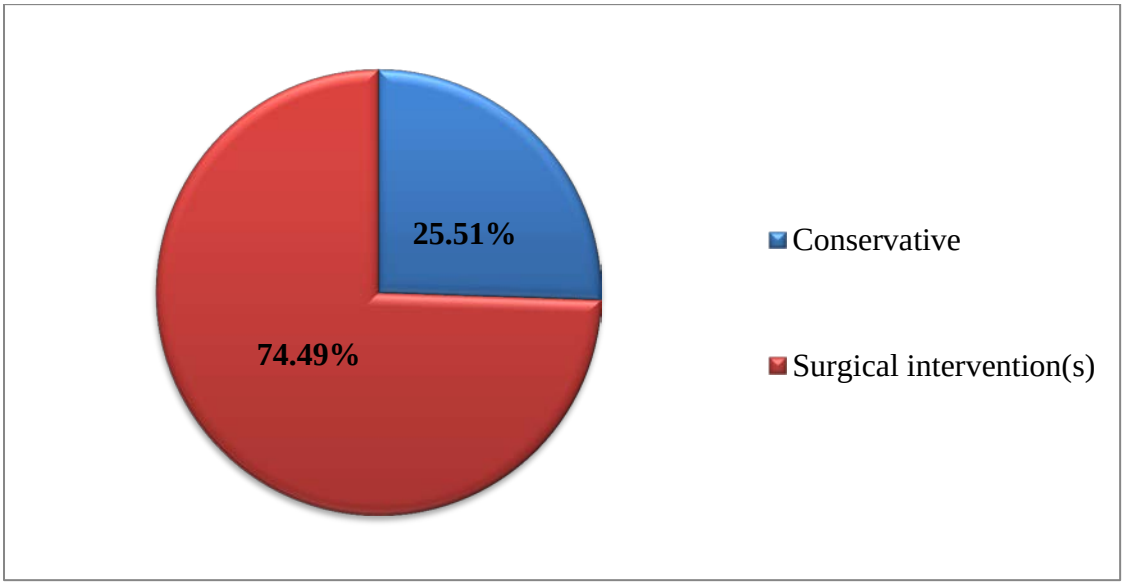
In the remaining two patients, serum creatinine levels did not return to normal range as one patient expired after one day and the other patient who was diagnosed with acute renal failure required hemodialysis but eventually expired after 11 days of treatment.

URINE MYOGLOBIN

Urine myoglobin levels were done for all patients on the day of admission to rule our myoglobinuria.

It was found to be negative in all patients.

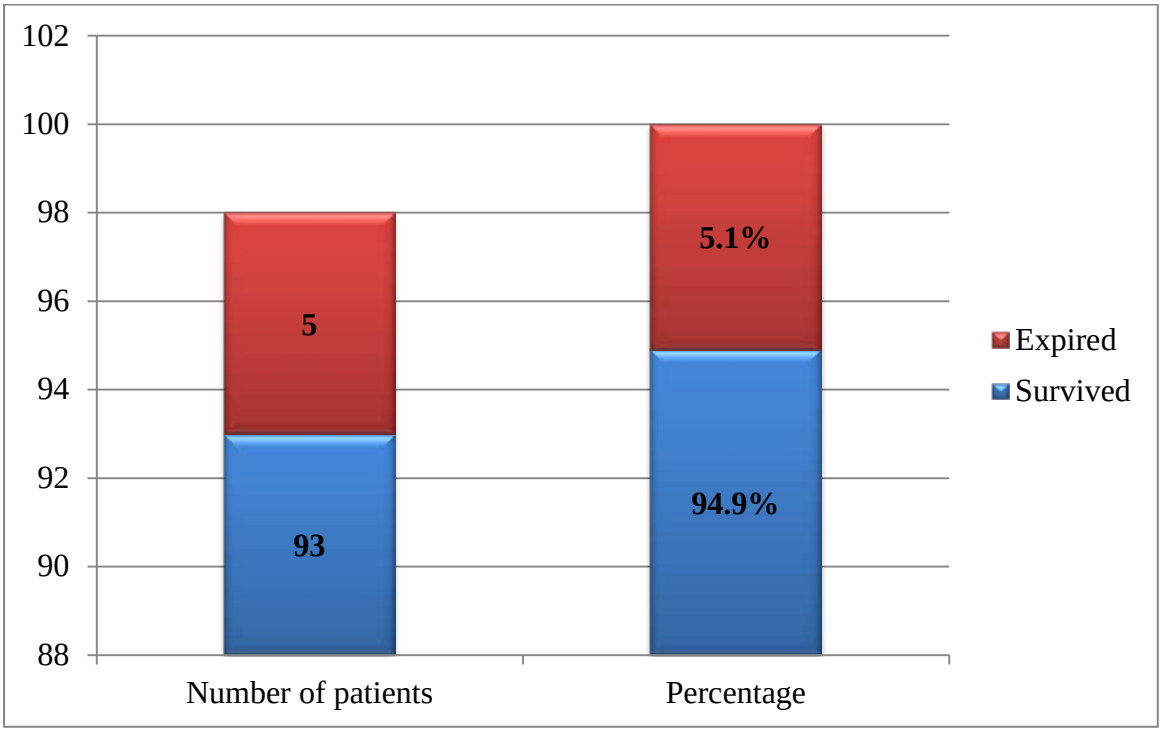
TREATMENT DONE



Out of 98 patients, 25 patients (25.51%) were managed conservatively with intravenous fluid resuscitation, regular vitals monitoring and daily dressings.

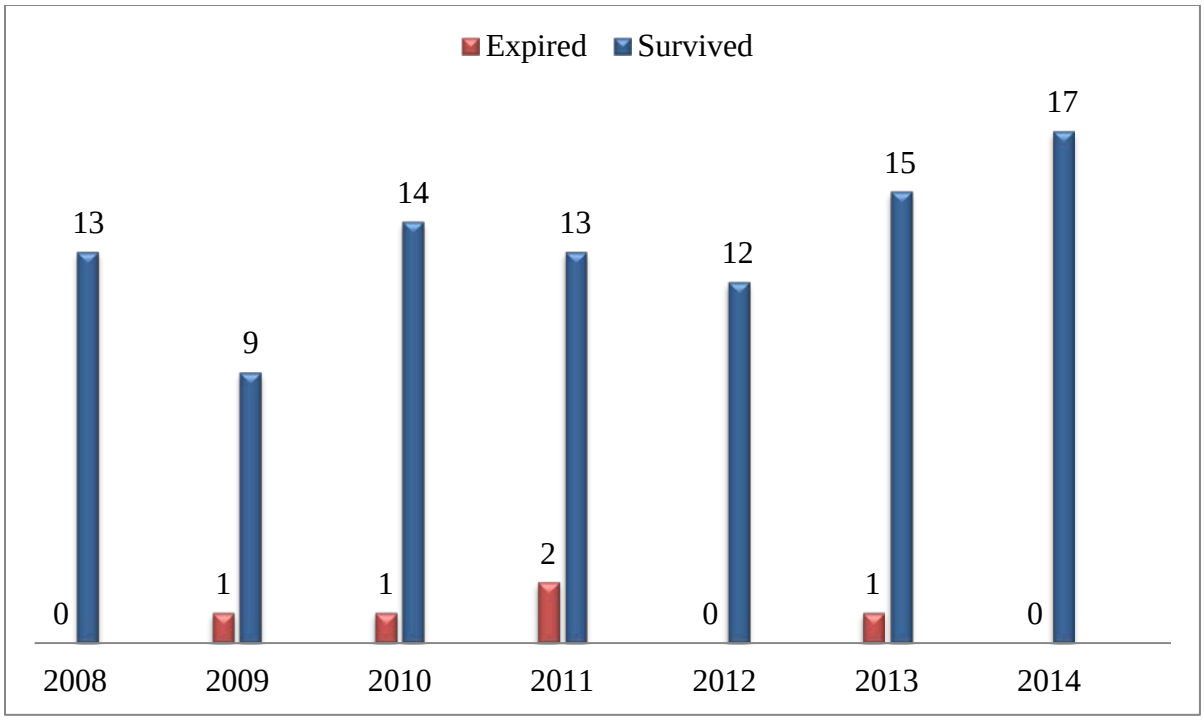
Remaining 73 (74.49%) patients required either single or multiple surgical interventions during the course of their hospital stay and treatment.

OVERALL OUTCOME AT DISCHARGE



Out of 98 patients included in this study, 93 (94.9%) patients survived and 5 (5.1%) patients expired.

YEAR-WISE OUTCOME AT DISCHARGE



Out of 98 patients included in this study, Survived – 93, Expired – 5.

13 patients were admitted in 2008: Survived – 13, Expired – 0

10 patients were admitted in 2009: Survived – 9, Expired – 1

15 patients were admitted in 2010: Survived – 14, Expired – 1

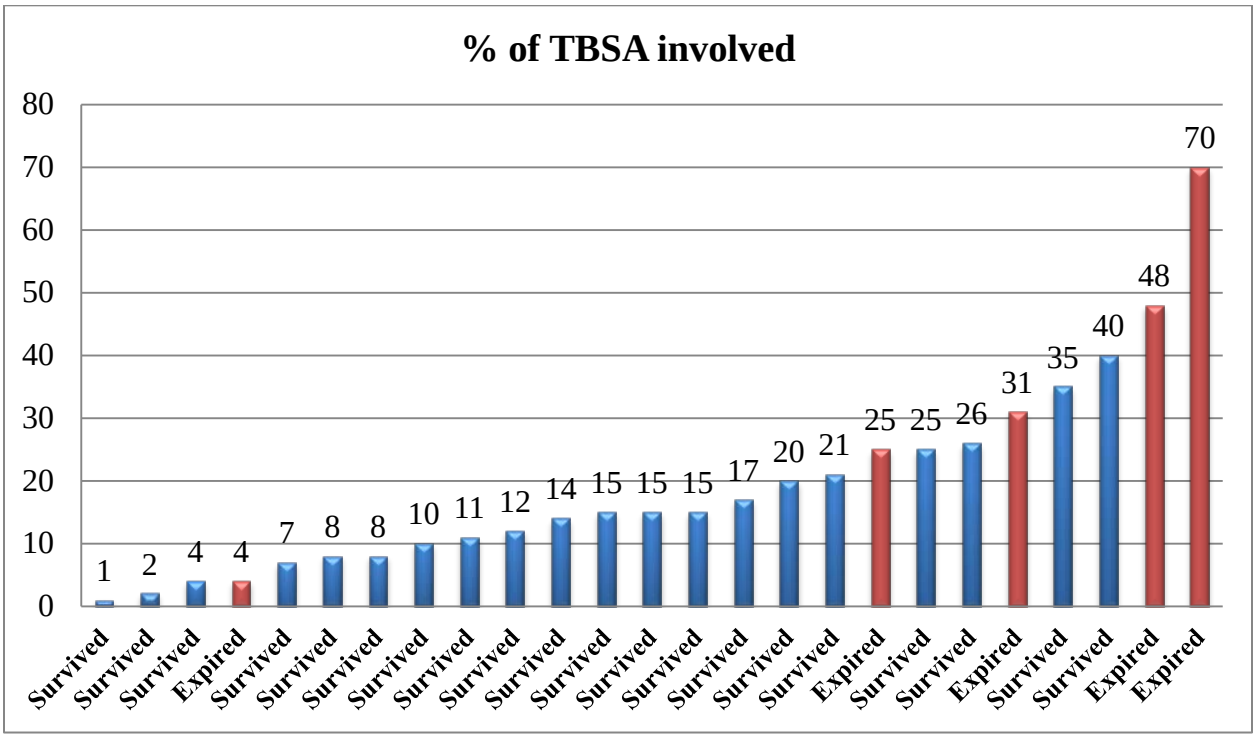
15 patients were admitted in 2011: Survived – 13, Expired – 2

12 patients were admitted in 2012: Survived – 12, Expired – 0

16 patients were admitted in 2013: Survived – 15, Expired – 1

17 patients were admitted in 2014: Survived – 14, Expired – 0

OUTCOME OF PATIENTS TREATED CONSERVATIVELY



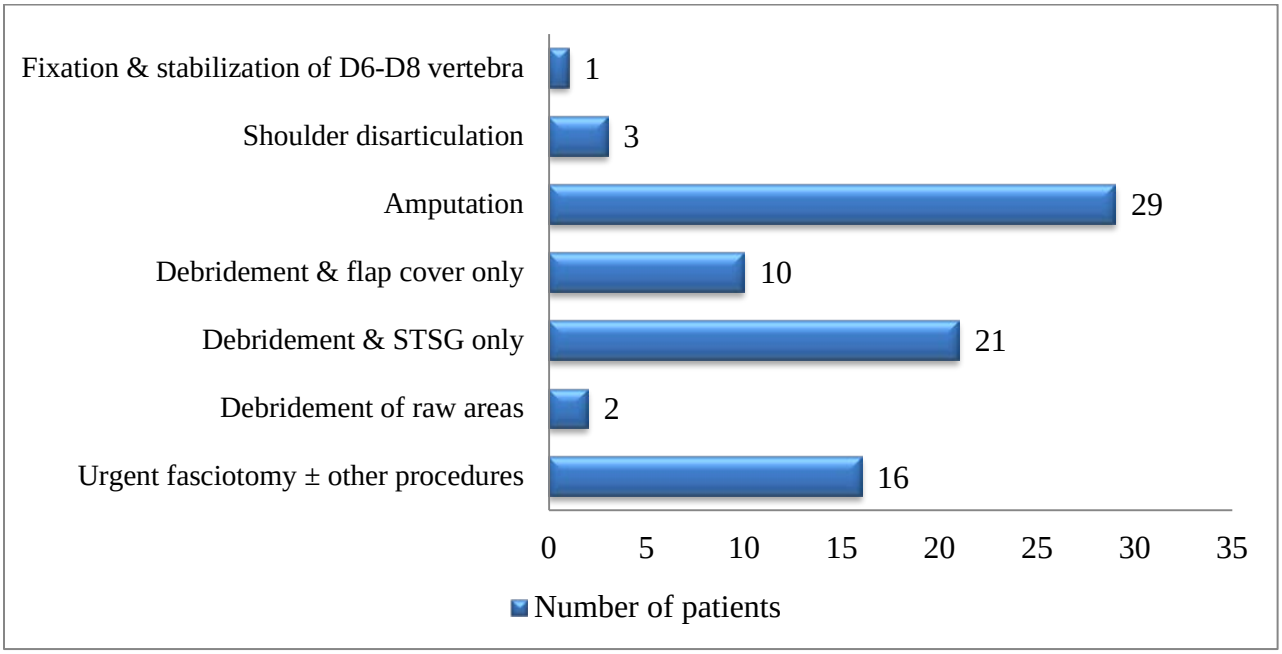
Out of the 25 patients treated conservatively, 20 patients survived and 5 patients expired.

The average percentage of involved TBSA in these patients was 19.36%.

Overall out of 98 patients in this study, 5 patients expired and all 5 patients were treated conservatively. Three patients had >30% (31%, 48%, 70%) of the TBSA involved. One of the patients had depressed frontal bone fracture and a low GCS score. One of the patients developed acute renal failure and subsequently developed pneumonia and multi – organ failure.

All patients who expired were males with an average age of 38.6 years with minimum age being 25 years and maximum age being 52 years.

SURGICAL INTERVENTIONS DONE



Out of the 98 patients included in this study, 73 patients required surgical interventions.

Out of these 73 patients, 16 patients required urgent fasciotomy followed by secondary procedures.

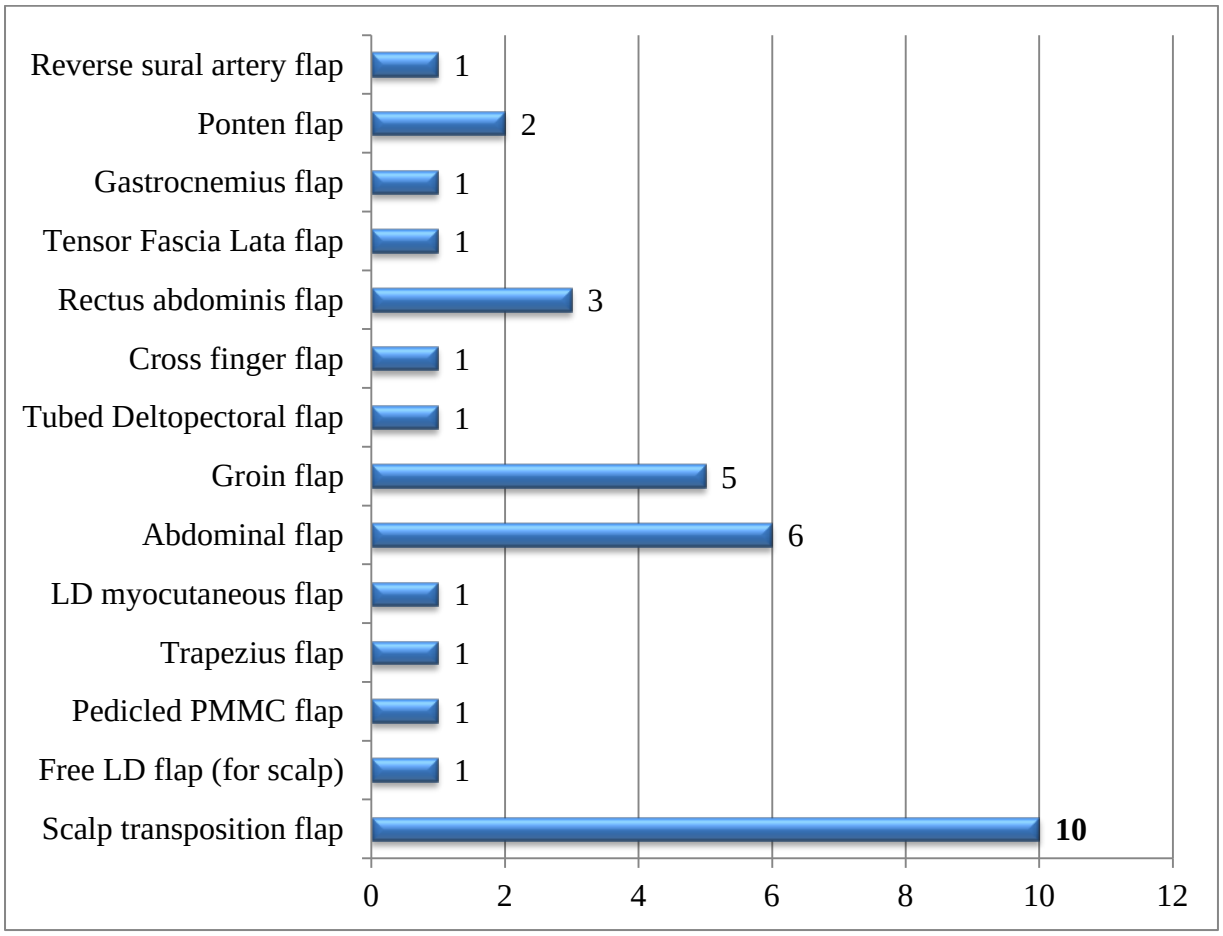
Two patients required debridement of the raw areas.

21 patients required only debridement of raw areas and STSG (split thickness skin graft cover).

Ten patients required only debridement of raw areas and flap cover.

29 patients required amputations, 3 patients required shoulder disarticulation and one patient required fixation & stabilization of D6 – D8 vertebra.

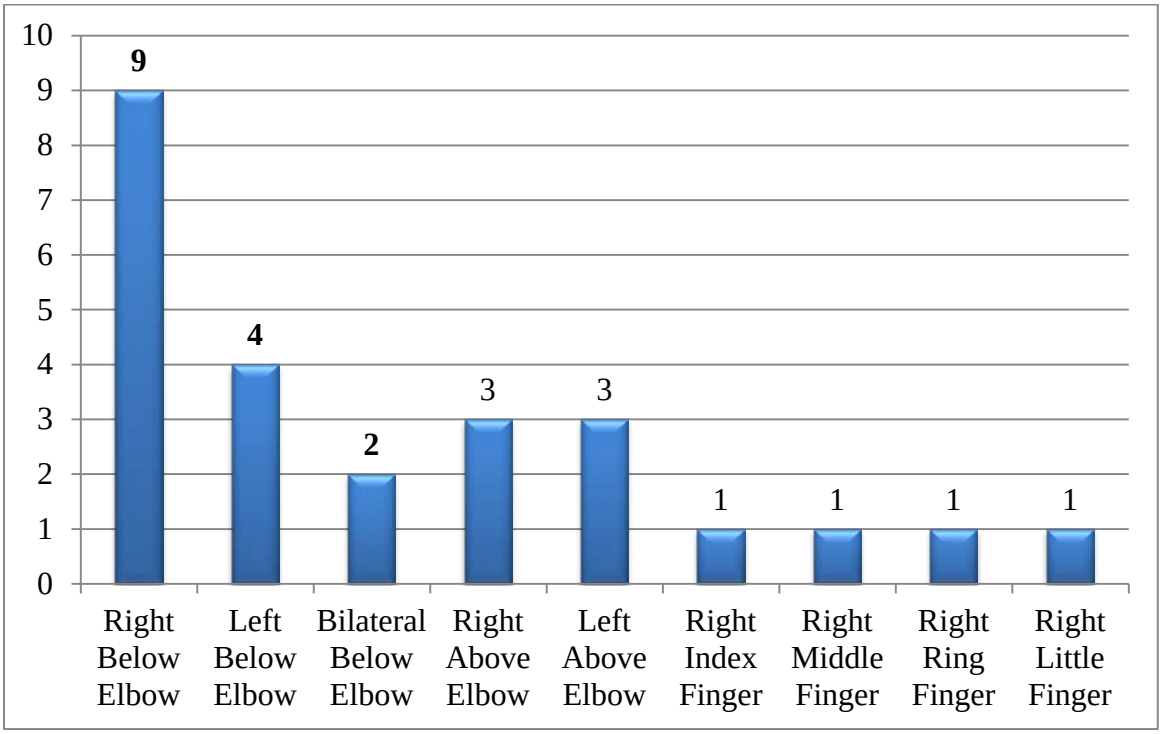
DEBRIDEMENT AND FLAP COVER



Flap done	**Number**
Head and neck defect	
Scalp transposition flap	10
Free LD flap (for scalp)	1
Pedicled PMMC flap	1
Trapezius flap	1
Chest wall defect	
Pedicled LD myocutaneous flap	1
Upper limb defects	
Abdominal flap (for forearm)	6
Groin flap (for wrist & index finger)	5
Tubed Deltopectoral flap (for thumb)	1
Cross finger flap	1
Lower limb defects	
Rectus abdominis flap (for exposed femoral vessels & grochanter)	3
Tensor Fascia Lata flap (for femoral vessels)	1
Gastrocnemius flap (for knee)	1
Ponten flap (for knee)	2
Reverse sural artery flap (for foot)	1

AMPUTATIONS

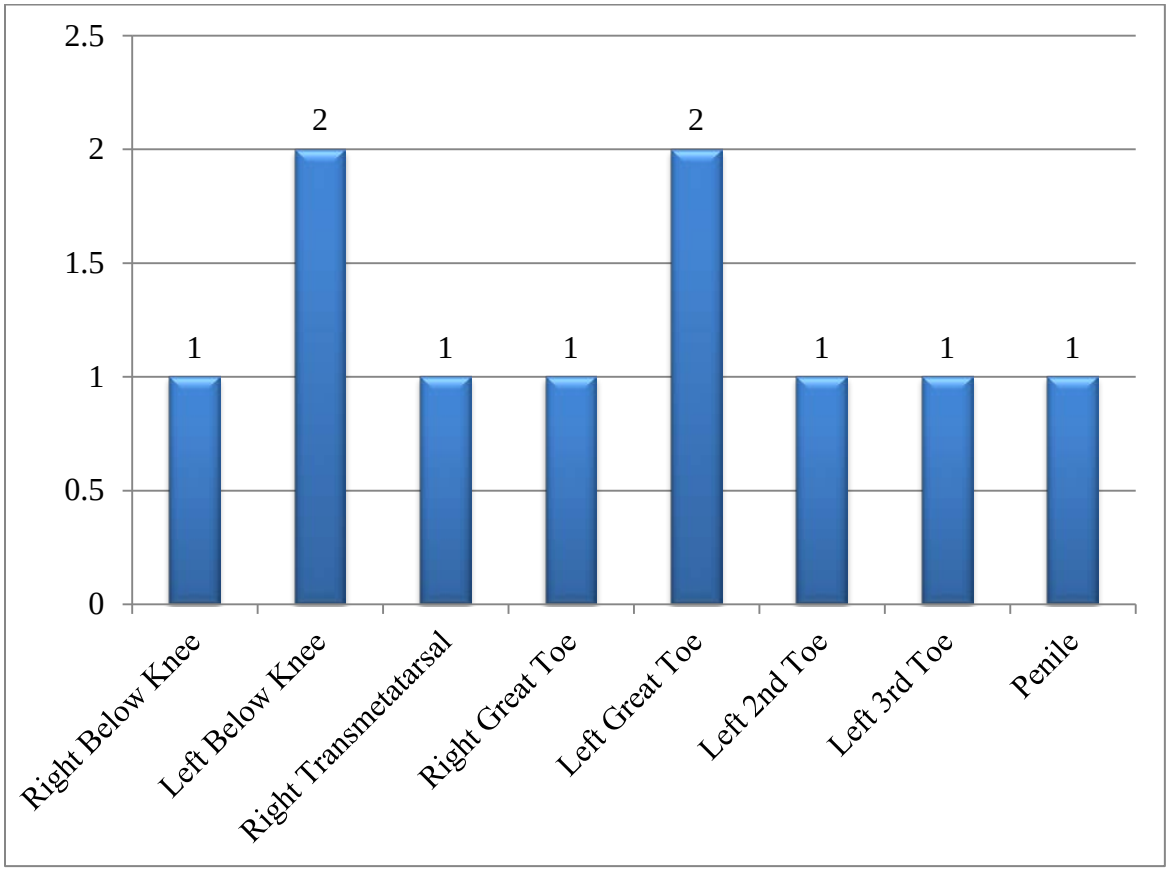
UPPER LIMB



Out of the 98 patients included in this study, majority of the patients that had amputation of upper limb underwent below elbow amputations (15), with the maximum cases undergoing right below elbow amputation, followed by left below elbow and bilateral below elbow amputations.

AMPUTATIONS

LOWER LIMB

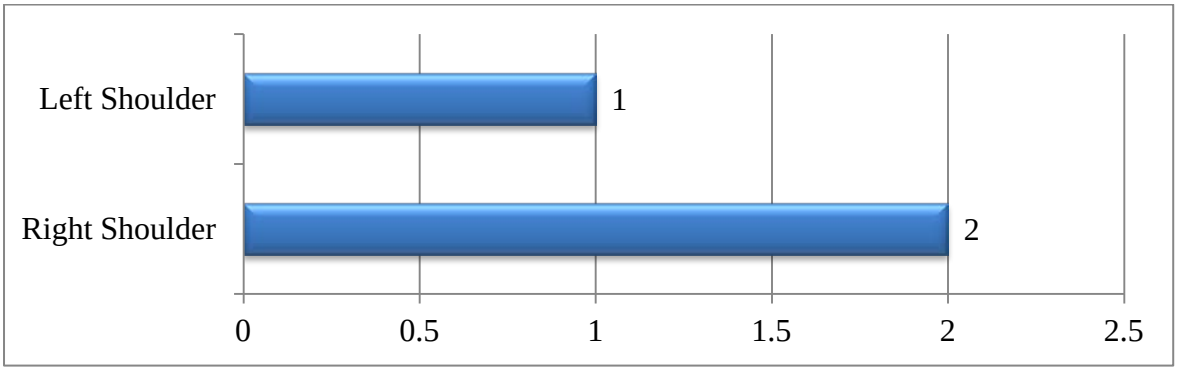


Out of all patients in this study, 9 patients underwent lower limb amputations and one patient developed penile necrosis for which he underwent penile amputation.

The proximal extent of lower limb amputation was below knee.

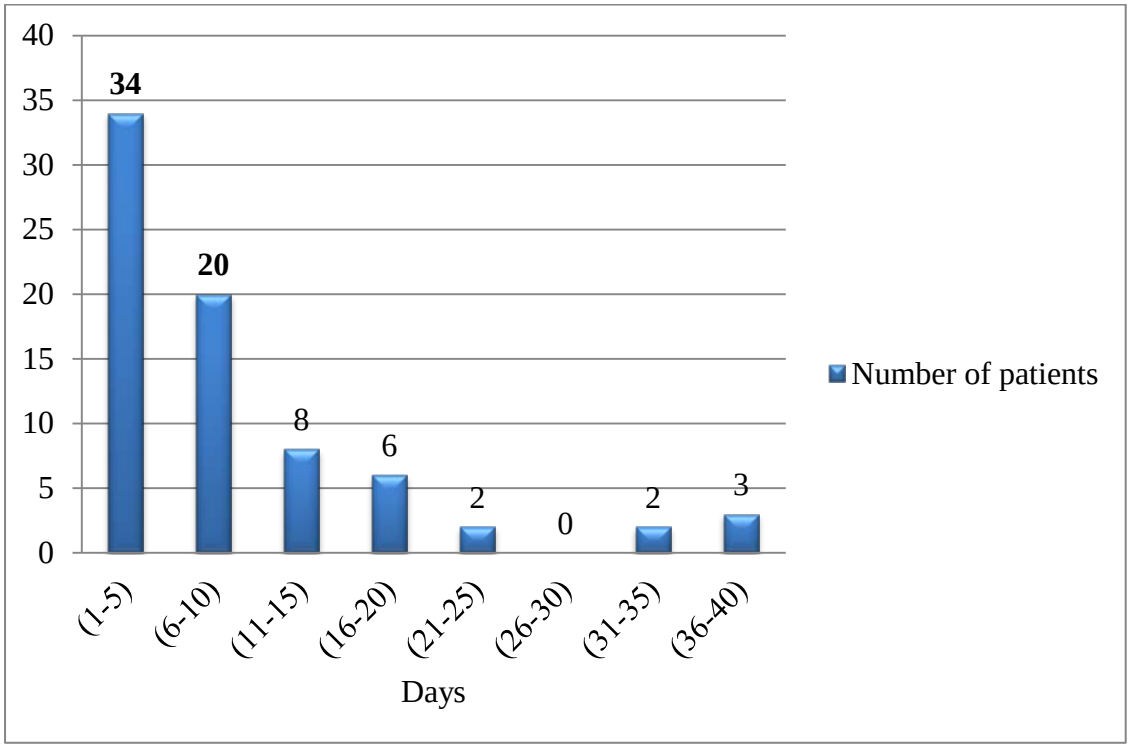
None of the patients required above elbow amputations.

SHOULDER DISARTICULATION



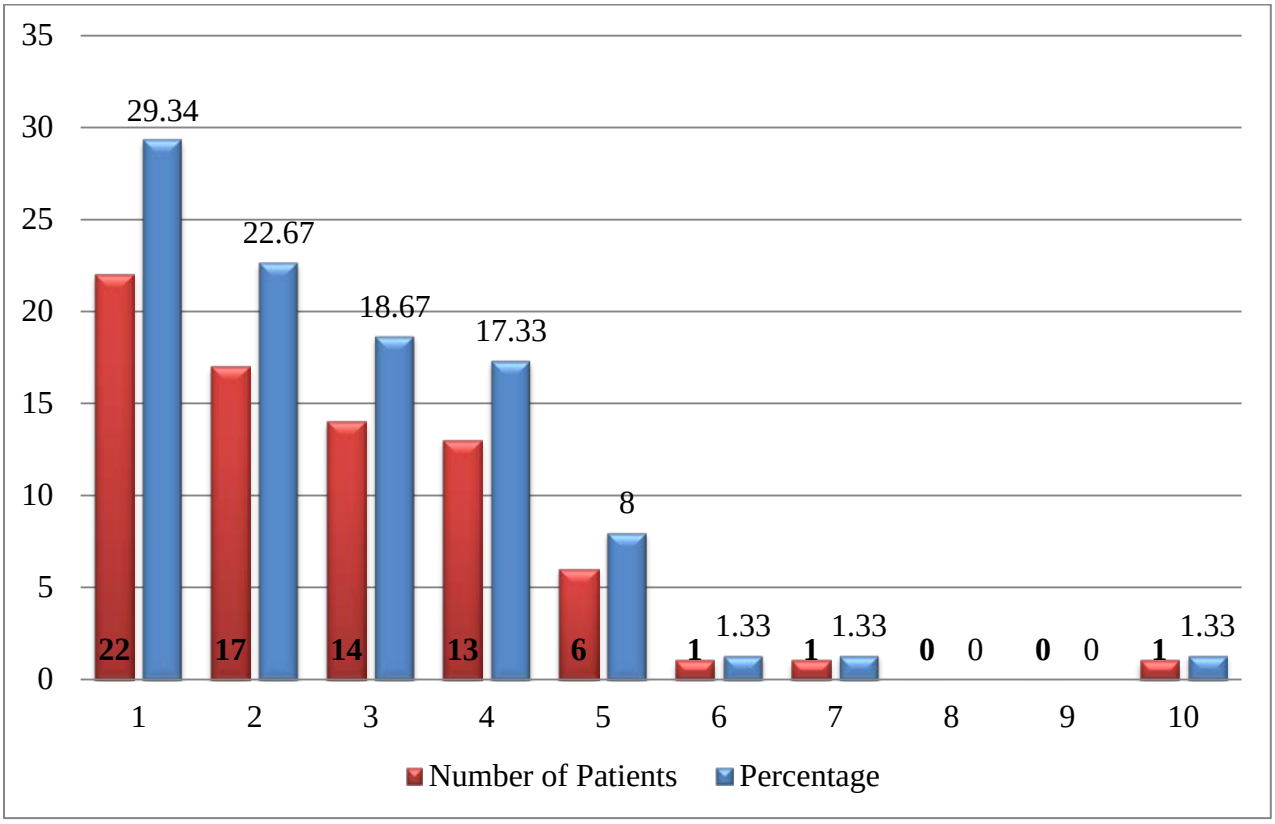
Out of all patients, three patients required shoulder disarticulation. Two of these patients underwent right shoulder disarticulation and one underwent left shoulder disarticulation.

FIRST SURGERY WAS DONE AFTER _ DAYS



Out of 75 patients who underwent surgical intervention during the course of their treatment, majority of them (34 patients, 45.33%) underwent the first surgery within the first five days of admission, followed by (20 patients, 26.67%) six to ten days.

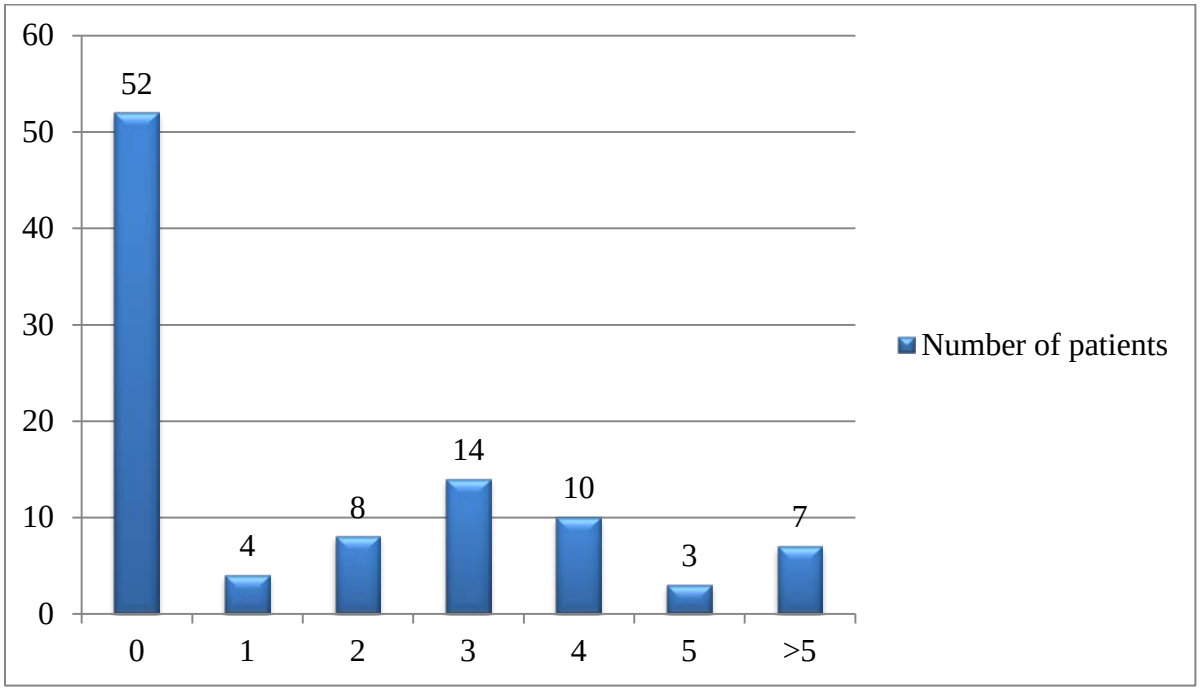
TOTAL NUMBER OF SURGERIES PERFORMED



Out of the 75 patients who underwent surgical intervention during the course of their treatment, 22 patients (29.34%) required a single surgical procedure, followed by 17 patients (22.67%) who required only two surgeries. These account for 39 patients out of 75 (52.01%).

Remaining patients required more than 3 surgical procedures.

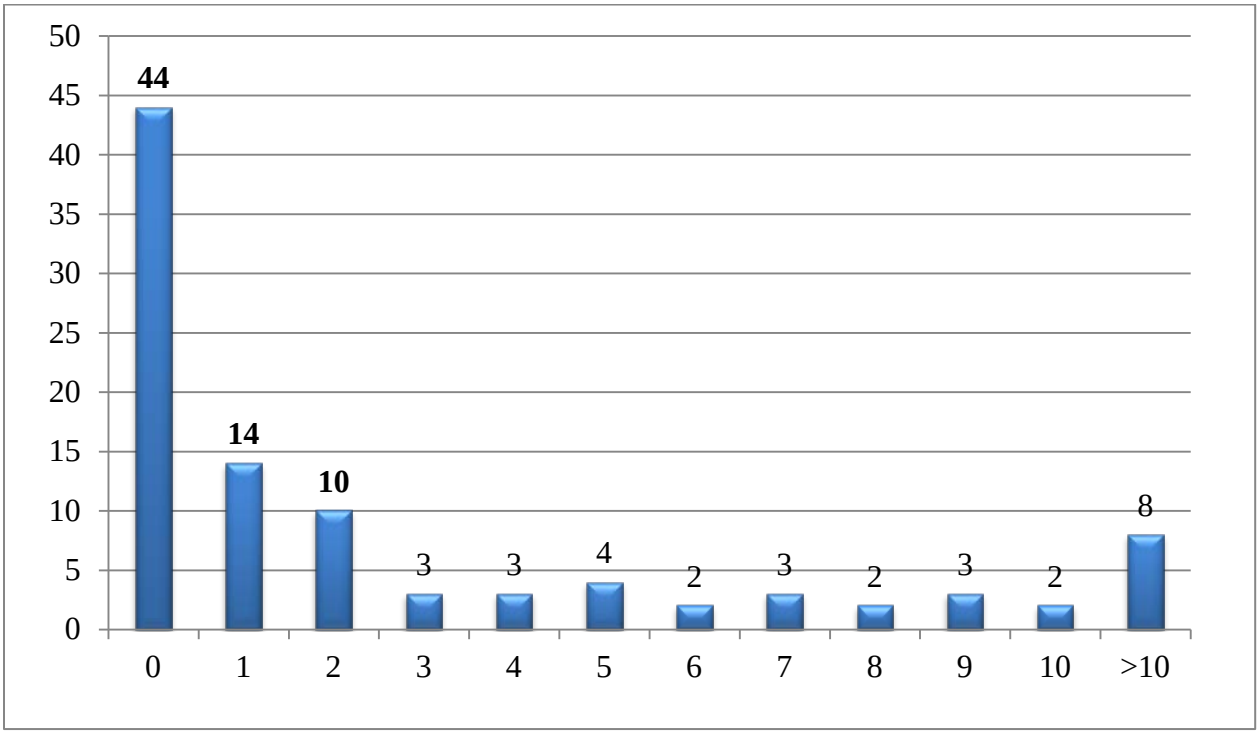
UNITS OF PLASMA TRANSFUSED



Out of all 98 patients included in this study, majority of the patients (52) were not transfused any units of plasma.

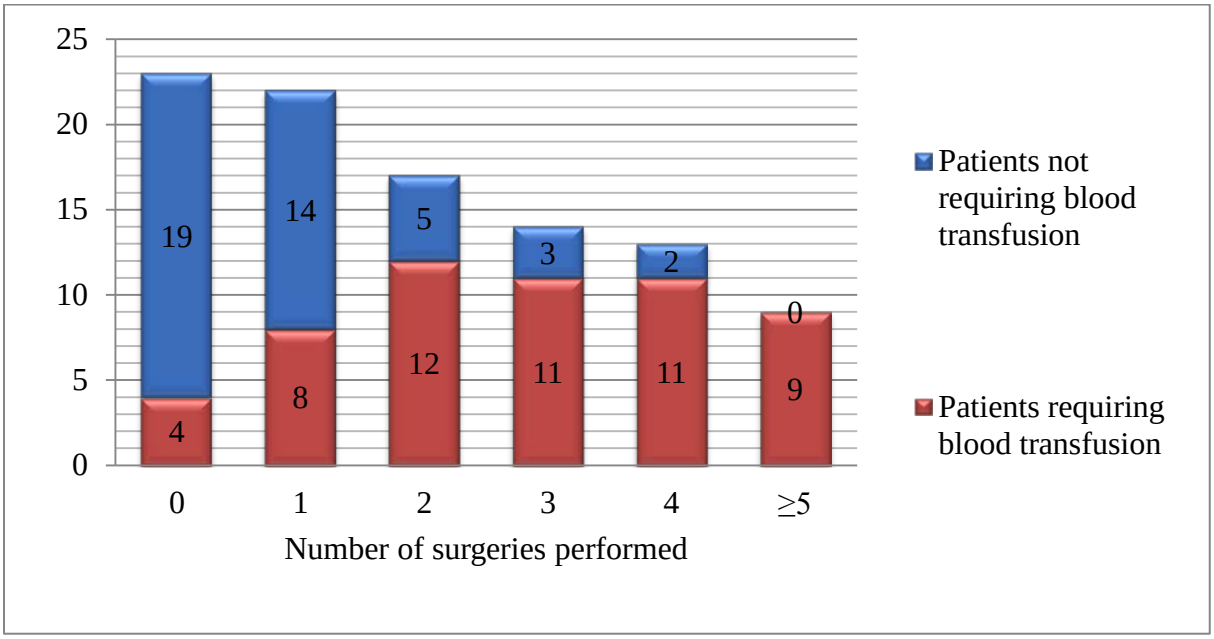
Fourteen (14) patients were transfused 3 units, ten patients were transfused 4 units, eight patients were transfused 2 units, four patients were transfused 1 unit, three patients were transfused 5 units, two patients were transfused 10 units, remaining five patients were each transfused 6 units, 8 units, 9 units, 11 units and 21 units of plasma respectively.

UNITS OF BLOOD TRANSFUSION REQUIRED



Out of 98 patients included in this study, majority of the patients (44) did not require any blood transfusion. 14 patients required only a single unit of blood during their course of treatment. 10 patients required two units of blood transfusion. Remaining patients requires more than three units of blood transfusion. Maximum units required in a patient were 18 units of blood.

UNITS OF BLOOD TRANSFUSION V/S NUMBER OF SURGERIES PERFORMED



All patients which underwent surgical intervention in the course of their treatment were analyzed for the relation between the units of blood transfused and the number of surgeries performed.

Out of 23 patients who were not operated, 4 patients were transfused blood and remaining 19 did not require any blood transfusion.

Out of 22 patients who were operated one time, 8 patients required blood transfusion and remaining 14 did not require blood transfusion.

Out of 17 patients who were operated two times, 12 patients required blood transfusion and remaining 5 did not require blood transfusion.

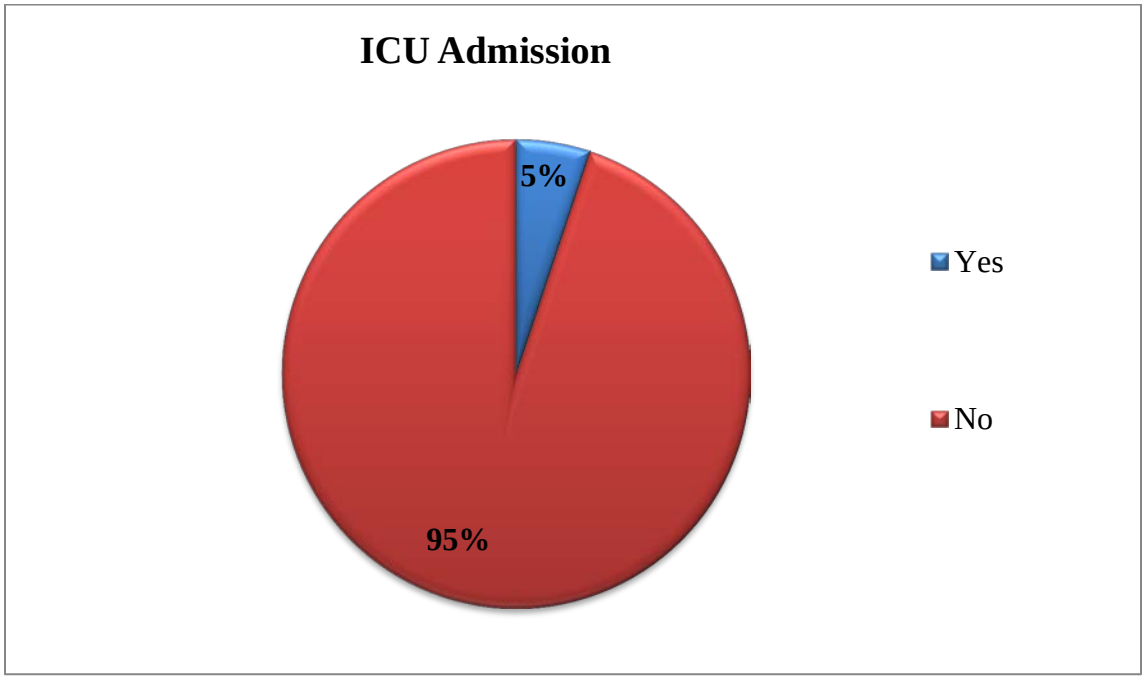
Out of 14 patients who were operated three times, 11 patients required blood transfusion and remaining 3 did not require blood transfusion.

Out of 13 patients who were operated four times, 11 patients required blood transfusion and remaining 2 did not require blood transfusion.

Remaining 9 patients who were operated five or more times, all required blood transfusion.

Thus, it was found that as the number of surgeries performed increased, the need for blood transfusion also increased.

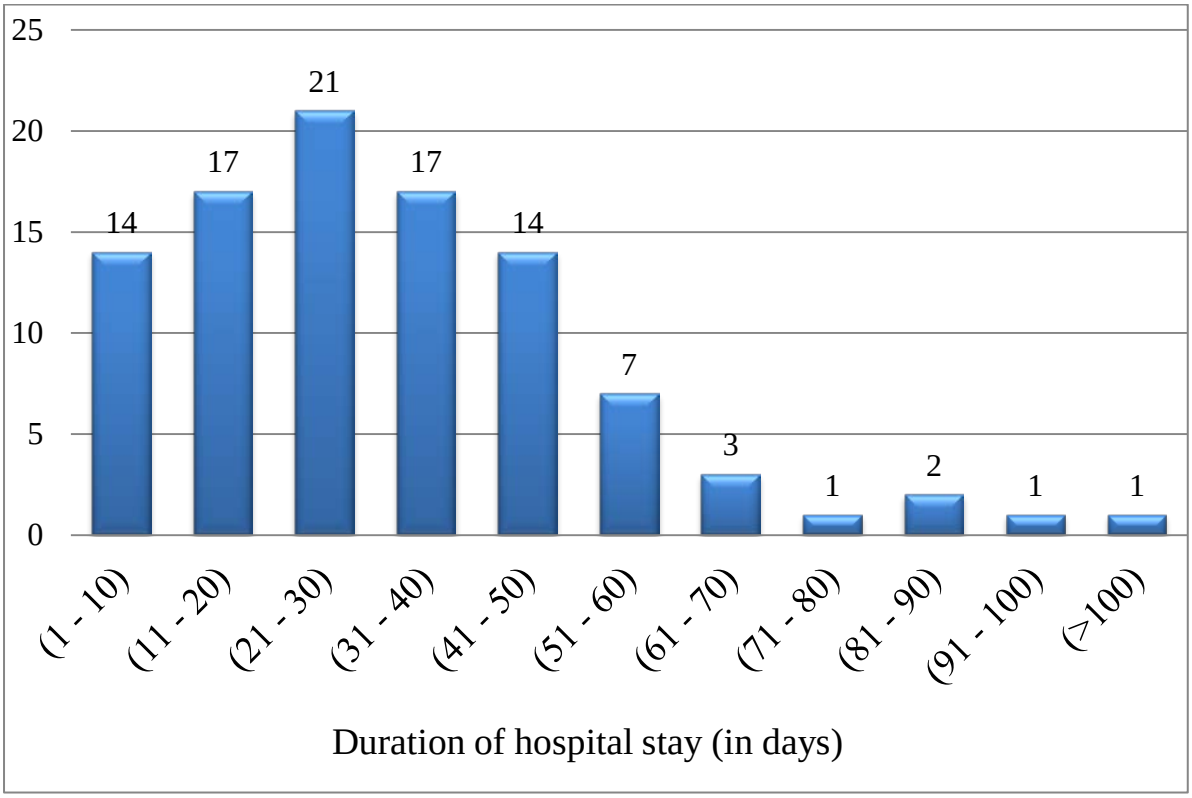
NEED FOR ICU ADMISSION



Out of 98 patients, 93 patients (95%) did not require to be shifted to ICU for treatment.

Only 5 patients (5%) needed ICU admission for ventilator support and vitals monitoring.

DURATION OF HOSPITAL STAY



Majority of the patients were admitted for maximum 30 days.

Mean duration of hospital stay was 32.13 days (ranging from 1 day to 132 days).

DISCUSSION

DISCUSSION

Patients sustaining electrical burns are less common than those sustaining thermal or flame burns in our institute. They have a relatively low case fatality or mortality rate, but still the immediate and late consequences leave the patients with a high level of morbidity and permanent disability.

In the study done by A. Pittrowski et. al(4), 311 patients were studied from 1996 to 2005 and the mean age of the injured workers was found to be 36.7 years ranging from 19 years to 59 years. Similarly, a retrospective analysis by Ayten Saracoglu et. al.(6), included 101 patients with a mean age of 35.6 years among patients that expired and a mean age of 32.7 years among the patients that survived. A. Tarim and A. Ezer (7) reported a study in 2013 consisting of 1144 patients, of which 214 patients sustained electrical injuries. The mean age of all patients was 38 years. In the same year (2013), S.B. Duci et. al.(8), published a report in European journal of trauma and emergency surgery consisting of 246 patients. The average age of the affected patients was 33.6 years (range 1 to 64 years). Majority of these patients (n=115, 46.7%) were between the age groups 20-29 years (n=66, 26.8%) and 30-39 years (n=54, 22%). Chao-Feng Sun et. al.(9), published a retrospective study including 383 patients. The mean age of patients included in this study was 35.4 years (range 9 – 62 years). S.R.Mashreky et. al.(10), published a report of a community based national survey from Bangladesh in 2012 including 604 patients sustaining non-fatal electrical injuries. Forty – five % patients were under the age of 18 years, whereas remaining 55% were above 18 years of age. In 2011, Shagun Aggarwal et. al.(11); conducted a study of 119 patients that suffered from electrical injuries. The mean age of admitted

patients was 32.7 years (range 21–55 years), while that of patients treated as outpatients was 41.13 years. In 1998, I. Ferreiro et. al.(5); published a study of 1557 patients, of these 59 patients sustained electrical injuries with an average age of 32 years. In our study of 98 patients, the mean age of all patients was 30.44 years (range 15 – 60 years). Maximum patients (32) were between 21 to 25 years accounting to 32.65%. Out of 98 patients in the study, 60 patients were among the age range of 21-35 years, accounting to 61.63%. Thus, it shows that most of electrical injuries occurred between the ages of 20 years to 50 years in almost all studies reviewed. This age group included the main earning member of the families.

In the studies by Pittrowski et. al. and Ayten Saracoglu et. al.(4,6), 99% patients were males males. Duci et. el.(8), reported that 93.9% patients were males. In the study by Chao-Feng Sun et. al.(9), 90.3% were males while in the study by Shagun Aggarwal et. al.(11), 90.0% were males. In the study by I. Ferreiro et. al.(5), 80.0% were males. In our study also, 95% patients were males (96/98). Thus, it is consistently shown that males are predominantly affected by electric burn injuries and the most common etiology is work-related injuries.

In the study done by A. Pittrowski et. al.(4), all patients were workers at a French electric company, in the report by Ayten Saracoglu et. al.(6), majority of the patients sustained injuries while at work by alternating current, S.B. Duci et. al.(8), reported a high incidence of the low tension injuries (56.1%) that occurred at the victims residence due to accidental burns, while remaining patients (43.9%) sustained injuries at work as occupational hazard. Chao-Feng Sun et. al.(9) found that Majority of the patients were working as electricians or helpers, accounting for

78.4%. In their study, S.R.Mashreky et. al.(10), found that Majority of the injuries occurred at home (n=321,53.14%). In the report published by Shagun Aggarwal et. al.(11) majority of the patients were qualified electricians; I. Ferreiro et al.(5), had 75% of patients working as electricians. In our study, majority of the patients were labourers (31.6%), followed by electricians (26.5%), students (20.4%) and farmers (12.2%). Most of the labourers used to work as construction site workers where they were in close vicinity to overhead wires. Electricians are also the most vulnerable people to sustain electrical burn injuries. It is a well known occupational hazard for them. Farmers sustain electrical injuries by accidental contact with a loose or broken live wire lying in the field. While at work these farmers are often unaware of these live wires and they step on them and sustain electrical burns.

In our study, majority of the patients suffered the electrical injury at Chittoor, AP (34.7%), followed by Vellore, TN (19.4%) and Kadapa, AP (11.2%) which is usually near their residence. Few patients sustained the electrical injury while at work away from their residence at a remote place.

The percentage of total body surface burnt was found to 1 – 10% of the TBSA (Total Body Surface Area) for most of the patients (60%) in the study done by A. Pittrowski et. al.(4). The average percentage of total body surface area burnt was found to be 42.5% among the patients who expired and 26.5% among the survivors in the report by Ayten Saracoglu et. al.(6). In the study done by Chao-Feng Sun et. al.(9), the percentage of total body surface area involved ranged from 1 to 30%. Shagun Aggarwal et. al.(11); found a mean percentage of total body

surface area burnt was 8.76% (range2–30%) in their study. Kingsly et. al.(2), in this report had all patients with involvement of less than 20% of the total body surface area. I. Ferreiro et. al.(5) in their study found that in patients with contact burns, the average percentage of total body surface area burnt was 9%. In our study, we found that 84.6% patients sustained burn injuries involving less than 30% total body surface area (TBSA), of which 60.2% patients sustained burn injuries involving less than 20% total body surface area (TBSA). Thus, in most of the studies the mean percentage of TBSA involved was found to be less than 20%.

In the study done by S.B. Duci et. al.(8), the incidence of electrical injuries was recorded and grouped as per the seasons. It was noted that the maximum number of patients (n=91, 36.9%) sustained electrical injuries during the winter period, followed by summer period (n=70, 28.4%), spring season (n=46, 18.6%) and least during autumn (n=39, 15.8%). In our study, maximum incidence of electrical burn injuries was found to occur during the months of June, followed by April over the last seven years. Maximum number of patients (42.85%) sustaining electrical injuries was found to occur during the summer season between March to June.

In the study done by A. Pittrowski et. al.(4), the year-wise incidence was found to an average of 31 incidents. Chao-Feng Sun et. al.(9) noticed an increasing trend in the incidence of electrical burns from 2005. The total number of patients admitted with electrical injuries in the year 2009 was 53, the maximum incidence in a year-wise distribution. In our study, although there is no statistical significant difference in the yearly incidence of patients admitted with

electrical burn injuries, over the last three years the trend was on the increasing curve, with the maximum number of patients in a year (17 patients in 2014).

In the study done by A. Pittrowski et. al.(4), majority of the patients sustained high tension injuries. In contrast to that, S.B. Duci et. al.(8) recorded majority patients with low tension injuries as compared to high tension injuries (180 v/s 66). Similar findings were noted by Shagun Aggarwal et. al.(11) with most of the patients sustaining low voltage injuries (99) versus high voltage injuries (20). In a study by Arrowsmith et. al.(3), majority patients had low tension burns (128) and remaining were high voltage burns (17). Our results were contrast, with the low voltage injuries (7.1%) being less as compared to high voltage injuries (92.9%).

In the study done by A. Pittrowski et. al.(4), 5 patients had ocular complications, including unilateral or bilateral cataracts, retinal damage, and loss of vision. I. Ferreiro et. al.(5), had three patients (3%) developed cataract. In our study we found that more than 95% patient had no associated immediate or late ocular complaints. One of patients complained of immediate blurring of vision which was transient and has recovered over the course of treatment. One of the patients had developed right eye vitreous hemorrhage and decreased vision. One of the patients developed corneal ulcer due to exposure keratitis due to lower and upper eyelid ectropion due to contraction of the skin grafts applied for facial burns.

In their series, Kingsly et. al. (2), presented three cases with spinal cord injury without any obvious spine fractures. One of the patients was diagnosed as spinal cord syndrome with associated transverse myelopathy and incomplete tetraplegia at C4 level, while the other two cases did not have any abnormality detected in MRI or never conduction studies. In our study, 93 patients had no spine injury. Remaining 5 patients had spine involvement, 4 of them had injury of the thoracic spine and one patient had cervical spine injury with cord contusion. Of the 4 patients with thoracic spine injury, 3 were treated conservatively. Only one patient was operated with fixation and stabilization of the D6 – D8 fracture.

In the study done by Chao-Feng Sun et. al.(9), out of 383 patients, 116 patients (30.3%) suffered from cardiac effects, including 47 patients (40.5%) with an abnormal ECG and 91 patients (78.4%) with raised serum CPK levels and CK-MB levels. In the study led by I. Ferreiro et. al.(5), out of 59 patients, four patients (7%) developed cardiac arrhythmia, while one developed ventricular fibrillation requiring immediate treatment. In the study done by Arrowsmith, out of 114 patients, two patients had associated cardiac abnormalities on ECG. Abnormal ECG findings were recorded in four patients. All were present on the first ECG. The first patient was a 7 year old boy with ECG changes suggestive of atria1 ectopic beats. The second patient was a 38 year old lady who ventricular ectopic beats on the first ECG. The third patient was a 36 year old man, initial ECG showed atrial ectopic beats with normal cardiac enzymes. His cardiac rhythm also recovered without any medication within 5.6 hours. The fourth patient was a 29 year old man who had atrial fibrillation on his initial ECG, which settled after intravenous infusion of digitalis. No further atrial fibrillation was recorded during monitoring and his serial ECGs and cardiac enzymes were normal. They concluded their study with the

opinion that if the initial ECG was normal and there was no associated history or episode of unconsciousness, then there was rarely a risk of development of serious cardiac abnormalities. Therefore, it is not necessary to admit the patient with history of sustaining low tension or high tension electrical injury only for 24 hour cardiac monitoring. In our study, only two patients out of 98 included in the study had cardiac abnormalities detected on ECG. One patient had features of atrial fibrillation on initial ECG for which Tab.Metoprolol was initiated and patient was observed and repeat ECG were taken. The changes had reverted back and the patient did not require any further management as per the cardiologist advice. Other patient had features suggestive of ischemic heart disease (IHD) for which he was started on Tab.Deplatt A 75mg OD, Tab.Aztor 10mg OD and Tab.Metoprolol 25mg OD.

In the study done by I. Ferreiro et. al.(5), out of fifty – nine patients, sixteen patients (27%) had associated bone fractures. In our study, out of 98 patients included in this study, only two patients had associated limb fractures. One of them had closed fracture of right acetabulum which was managed conservatively; other patient had closed fracture of right femur shaft for which IM nailing was done once the burnt areas had healed by conservative measures. None of the patients had any upper limb fractures.

A. Pittrowski et. al.(4), reported four amputations (left below elbow, left little finger, left metacarpal, left middle finger and right thumb) in patients who suffered injury due to high voltage current. Ayten Saracoglu et. al.(6), reported seven patients who underwent amputation, two of these patients expired due to other complications. In the study led by A. Tarim and A.

Ezer (7), forty four patients underwent amputations at varied levels and most of these patients had sustained high tension electrical burns. S.B. Duci et. al.(8), in their study reported sixteen patients who underwent amputations and all of them had sustained high voltage injuries. I. Ferreiro et. al.(5), reported that nine patients required amputations. In all studies the proximal extent of the amputations was below elbow and there were no reports of lower limb amputations. In our study, 29 patients required amputations. Out of these, majority of the patients that had amputation of upper limb underwent below elbow amputations (15), with the maximum cases undergoing right below elbow amputation, followed by left below elbow and bilateral below elbow amputations and 9 patients underwent lower limb amputations, all were below knee amputations. Thus, it can be concluded that since the upper limb is the most part of the body affected in electrical burns, incidence of upper limb amputations is also high as compared to lower limb amputations.

In the study done by A. Pittrowski et. al.(4), 16 patients (5%) required surgical intervention, while Ayten Saracoglu et. al.(6), reported a higher incidence of surgical interventions, 58 patients (57.4%). S.B. Duci et. al.(8), recorded 79 patients out of 212 patients (37.2%) that required surgical procedures, whereas in the study published by Chao-Feng Sun et. al.(9), majority of the cases (>75%) required surgical intervention. In the study reported by Shagun Aggarwal et. al.(11), forty nine patients out of fifty seven patients (86%) required surgical intervention. In our study, out of the 98 patients included in this study, 73 patients (74.49%) required surgical interventions.

In the study done by Ayten Saracoglu et. al.(6), twenty seven patients required ICU admission, whereas Shagun Aggarwal et. al.(11), reported six patients requiring ICU admissions. In our study, out of 98 patients, only 5 patients (5%) needed ICU admission for ventilator support and vitals monitoring.

In the study done by A. Pittrowski et. al.(4), out of 311 incidents, 10 incidents were fatal accounting to 3.2%. Ayten Saracoglu et. al.(6), reported a high incidence of deaths, 27 patients out of 101 with a case fatality rate of 26.7%. A. Tarim and A. Ezer (7), also had a relatively higher mortality, 11.4%, as compared to the other studies. S.B. Duci et. al.(8), had a mortality rate of 2.4% (6 patients out of 246 patients). Similarly, Chao-Feng Sun et. al.(9), reported a case fatality rate of 1.6% (6 patients out of 383 patients). Shagun Aggarwal et. al.(11); reported no deaths out of 119 patients. I. Ferreiro et. al.(5), reported a higher mortality rate of 12 % (7 patients out of 59 patients). In our study, out of 98 patients in this study, 5 patients expired and all 5 patients were treated conservatively. Three patients had >30% (31%, 48%, 70%) of the TBSA involved. One of the patients had depressed frontal bone fracture and a low GCS score. One of the patients developed acute renal failure and subsequently developed pneumonia and multi – organ failure. All patients who expired were males with an average age of 38.6 years with minimum age being 25 years and maximum age being 52 years.

In the study done by A. Tarim and A. Ezer (7), the average duration of hospital stay was also found to be higher in patients undergoing amputation (36.21 days) as compared to those who did not undergo amputation (19.54 days). S.B. Duci et. al.(8), reported that the mean

duration of hospital stay in their study was 14.9 days, ranging from 1 to 111 days. Chao-Feng Sun et. al.(9), found that the higher the voltage of injury, longer was the duration of hospital stay, increasing from 18 days for 380V (70 patients) to 31.1 days for <10KV (131 patients) and 60.5 days for >10KV (182 patients). In the study published by Shagun Aggarwal et. al.(11), the average duration of hospital stay was 9.95 days (1–27 days), while I. Ferreiro et. al.(5) reported an average duration of hospital stay of 23 days. Majority of the patients were admitted for maximum 30 days. Mean duration of hospital stay was 32.13 days (ranging from 1 day to 132 days).

In our study, we did not find any particular day of the week on which the incidence of sustaining electrical burns was significantly higher than other days. We also analyzed time of injury for each patient, over the last seven years. We found that majority of the patients (70 out of 98), accounting to 71%, sustained the electrical burn injury during the daytime between 8 AM to 5:30 PM. This time interval is the usual working time in most places in our country. We also found that the delay in reporting to our hospital after the injury was a median time of 7.87 hours. Majority of the patients (38%), in our study, sustained mixed type of burn injury followed by flash burns which accounted for 31% of the patients. Out of the remaining, 21% patients sustained contact burns whereas 8% sustained are burns. Fifty two patients out of the total 98 patients (53%) had history of fall from height. Five patients of them had associated intrathoracic injuries; one patient developed bilateral hemothorax, one had fracture of the 3rd to 5th ribs with open pneumothorax and three patients had closed fracture of unilateral clavicle. Majority of the patients did not require plasma or blood transfusions. The requirement of blood transfusions increased as the number of surgeries performed increased.

CONCLUSION

CONCLUSION

From our study, we can conclude that there is increasing trend of electrical injuries over the last three years. Most of the affected patients are young, adult males between the ages 21 to 40 years, who are the main earning members of the family. Incidence of cardiac abnormalities or ECG changes is not significant. Early referral to higher centre as soon as possible and timely intervention can help prevent amputations and thus avoid permanent disability. Though the overall mortality is very low, the short term and long term consequences and subsequent rehabilitation phase make electrical burn injuries a challenge to manage.

Awareness about the safety measures, avoidance of handling of electric wires by persons who are not specifically trained for the same and tertiary care are all important for the prevention and management of these injuries.

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ANNEXURE – 1

(PROFORMA)

PROFORMA

1. Patient initials:
2. Hospital No:
3. Age:
4. Sex:
5. Residence:
6. Place of injury:
7. Occupation:
8. Day of injury:
9. Month of injury:
10. Year of injury:
11. Voltage of current involved: High/Low
12. Time of reporting to hospital after injury:
13. Delay in reporting to CMC after injury:
14. Type of electrical injury: Contact burns/ Flash burns/ Arc burns/ Mixed:
15. Percentage of Total Body Surface Area involved:
16. Fall from height: Yes / No
17. History of head injury: Yes / No
18. History of Unconsciousness: Yes / No
19. History of known co-morbid conditions: DM/ HTN/ Others

20. Ocular involvement: Absent/ Present:

    a. If present: Immediate/ Late:

    b. Type of disorder: Cataract/ Permanent loss of vision/ Others

21. Spine injury: Absent/ Present:

    a. If present: Cervical/ Thoracic/ Lumbar/ Sacral

22. Intra-abdominal injury: Absent/ Present:

    a. If present, which organ(s) were affected:

23. Upper limb fractures: Absent/ Present:

    a. If present, which bones were involved:

24. Lower limb fractures: Absent/ Present:

    a. If present, which bones were involved:

25. Cardiac abnormalities: Present/Absent.

26. Serum CPK levels: Within normal range/ Increased:

    a. If increased, after how many days levels were within normal range:

27. Serum creatinine levels at the time of admission: Normal/ Increased:

    a. If increased, after how many days levels were within normal range:

28. Urine Myoglobin: Positive/ Negative

29. Treatment done:

    a. Conservative management:

    b. Urgent fasciotomy:

c. Amputation:

    i. Below elbow: Unilateral / Bilateral

    ii. Above elbow: Unilateral / Bilateral

    iii. Below knee: Unilateral / Bilateral

    iv. Above knee: Unilateral / Bilateral

    v. Shoulder disarticulation: Unilateral / Bilateral

d. Debridement and Skin Grafting:

e. Debridement and Flap cover with/without skin graft:

30. Time interval between day of admission and first surgery:

31. Number of surgeries performed:

32. Total units of plasma transfusions:

33. Total units of blood transfusions:

34. Whether patient required ICU admission:

35. Final outcome at discharge: Survived/ Expired.

36. Total duration of hospital:

ANNEXURE – 2

(MASTERSHEET)

Annexure – 2 (Mastersheet)

SN	t. initial	Age	Sex	siden	e of in	cupat	Day	Date	Month	Year	e of in	ng to C	oltag	Type	TBS	rom	ad inj	onsc	orbid	cular i	ne inj	inal/ I	limb f	limb f	abnor	CPK		S.Creatinine		e myog	reatment do	vas do	geries	lasma t	lood t	admi	utco	of hospital stay
											(In hours)															Normal/Incr		r ho	al/Incr	r how many days									(in days)
1	AVR	30	1	2	2	3	2	21	6	2010	1930	12	1	4	11	1	0	0	0	0	0	0	0	0	0	1		1	1	1	2	7	5	0	8	0	1	49
2	ANM	27	1	2	20	1	1	30	3	2008	1800	8	1	2	30	1	0	0	2	0	0	0	0	0	0	1		0		1	2	36	2	0	2	0	1	47
3	ANV	26	1	17	4	1	1	11	1	2009	1730	6	1	3	24	0	0	0	0	0	0	0	0	0	0	1		0		1	2	25	1	5	1	0	1	36
4	AMS	22	1	1	1	4	1	10	4	2011	2100	2	1	3	27	0	0	0	0	0	0	0	0	0	0	1		0		1	3	3	2	0	1	0	1	30
5	ANK	23	1	1	4	5	3	21	9	2010	1500	5	1	3	16	1	0	0	4	0	0	0	0	0	0	1		0		1	2	6	1	3	0	0	1	14
6	BLJ	16	1	13	6	4	7	22	5	2010	1515	1.5	1	1	15	1	0	0	0	0	0	0	0	0	0	1		0		1	4, 5, 2	5	5	1	9	0	1	43
7	BRK	34	1	2	2	3	2	9	6	2008	1730	24	0	2	15	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	3	14	2	0	1	0	1	33
8	BRG	48	1	2	2	1	4	10	4	2010	1430	7.5	0	1	1	1	0	0	0	0	0	0	0	0	1, 2	1		0		1	1	0	0	0	0	0	1	9
9	CMK	33	1	1	1	1	1	3	4	2011	930	6	1	3	10	1	0	0	0	0	0	0	1, 2	0	0	1		1	1	1	2	39	1	0	0	0	1	47
10	CSG	35	1	1	19	1	7	3	9	2011	1230	9	1	3	22	1	0	1	0	0	0	0	0	0	0	1		0		1	4, 24, 3	1	5	3	5	0	1	56
11	DRN	32	1	1	1	1	6	11	11	2011	1800	8	1	3	20	0	0	0	0	0	0	0	0	0	0	1		0		1	1	0	0	2	0	0	1	9
12	DSK	52	1	2	2	3	6	11	3	2011	1000	3.5	1	3	70	0	0	1	0	0	0	0	0	0	0	1	11	0		1	1	0	0	6	0	1	0	15
13	GPB	23	1	1	1	1	4	2	6	2010	1100	4	1	3	10	1	0	0	0	0	0	0	0	0	0	1		0		1	4, 6, 2	1	3	0	5	0	1	21
14	HHN	28	1	4	4	1	4	24	3	2010	1500	6.5	1	3	22	1	0	0	0	0	0	0	0	0	0	1		0		1	2	8	1	0	3	0	1	27
15	JKS	30	1	1	1	3	7	15	1	2011	1800	27	1	4	25	0	0	1	0	0	0	0	0	0	0	1		1	1	1	4, 3	1	3	2	2	0	1	34
16	JKK	42	1	1	1	3	3	14	6	2011	1600	4	1	2	25	1	1	1	0	0	0	0	0	0	0	1		1	1	1	1	0	0	0	2	0	0	8
17	JRG	45	1	7	8	1	6	10	7	2009	1430	22	1	2	4	1	0	1	0	0	0	0	0	0	0	0		0		1	1	0	0	0	0	0	1	19
18	KMN	38	1	2	30	3	2	29	6	2011	830	3	1	2	25	1	0	0	0	0	0	0	0	0	0	1		0		1	2, 3	36	3	2	2	0	1	98
19	MDD	24	1	6	25	3	7	27	9	2008	930	2	0	2	7	0	0	0	0	1, 2	0	0	0	0	0	0		0		1	1	0	0	0	0	0	1	7
20	MHB	21	1	1	1	4	3	12	4	2011	1100	7	1	3	15	1	0	1	0	0	0	0	0	0	0	1		0		1	1	0	0	0	0	0	1	11
21	MPV	24	1	2	22	1	4	27	8	2008	930	72	1	3	35	0	0	0	0	0	0	0	0	0	0	0		0		1	1	0	0	3	0	0	1	18
22	MCD	20	1	1	1	2	4	10	2	2010	700	9	1	3	9	1	0	1	0	0	0	0	0	0	0	1		0		1	13, 2	18	2	2	0	0	1	29
23	MTR	30	1	2	2	3	7	9	4	2011	1630	4	1	3	38	0	0	1	5	0	0	0	0	0	0	1		1	1	1	3, 2	5	2	4	2	0	1	41
24	MNS	15	1	1	1	4	2	1	6	2009	1400	10	1	4	33	0	0	0	0	0	0	0	0	0	0	1		1	1	1	23, 2, 3	5	4	2	18	0	1	67
25	NKP	17	1	1	1	4	4	10	2	2010	2230	8	1	3	38	0	0	0	0	0	0	0	0	0	0	1	5	0		1	4, 2, 3	1	5	4	10	0	1	67
26	OBR	32	1	1	2	2	2	27	6	2011	2330	5	1	3	15	0	0	0	0	0	0	0	0	0	0	1		0		1	2	10	3	4	8	0	1	60
27	PSM	32	1	2	8	1	2	22	11	2010	1500	2	1	3	45	0	0	0	0	1, 3	0	0	0	0	0	1	14	1	1	1	4, 24, 2, 3	1	10	0	15	1	1	132
28	PNT	24	1	2	2	7	1	13	3	2011	1000	2	0	1	2	0	0	0	0	0	0	0	0	0	0	0		0		1	3	16	2	0	0	0	1	22
29	RJR	35	1	2	2	3	5	15	12	2011	1715	4.5	1	3	17	1	0	1	0	0	0	0	0	0	0	0		0		1	5, 3	1	4	2	1	0	1	44
30	RKJ	17	1	9	21	4	5	9	6	2011	1500	360	1	3	20	0	0	0	0	0	0	0	0	0	0	0		0		1	7, 9, 15, 2	9	3	0	2	1	1	61
31	RCD	60	1	2	2	9	4	30	6	2010	330	2	1	1	5	0	0	0	0	0	0	0	0	0	0	0		0		1	3	20	2	0	0	0	1	27
32	RMS	50	1	5	17	1	5	15	5	2008	1015	6.5	1	2	30	1	0	1	3	0	0	0	0	0	0	1	1	0		1	2	19	1	3	0	0	1	34
33	RMH	21	1	1	1	3	4	13	5	2009	1700	7	1	2	20	1	0	0	0	0	0	0	0	0	0	1		1	2	1	2, 3	19	3	3	3	0	1	53
34	RDS	43	1	1	13	6	5	12	2	2009	1700	24	1	2	4	1	0	0	0	0	0	0	0	1, 2	0	1		0		1	2	13	1	0	0	0	1	21
35	RBD	20	1	1	1	3	3	5	8	2008	1300	1	1	2	25	1	0	0	0	0	0	0	0	0	0	1		0		1	2	34	1	4	0	0	1	41
36	STY	23	1	2	2	4	1	10	5	2009	630	4.5	1	3	29	1	0	1	0	0	0	0	0	0	0	1		0		1	2	22	1	4	0	0	1	29
37	SKB	22	1	1	19	4	1	10	7	2011	1730	11.5	1	2	20	0	0	1	0	0	0	0	0	0	0	1		0		1	2	11	2	4	0	0	1	34
38	SMN	24	1	16	16	4	2	16	2	2009	1100	72	1	3	27	0	0	0	2	0	0	0	0	0	0	1		0		1	24, 10	1	4	5	9	0	1	35
39	SDK	35	1	2	2	13	7	17	7	2010	910	5	1	2	15	1	1, 2	1	0	0	0	0	0	0	0	1		0		1	1	6	1	0	0	0	1	17
40	SDV	22	1	1	1	4	3	21	9	2010	1500	8	1	3	26	1	0	1	0	0	0	0	0	0	0	1		0		1	2, 3	9	7	3	7	0	1	75
41	SRM	24	1	1	1	4	1	17	10	2010	900	7	1	1	3	0	0	0	0	0	0	0	0	0	0	1		0		1	3	9	4	0	0	0	1	50
42	VJK	35	1	2	2	3	3	8	1	2008	1200	1	1	3	25	0	0	0	0	0	0	0	0	0	0	1		0		1	5, 2	10	2	0	5	0	1	36
43	VLK	32	1	2	24	3	4	24	9	2008	1215	264	1	2	21	0	0	0	0	0	0	0	0	0	0	0		0		1	2	7	1	0	0	0	1	22
44	PBU	23	1	2	28	4	5	8	3	2012	1900	7	0	3	5	1	0	0	0	0	0	0	0	0	0	0		0		1	2	7	2	0	0	0	1	24
45	JYL	21	0	1	1	4	1	15	4	2012	1800	9	0	1	2	0	0	0	0	0	0	0	0	0	0	1		0		1	1	0	0	0	0	0	1	7
46	SNT	21	1	11	1	3	4	18	4	2012	1345	111	1	4	20	1	0	1	0	0	0	0	0	0	0	1		0		1	14, 2, 3	8	5	0	11	0	1	43
47	RVA	32	1	1	7	3	2	4	6	2012	1900	4.5	1	3	20	0	0	0	0	0	0	0	0	0	0	1		0		1	4, 2, 3	1	4	4	13	0	1	83
48	SRK	25	1	8	1	3	6	6	7	2012	1130	3.25	1	1	7	1	1	1	0	0	0	0	0	0	0	1		0		1	5	7	1	0	6	0	1	11
49	SKM	48	1	5	25	3	6	27	7	2012	930	8	1	4	11	1	0	1	0	0	0	0	1, 2	0	0	1		0		1	3	14	1	0	0	0	1	25
50	LKM	26	1	1	1	11	1	26	8	2012	2030	4	1	1	12	0	0	1	0	0	0	0	0	0	0	1		0		1	1	0	0	0	0	0	1	3
51	AML	60	1	5	27	2	7	8	9	2012	400	12	1	1	4	0	0	0	0	0	0	0	0	0	0	1		1	1	1	3	1	3	0	1	0	1	30
52	JAK	19	1	12	14	3	4	31	10	2012	1300	360	1	1	25	0	0	0	0	0	0	0	0	0	0	0		0		1	5, 2, 3	9	6	1	13	0	1	89
53	RVB	35	1	1	1	3	3	22	10	2012	830	9.35	1	2	10	1	0	1	0	0	0	0	0	0	0	0		0		1	1	0	0	0	0	0	1	8
54	MMR	41	1	10	10	2	5	17	1	2013	1930	240	1	3	5	0	0	0	0	0	0	0	0	0	0	1		1	1	1	7, 2	1	2	0	2	0	1	20
55	GSV	26	1	1	1	1	3	26	3	2013	1730	8.25	1	1	11	0	0	0	0	0	0	0	0	0	0	1		0		1	4, 5, 2	1	3	3	0	0	1	32

SN	t. initial	Age	Sex	siden	e of in	cupat	Day	Date	Month	Year	e of in	ng to C	oltag	Type	TBS	rom	ad inj	onsc	orbid	cular i	ine inj	inal/ I	limb f	limb f	abnor	CPK		S.Creatinine		e myog	reatment do	vas do	geries	lasma t	lood t	admi	utco	of hospital stay
											(In hours)															Normal/Incr		ho	al/Incr	r how many days									
56	LGH	29	1	11	11	3	5	4	4	2013	800	9	1	3	20	1	0	1	0	0	0	0	0	0	0	1		0		1	3	14	3	3	0	0	1	48
57	SHB	35	1	2	2	3	7	13	4	2013	1600	8.75	1	3	48	1	1, 3	1	0	0	1, 2	0	0	0	1, 3	1	1	1	1	1	2	33	1	4	1	0	1	56
58	VRP	37	1	1	1	2	1	12	5	2013	900	3	1	4	12	0	0	0	0	0	0	0	0	0	0	1		0		1	11, 3	5	4	3	1	0	1	27
59	SAM	20	1	2	2	4	1	12	5	2013	730	16.5	1	3	15	1	1, 4	0	0	0	0	0	0	0	0	1		0		1	3	14	1	0	0	0	1	22
60	SKT	35	1	2	2	2	1	9	6	2013	1200	3.5	1	3	15	1	0	0	0	0	0	0	0	0	0	1		0		1	17, 2	5	4	3	4	0	1	41
61	SVE	22	1	1	1	1	2	29	7	2013	1500	75.8	1	1	10	1	0	1	0	0	0	0	0	0	0	1		0		1	7 and 9	2	3	0	9	0	1	33
62	RVT	35	1	1	1	3	7	3	8	2013	1100	8.5	1	3	28	1	0	0	0	0	0	0	0	0	0	1		1	2	1	12, 16	1	2	8	6	0	1	22
63	RMC	43	1	1	1	1	6	8	8	2013	600	10.5	1	2	25	1	0	1	0	0	0	0	0	0	0	1		0		1	1	0	0	4	0	0	1	8
64	VKT	25	1	1	1	2	3	27	8	2013	1830	24	1	1	12	0	0	1	0	0	0	0	0	0	0	1		0		1	4, 5, 2	1	3	0	0	0	1	22
65	NGS	21	1	2	23	1	5	14	11	2013	1600	144	1	3	16	0	0	0	0	0	0	0	0	0	0	1		0		1	6, 2, 3	2	4	0	4	0	1	52
66	VYB	23	1	1	18	10	7	14	12	2013	1730	27	1	3	38	1	0	1	0	0	0	0	0	0	0	1		0		1	4, 11, 6, 2	1	3	9	11	0	1	41
67	MVR	35	1	2	2	1	4	25	12	2013	1430	9.75	1	3	31	1	0	1	0	0	0	0	0	0	0	1		0		1	1	0	0	11	2	0	0	7
68	LDK	49	0	2	2	13	4	25	12	2013	1400	504	1	1	20	0	0	0	0	0	0	0	0	0	0	0		0		1	16	5	1	0	7	1	1	7
69	VYD	18	1	1	4	3	6	7	3	2014	1030	54.8	1	1	10	0	0	0	0	0	0	0	0	0	0	1		0		1	4, 18, 19, 2	1	3	0	1	0	1	40
70	PRN	19	1	1	1	2	6	4	4	2014	2100	7	1	2	17	1	0	0	0	0	1, 3	0	0	0	0	1	5	0		1	1	0	0	1	0	0	1	12
71	SBS	23	1	12	12	1	6	13	6	2014	1530	168	1	4	10	0	0	0	0	0	0	0	0	0	0	0		0		1	23, 2, 3	1	3	0	4	0	1	26
72	RJH	25	1	1	1	4	3	1	7	2014	830	2	1	2	5	1	0	0	0	0	0	0	0	0	0	1		0		1	2	13	2	0	1	0	1	31
73	BBR	40	1	1	4	2	7	26	7	2014	1030	3	1	2	8	0	0	0	0	0	1, 4	0	0	0	0	1		0		1	1	0	0	3	0	0	1	11
74	MTG	18	1	2	2	4	1	31	8	2014	630	1	0	2	26	0	0	0	0	0	0	0	0	0	0	1	11	0		1	3	9	1	0	0	0	1	24
75	PGV	55	1	5	5	1	3	9	9	2014	630	7	1	3	15	1	0	1	0	0	1, 5	1, 2	0	0	0	1		0		1	1	0	0	0	1	0	1	8
76	OSC	22	1	2	2	1	6	12	9	2014	1000	12	1	4	10	1	0	1	0	0	0	0	0	0	0	1	2	0		1	4, 6, 2	1	4	0	3	0	1	45
77	PTP	37	1	1	1	3	7	20	9	2014	930	5	1	2	23	1	0	1	0	0	0	0	0	0	0	1		0		1	2	8	2	0	1	0	1	32
78	SKM	24	1	2	2	3	3	9	9	2014	1515	1.75	1	1	8	1	0	1	0	0	0	0	0	0	0	1	7	0		1	4, 5, 20, 2	1	4	0	2	0	1	38
79	SND	24	1	14	1	1	6	24	10	2014	1500	2.5	1	2	11	0	0	0	0	0	0	0	0	0	0	1		0		1	1	0	0	1	0	0	1	9
80	SVN	51	1	2	9	1	2	3	11	2014	1630	2.5	1	2	10	0	0	0	0	0	0	0	0	0	0	0		0		1	2	11	1	0	0	0	1	31
81	KNN	24	1	2	2	4	7	8	11	2014	900	5.75	1	2	6	0	0	1	0	0	0	0	0	0	0	1	7	0		1	2	6	2	0	0	0	1	14
82	BDB	28	1	1	1	2	3	23	12	2014	1730	7.75	1	2	20	1	0	0	0	1, 4	0	0	0	0	0	1	9	0		1	2, 3	5	4	0	0	0	1	45
83	SVM	29	1	1	1	1	2	22	12	2014	1100	4	1	2	14	0	0	0	0	0	0	0	0	0	0	0		0		1	1	0	0	0	0	0	1	12
84	PBS	19	1	2	2	4	7	8	11	2014	1500	0.5	1	2	26	1	0	1	0	0	0	0	0	1, 3	0	1		0		1	1	0	0	4	0	0	1	13
85	MNA	21	1	1	1	3	4	4	7	2012	1600	4	1	3	40	1	0	1	0	0	0	0	0	1, 2	0	0	1	0		1	8, 3, 2	8	4	3	10	0	1	57
86	PBR	57	1	15	15	8	6	31	10	2014	1300	528	1	1	16	0	0	0	2	0	0	0	0	0	0	0		0		1	7, 2	1	2	0	7	0	1	19
87	SBR	50	1	2	2	3	2	19	5	2008	900	22	1	2	21	1	0	0	0	0	0	1, 3	0	0	0	1		0		1	1	0	0	3	1	0	1	9
88	RMJ	17	1	2	2	4	2	9	6	2008	1730	24	1	2	8	1	0	0	0	0	0	0	0	0	0	1	3	0		1	1	0	0	0	0	0	1	11
89	TKR	45	1	2	29	1	4	11	6	2008	1545	7.5	1	2	37	1	0	0	2	0	0	0	0	0	0	1		0		1	4	1	1	10	5	0	1	51
90	RJN	36	1	2	2	1	3	16	9	2008	930	14	1	3	34	0	0	0	0	0	0	0	0	0	0	1		1	1	1	16	9	1	21	14	1	1	28
91	DJR	29	1	4	4	3	4	31	12	2008	645	50	1	1	9	0	0	1	0	0	0	0	0	0	0	1		1	2	1	2	18	1	0	0	0	1	29
92	EWR	22	1	2	2	3	2	9	3	2009	1500	1	1	2	22	1	0	1	0	0	1, 6	0	0	0	0	1		0		1	21	1	1	0	0	0	1	32
93	TLD	46	1	2	2	3	2	6	4	2009	2230	15.8	1	2	40	1	0	0	0	0	0	0	0	0	0	1		0		1	1	0	0	3	0	0	1	13
94	DJK	25	1	1	1	3	3	14	4	2009	1800	12	1	3	48	1	0	0	0	0	0	0	0	0	0	1		1		1	1	0	0	2	0	0	0	1
95	RGR	39	1	2	2	2	3	9	11	2010	730	96	1	1	4	0	0	0	0	0	0	1, 4, 5	0	0	0	1		1		1	22, 1	1	1	0	1	0	0	11
96	PKS	25	1	2	26	1	6	17	12	2010	1300	11	1	1	33	0	0	0	0	0	0	0	0	0	0	1		0		1	4, 5, 24, 2	1	4	10	11	0	1	39
97	PRS	23	1	2	2	2	5	1	3	2012	2030	10.5	1	2	21	0	0	0	0	0	0	0	0	0	0	1		0		1	2	7	2	5	2	0	1	30
98	GPC	20	1	1	1	4	4	28	8	2013	730	6	1	1	12	1	0	0	0	0	0	0	0	0	0	1		0		1	4, 2	1	5	2	1	0	1	39