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Electrocution as a Cause of Death

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ABSTRACT:

Death is one of the serious complications of electrical injuries. By one year field study from the 1st of May 2014 to the 1st of May 2015 at Babil governorate, we did try to study the pattern of electrical injuries seeking factors affecting mortality rate and trying to lower it as possible as we can. The study was dependent on the medical records of Al-Hilla teaching hospitals, and the autopsy were accomplished at the Department of Forensic Medicine of Babil health directorate. Electrical injuries of severe type were studied according to the voltage, injury time, accompanied trauma and Its relation to the occupation, age, sex, medical interference,the direct cause of death, the time of injury is it day or night, if there is consumption of alcohol and drugs. The total number of hospitalized and none hospitalized victims were 41. Male to female ratio is 2/1, 24.4% of victims were below 12 years, 4.87% of the accidents occurred at work place, 48.78% of the injuries at the upper extremities, low voltage caused 95.12% of the injuries, 92.68% of electrical accidents occurred in summer, with 73.17% at day time. Three victims only survived the injury. The direct causes of death were cardiopulmonary arrest following the electrical injury with no trauma attributed to death. Mortality rate was 92.68%, which is incredibly high. Conscious and safe use of electricity by society is preventable measures.The quick transfer to hospital is lifesaving, medical staff should be aware that any electrically injured victims usually appeared dead and resuscitation may bring them alive.

Key word: emphasis; high voltage; low voltage; mortality.

Introduction:

Death due to electrical injuries is uncommon[1,2], and mostly are accidental, rare to be suicidal or homicidal[3,4,5].

The effect of the electrical current on human body depend on several factors: the main rectifiers of electrical current, amperage, voltage and resistance usually represented by a formula A= V/R. Person start to feel electrical current with intensity of one mA and when it reaches 15 mA, the flexor muscles of the hand start to spasm and preventing the electrical current source from dropping. One thousands volts Is the border line between low and high voltage current. Electrical arc is area around electrical current where the effect of electricity appear in, 100 Volt current the area is few millimeter, while with 100 000 Volt, it is 35cm. The skin of human is the first line of resistance to the current so a dry highly keratinized farmer's skin has a resistance of 1 to 2 million ohms, this will drop to few ohms when the hand is wet. Type of current: alternating or direct, electrical injury are usually caused by alternating current which causes muscular spasm and prevent dropping of the current cable. Human sensitivity to alternating current is six times greater than that to the direct current. Direct current causes short lived muscular shake so it throws person away. Easy connection with earth i.e.bare feet.Amplitude of Area exposed to the current: the larger the area the lesser is the effect.Time of exposure to current: death may result even with low voltage current, when connection is good and the time of exposure is prolonged[1,6,7].

There are three groups of fatal electrocution: Domestic; varies from country to another, the most common is 220-240 volt, alternating current. Industrial: very high voltage, may reach up to 400000 volt. Lightning:

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Static electricity, or direct current with high voltage.The first to explain lightning was Benjamin Franklin in 1750[8].

Theautopsy findings: high suspicion, careful examination of victims and the scene are corner stone in the diagnosis of electrocution. Most cases have no gross findings, especially with low voltage injuries[9,10], and if such findings present, they are usually not pathognomonic[7]. The typical skin lesion is an electrical burn, rounded or oval or irregular in shape, with black center, surrounded by pale rim. This is called electrical current inlet, may or may not be associated with more or less, a similar skin lesion called current exit. When electrocution occurred in water for example, no obvious external findings is expected i.e. where the area of contact with the electrical source is wide[9,1,11]. By examining the skin with microscope, Swiss cheese appearance is predominant in epidermis. It is impossible to decide whether electrical burn is ante mortem or post mortem. In high voltage electrical injuries, a third degree burn may be caused with skin reflection, or a skin mark called mark of Joule. In low voltage electrical injuries, the examination of the electrical tool may be more beneficial than the examination of the victim, because electrical burn does not exist usually. When a lightning struck a person, either injured or killed, the injured person usually survives, direct lightning strike is definitely fatal . Lichtenberg figure forms (erythematous pattern of skin lesion looks like a fern) within hours, and starts to fade until 24 hours, it is usually rare to occur but very pathognomonic[1,12,13,14,15].

Causes of death: cardiac arrhythmia mainly ventricular fibrillation ends in heart arrest when the current entrance is through the chest and the myocardium. Respiratory arrest is less in occurrence than cardiac arrest, the current passes through the thorax causing spasm of the diaphragm and intercostal muscles. Brain stem may be affected but in rare condition as the current passes through the head, leading to cardio-pulmonary arrest.Damage to the central nervous system may appear as anxiety, confusion, memory loss, unconsciousness, or respiratory arrest. With high voltage current in judicial execution, the temperature of the brain reaches 63 degree centigrade.Mechanicaltrauma associated is responsible of 15% of deaths in electrocution. Severe burns may cause late death[7,8,16,17].

The heart is highly sensitive to the damage caused by electrical current, but the central nervous system is very highly sensitive to that damage. This damage in its severe state can causes fluid loss and severe hypotension. Multi- system organ failure and drowning may be other causes of death[18,19].

Material and methods:

One year field study of electrically injured victims of severe type both hospitalized and dead, was conducted in the province of Babylon , Iraq from the 1st of May 2014 to the 1st of May 2015. Data were collected from medical records of Al-Hilla teaching hospital and the autopsy and associated laboratory tests like a histopathological, toxicological, alcohol test were achieved at the department of Forensic medicine of Babil Directorate, age, sex, occupation Whether it's work related or not , place of the accident, type of the current, voltage, associated trauma, resuscitative measures, time day or night, detailed circumstances of the death, the season, and the direct cause of death, all were recorded .

Results:

Total number of victims was 41,28 males' 13 females'.Number of hospitalized patients was 5, 3 of them got improved. Two died, led to a mortality rate in hospitalized victims of 40%. 36were either died at the place of the accident or dead on arrival to the hospital. Ten of the victims 24.39%were under the age of 12 years.The age range of the rest was(12 -52) years.The upper extremities were the site of injury in20 victims (48.78%), 9 in the lower extremities 21.95%, 6 in the chest 14.63%, 4 in the head 9.75%, 2with no skin lesion 4.87% (fig.2).Fifteen victims only (36.58%) received resuscitative measures. Low voltage current is the commonest cause of electrical injury (37 victims 90.24%). Two victims only exposed to lightening 4.87%, and two male

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victims were exposed to high voltage current in work related accidents 4.87% (fig.2). The direct cause of death was cardiopulmonary arrest following electrical injury. No trauma was recorded as a direct cause of death. 34 electrical accidents 82.92%occurred in summer season,only 7 in winter. 30 electrical injuries occur during daytime 73.17%. No evidence of alcohol or drugs in all cases. In all cases except one, the diagnosis was madeby the characteristic skin lesion (inlet of the current) i.e. electrical burn in 97.56% of the cases. In a single low voltage current injury case, we recorded no electrical mark, and the diagnosis of electrocution as a direct cause of death was depended on the detailed circumstances of death and exclusion of other violent, natural, and toxicological causes. All deaths were accidental. 5 electrical accidents occurred during early morning time 12.19% (including 4 high voltage victims). The general mortality rate in our study was 92.68%.

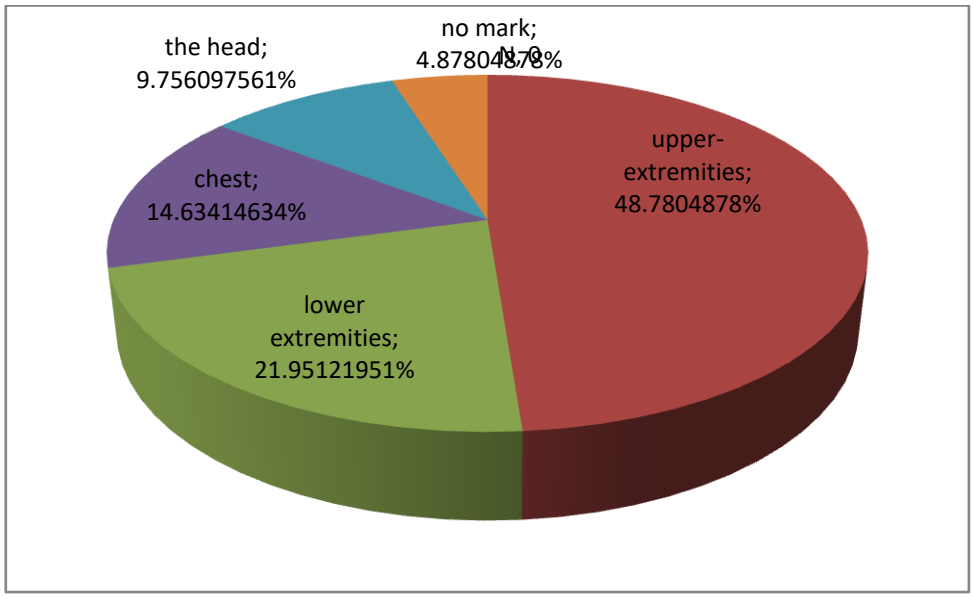

Fig.1: The site of electrical mark

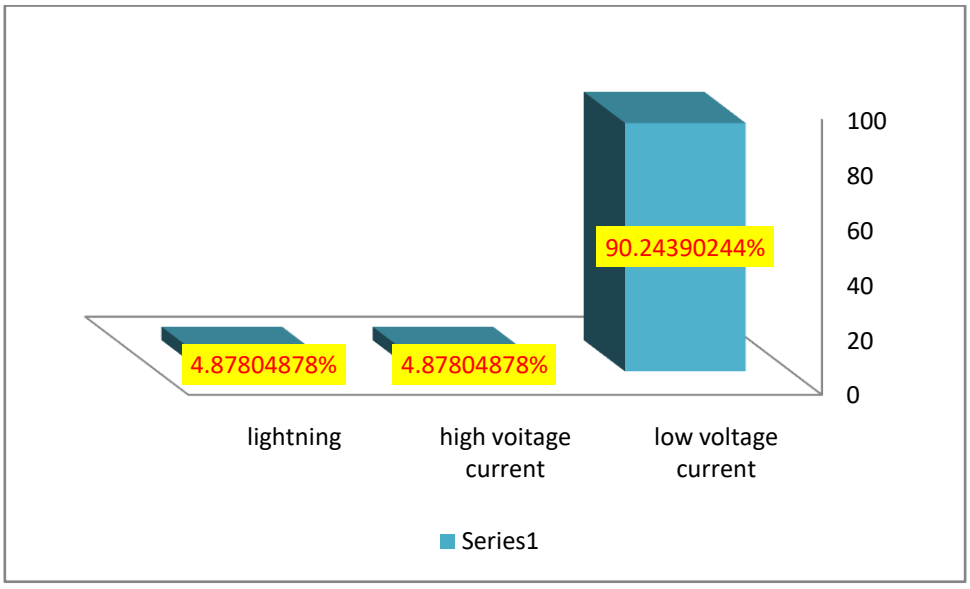

Fig.2: Groups of electrical injuries

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Discussion:

Electrocution in Babylon occurs in average of about four victims every month, this reflects a medical dilemma, and keeping with the literatures of Blwmenthal, and the opinion of Simpson[6,10], but in contrary to most current literatures[1,2,20]. The low incidence of electrocution in the most of thecivilized world usually result from the regular national electricity supply, and the awareness in its use, and these two points are absent in our society. In our study, the electrical injuries were more common inmalesthan females and it is compatible with the studies[13,21,22,23,24]. The occupations related to electricity are usually males connected, and it is logical for males to be injured during work more than females. The male to female ratio is about 2:1 which is low, in contrast to other studies which is around 10:1 or more[20,25,26]. This lowering in the ratio could be understood in our society on the concept of women's attempt to take a greater measure in the responsibility of contemporary day life, especially when the males are outdoor.Tow work related victims 4.87% were recorded, this low incidence was at odd with the literature which mentioned that electrocution related trauma is an important common cause of death during work[27].The reasons for high general rate of death in our study may be due to society concept that the electrocution is inevitably lethal and there is no benefit of transferring the victims to any medical institutions but only for the issuing of death certificates, orthe delay in transferring of electrically injured victims to any medical centers. Offering inappropriate medical interference may be another cause,(in our study we did subgroup the victims into three subgroups: low voltage, a high voltage and lightning), each group has its own management[28], and there is no such considerations in our emergency departments. Our medical staff is unfamiliar with the concept of apparent death, with which the victim appeared dead(difficulty in listening to heartbeat, absent pulsation of the radial artery and fixed pupil), and how to differentiate it from outright death. This will lead to early announcement of death which necessitate cancelation or cessation and early discontinuity of resuscitation. The bad prognosis of electrical injury in our study coincided some studies conducted in the third world region[29].All references insisted on resuscitation for enough time even after resuming regular pulse when cardiopulmonary arrest, coma or apnea existed. Resuscitation may be continuedfor hours[30,31,32,33]. 24.4% of victims were children under 12 years, this confirms the findings of similar study[34]. Most references stated that in low voltage current injuries, usually no electrical marks to be noticed and in most optimistic one pointed to find these marks in half number of victims[1,8]. Ivana et al mentioned in a similar study that no skin lesion was detected in all low voltage current accidents[24].Most accidents of electrocution reported in the above studies occurred in wet environments like bathrooms, or with wide skin area exposed to electrocution, or small wiresaccidents, where no skin lesion is expected usually.Two victims only had no electrical mark in our study, Ryan mentioned the same results of our study[10]. Upper extremities were the site of skin lesion in about half number of victims and this emphasized the results of most other studies[2,14,23,35,36,37]. The manner of death for all cases in our study was accidental which is the commonest manner in death by electrocution[6,7,14,23,38,39,40]. In 95.12% of victims, the accidents occurred at rest time indoor, and this is compatible with literatures[21,39]. The important direct cause of death mentioned by several references and literatures was cardiopulmonary arrest following electrical injury which was affirmed by our study[1,6,7,41]. 82.92% of accidents in our study occurred during summer time, the most common season for electrical injuries to occur all over the world[20,26]. In developed countries, the reason for such increase is usually the increase of outdoor activities during summer, while in our society perhaps, the lack of supply with national electricity, especially during summer and the search for alternative sources for electricity which are often unstable and unsafe. 73.17% of electrical injuries in our society occurred at day time, an emphasis of other literatures like that of Taylor[42], but violated the local research of Ryan[10], which indicated that electric shock incidents especially high voltage type, often occur at night, as they are related to theft operations from national electricity. It is very noticeable that our study showed no evidence of alcohol or drugs in all victim blood samples, which limited or eliminated the incidence of homicide and suicide accidents, a point many studies ignored it.

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Conclusion:

Death by electricity is a real medical problem in our society.Most accidents occurred during searching an alternative to national electricity which are usually unstable and unsafe.All safety and security measures should be followed and insisted upon while performing hazardous work in the area of private and governmental activities. Majority of electrical injuries are accidental so we should concentrate efforts on the instructions of safety use of electricity and technical safety.Emergency medical staff should be highly trained (especially newly graduated doctors) experienced and familiar with the concept of apparent death at least at day time, and should believe that resuscitation and for long time may alter the outcome greatly.The community should be a awarded that rapid transfer of electrically injured victims to any health institutions may bring them back to life.

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