

Research Article

Accidental electrocution fatalities in Puducherry: A 3-year retrospective study

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Abstract

Background: Electrocutions are unusual and almost accidental in nature. They have not been sufficiently studied earlier in the Union Territory.

Objectives: This study was focused on the magnitude, manner of death, profile, and pattern of injuries among electrocutions.

Materials & Methods: We considered 3-year data of all electrocution-related deaths for which autopsies were carried out at the Indira Gandhi Government General Hospital and Postgraduate Institute, Puducherry, from January 2011 to December 2013. We retrospectively reviewed all the medicolegal records and gathered demographic, traumatic and investigative information, and finally analyzed the data.

Results: Electrocutions were accounted for 1.18% (52) of all medicolegal autopsies ($n = 4403$) conducted at our study center during those 3 years. The age of the victims were from 18 months to 68 years, but young adults aged between 21 and 30 years (33%) and males (81%) were more in numbers. The majority of the victims were Hindus (83%) and from rural backdrop (56%). Domestic accidents are clearly prevailed over industrial accidents. Occupants electrocuted most often are agricultural workers (27%), housewives (19%), laborers (17%), and students (12%). Hands and fingers are the most common sites for entry marks (65%), whereas soles and toes (17%) are frequent sites for exit marks in fatal cases. Only entry marks were reported in 58% cases, but both entry and exit marks were noticed in 23% cases. All deaths were accidental, no suicidal and homicide cases were reported. Chemical analysis and histological investigations helped in determining the cause of death in unclear and suspected cases.

Conclusions: Electrocutions represent only a small segment of unnatural deaths; they often occur accidentally in domestic and occupational places. Thus, it is necessary to reduce fatalities related with electrocution among the general public and risk groups by promoting health education on how to prevent electrocution and flawless use of simple safety precautions.

KEY WORDS: Fatalities, domestic, accidents, manner of death

Introduction

Electricity is essential for modern human life and is extensively used for domestic and occupational purposes, both in developed and developing countries. Electric current is accountable for a significant proportion of deaths, but such

hazards can be minimized with the proper use of safety measures.^[1] Electrical injuries are becoming an emerging health problem in low-income countries due to extensive usage of electricity by general public and less awareness of safety issues among them.^[2] Data on accidental deaths and suicides in India (2012) have reported that 8945 and 8750 individuals were electrocuted in 2011 and 2012, respectively. Therefore, electrocutions contributed to 2.2% of total accidental deaths during those 2 years.^[3] The majority of the electrocutions in India are due to accidental contact with low-voltage current (AC, 220–240 V) used in houses and small-scale industries, whereas suicides and homicides by electrocution are rare.^[4] It was reported that accidental deaths are highest from Pondicherry compared to the Indian national average.^[3] This study was focused at the magnitude, manner of death, victims epidemiological data, risk groups for electrocution,

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and also the pattern of injuries among studied Puducherry population.

Materials and Methods

This study was conducted in the Union Territory of India (Pondicherry), which is located in the south Indian coastal area with a population of 974,345 inhabitants, literacy rate of 86.55%, and agriculture being the prime occupation.^[5] All medicolegal autopsies performed between January 2011 and December 2013 at the Indira Gandhi Government General Hospital and Postgraduate Institute (IGGGH & PGI), Puducherry, were included in the study. Among them, 52 cases were of electrocution. Jawaharlal Institute of Postgraduate Medical Education & Research (JIPMER) and IGGGH & PGI are the only two nodal health centers where all medicolegal autopsies are being conducted in this Union Territory. The sources for data collection are autopsy reports, records of investigating officers, death certificates, hospital records, histopathology reports, and chemical analysis reports. We studied all these official documents and collected relevant data for every case of electrocution.

Each fatal case was evaluated for demographic data, place and time of accident, external and internal autopsy findings, investigations performed and their results, and manner and cause of death. We followed ethical principles by maintaining confidentiality of the data and documents, and also by obtaining official permission from the authorities to refer the documents.

Statistics

The qualitative data were entered into Microsoft Excel sheets (version 2007) and analyzed for descriptive statistics in the form of frequencies, percentages, and proportions. Tables, bar charts, and line diagrams were used appropriately for interpreting results of this study.

Results

Overall, 4403 medicolegal autopsies were conducted in the study center during last 3 years (2011–2013). Among

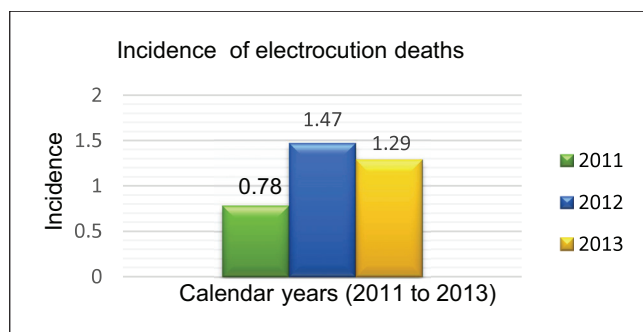


Figure 1: Incidence of fatal electrocution cases for 3 years

Table 1: Gender and age distribution of electrocution fatalities

Age group (years)	Male gender, n (%)	Female gender, n (%)	Total cases, N (%)
0–10	03 (06)	01 (02)	04 (08)
11–20	04 (08)	01 (02)	05 (10)
21–30	14 (27)	03 (06)	17 (33)
31–40	09 (17)	02 (04)	11 (21)
41–50	07 (13)	02 (04)	09 (17)
51–60	03 (06)	00 (00)	03 (06)
>60	02 (04)	01 (02)	03 (06)
Total	42 (81)	10 (19)	52 (100)

them, 52 autopsies established electrocution and constituted 1.18% of total autopsies [Figure 1]. The incidents were much higher in men than women, with male-to-female ratio of 4:1. The age distribution was uneven and ranged from 18 months to 68 years, but overwhelmingly higher in adults aged between 21 and 40 years (54%) and specifically much higher in young adults aged between 21 and 30 years (33%). Gender and age distribution of cases are shown in Table 1. Demographically, most of them are Hindus (83%) and belong to rural background (56%).

Domestic accidents (29, 56%) have outnumbered industrial accidents (17, 33%), and it was noticed that most of the events have occurred while handling electrical appliances. Occupations of the victims to electricity are arranged in decreasing order; agriculture workers and farmers (27%), housewives (19%), laborers (17%), and students (12%) [Figure 2]. Significantly higher numbers of accidents were reported in the months of March, April (summer), July, and August (early monsoon) [Figure 3]. As per our study, majority of the accidents occurred during daytime between 6 AM and 6 PM (79%) [Figure 4]. Of 52 fatalities, majority were found dead at the scene of accident (65%) and rests were hospital-declared deaths. All fatalities were accidental in nature, no suicidal or homicidal deaths were reported during that period.

The hands and fingers (65%) of the upper extremities are the most common sites involved in electrical injuries, whereas

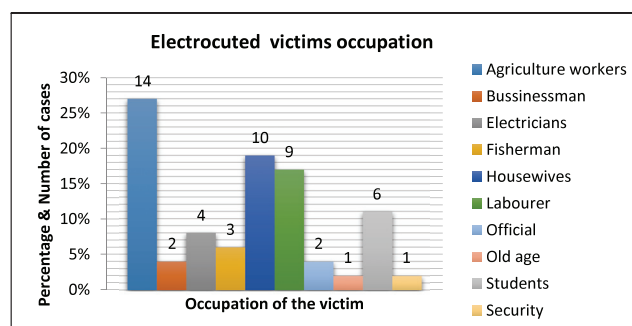


Figure 2: Occupation of the electrocuted persons

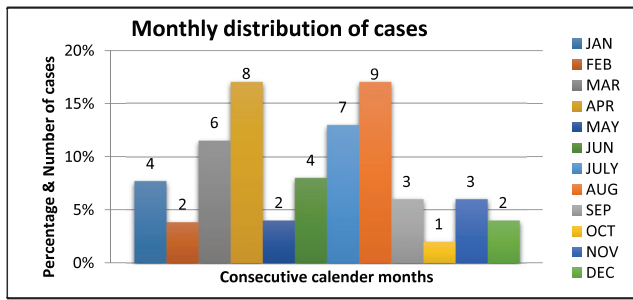


Figure 3: Month-wise distribution of the electrocuted cases

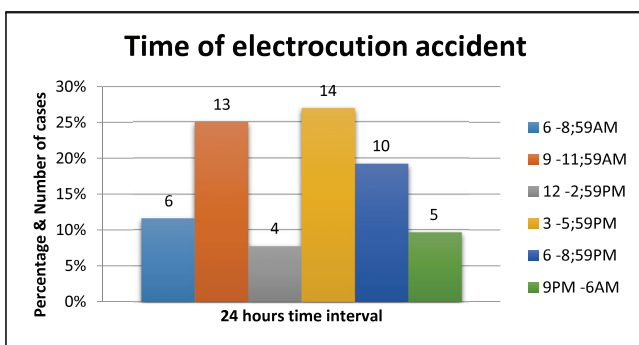


Figure 4: Time of occurrence of electrocution accidents

soles and toes (17%) of lower extremities are the frequent sites for exit wounds [Table 2]. In four cases, there was no entry or exit marks on the body, and the cause of death was reported to be determined chiefly based on circumstantial evidences, other body findings, and investigations opinion. Mechanical injuries were reported over the body in 33% of cases, which include both non-fatal and fatal. Among the mechanical injuries, contusions and abrasions are the most common injuries. Fatal injuries to head and neck structures were reported in two cases, and fatal injuries to chest and pelvis were noticed in one case.

Table 2: Type and site of electrical injuries over the body.

Type of electrical injuries	N	%	Location of electrical injuries	N	%
Only entry mark	30	58	Hands and fingers (upper extremity)	34	65
Only exit mark	06	12	Soles and toes (lower extremity)	09	17
Both entry and exit marks	12	23	Head and neck	02	04
No entry or exit marks	04	08	Chest	03	06
Burns	04	08	Abdomen	00	00
Other injuries (mechanical)	17	33	Pelvis	01	02

Discussions

Even with high utility of electricity in domestic places, electrocutions are not very common in this territory and most of these events are occurring accidentally. In the past 3 years electrocution-related deaths account for approximately 9000 deaths per year.^[3] The average frequency of electrocution-related deaths was 1.18% of the total medicolegal autopsies carried out. Many research studies in India and abroad have reported much higher frequency (1.9%–3.3%) of electrocution-related mortality.^[6–9] This low rate of mortality in our study supports recent decrease in electrocution-related mortality in India and the figure is also close to that reported in few recent Western studies.^[10,11] Poor educational status, difference in weather conditions, accessibility of electricity, and negligent handling of electrical appliances/utensils are the main factors responsible. Marked variations in public awareness about electrical hazards, precautions, and safety measures have also contributed to variable incidence of electrocution.

It was remarkable that males are electrocuted more than females (4:1), perhaps similar male gender predominance over females has been reported in all studies conducted in India and Western counties.^[1,6–12] According to our data, the vulnerable age for electrocution-related deaths is between 21 and 40 years (54%), particularly adults between 21 and 30 years (33%). We reported the least number of cases in extremes of ages, though children and adolescents up to 17 years represented about 15% of cases. When we compared our study findings with those of others, it is very clear that only few have narrowed their age range like our study, between 21 and 30 years,^[12,13] but most of them categorized under wider age range, either between 21 and 40 years^[6] or between 20 and 50 years.^[7,11] It is obvious that adults in the 20- to 40-year age group are most often engaged and exposed to electricity either at home or works places, hence we have to focus on this group to control disabilities and mortalities associated with electrocution.

The socio-demographic data of Pondicherry population according to 2011 census of India is as follows: Hindu 86.7%, rural population 33.7%, and literacy rate 86.5%.^[5] We reported much higher incidences of electrocutions among rural population (56%), because their percentage is high in this region. The majority of the victims are agriculture workers and farmers (27%), housewives (19%), laborers (17%), and students (12%). The higher rate of accidental deaths in this vulnerable population may be due to low level of education, lack of awareness about electrocution, and lack of safety precautions.

According to this study, maximum cases occurred during summer (March and April) and early monsoon (July and August) seasons. The high incidence of electrocution-related mortality at summer and monsoon is consistent with that reported in studies carried out in Turkey^[1] and New Delhi.^[6] The seasonal variations in electrocution-related deaths are due to differences in humidity, moisture, and individual behavior. A significant number of accidents occurred during daytime, between 9 AM and 6 PM (71%), compared to night-time (29%),

in our study. Notable reasons are heavy usage of domestic appliances and industrial machines during this time.

Of the electrocuted persons, 67% were found dead at the scene of accident, and the rest were declared dead at the hospital, either on arrival or within 1–6 h after admission to hospital. These findings are correlated with those reported in Sheikhaadi *et al.*^[11] study and but higher in Ragui *et al.*^[13] study. The high percentage of electrocutions at the scene of sport is due to the catch-on effect of low-voltage AC current (220–240 V) used in homes and small-scale industries in India.

In this study, it is noteworthy that the manner of death in all cases was accidental, no suicidal or homicidal cases were reported. Accidental and suicidal wet electrocutions using bathtubs and heaters are not reported in our study, unlike an Australian study.^[14] Wet electrocutions are unlikely to occur in this region due to hot and humid weather during most of the year, hence the use of water-heaters, boilers, and bathtubs is less likely. A majority of accidental electrocutions can be prevented by promoting health education and spreading awareness about simple safety measures.

The recognition of electrocutions is easy in a number of cases. It can be confirmed based on typical well-defined electrical injury marks and joule burns on the body at the site of electrical contact, clear history, and circumstantial evidences. In this study, we reported entry marks alone in 58% cases, only exit marks in 12% cases, but both entry and exit marks in 23% cases. Other studies have reported much higher percentage of entry marks alone (72%–86.27%).^[1,6,13]

Although most of the electrical wounds were located on the upper extremities, in the majority of cases entry marks were specifically noticed on the palms and fingers. Similarly, exit marks were commonly located on the lower extremities and more so on the soles and toes in this study. Many studies on electrocution-related injuries report that entry and exit marks are commonly located over upper and lower extremities,^[1,6,13] because most of the times people handle electrical appliances with bare hands and work without using any insulating materials or footwear. Entry mark alone is the major electrical injury in electrocution-related deaths. In most wet electrocution cases, neither entry nor exit marks are present. Some studies have reported that in rare cases, typical electrocution marks are not present even in dry electrocutions.

In four fatal electrocution cases, there were no entry or exit electric marks on the body and still death was declared due to electrocution; based on history, circumstantial evidences, associated injuries, and investigations. Chemical analysis was carried out in suspected cases of intoxication and foul play, and it was found to be positive for alcohol consumption in 10% cases. We noticed positive histopathological findings for electrical injuries in 54% cases.

This study has some limitations also. This is a retrospective study, so finer details of electrocution from eyewitnesses (family members, autopsy surgeons) and resource persons were not available; a prospective study would have been ideal for uncommon events like electrocution-related fatalities. Small sample size was another drawback, hence it was not

sufficient to make any generalization. Histopathology of tissues and chemical analysis of the viscera were not carried out in all cases, but were useful in determining the cause and manner of death in some cases. It was noticed that in certain cases, the surgeon performing autopsy faced difficulty and failed to determine the cause of death.

Conclusions

All electrocution-related deaths are accidental in nature and they are declining in recent times. Men aged between 21 and 30 years are the most affected group, and accidents related with domestic electrical use are prevailing over the industrial accidents. Most vulnerable population for electrocution-related deaths are agricultural workers, housewives, laborers, and students. The most common sites of electrical contact were hands and fingers. Entry marks alone are the most common type of electrical injury and they can be considered as guiding sign for electrocution. Contusions and abrasions are the most common non-fatal mechanical injuries in electrocution-related deaths. This study data on fatal electrocution cases among Puducherians may be useful for compiling statistical information and for developing preventive measures.

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