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Research Article

Electrocution Related Mortality: A 11 Year Retrospective Study

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ABSTRACT

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Background: Electricity is a fundamental part of the modern civilized community. Electrical burns are responsible for considerable morbidity and mortality and are usually preventable with simple safety measures. In India, the voltage of domestic supply is usually 220 V to 240 V. Death due to electrocution are rare at less than 100 V and most of deaths occur at voltages above 200 V. Majority of the electrical injuries are as a result of ignorance, misuse or carelessness.

Method: This is a cross-sectional and observational study, which was conducted in tertiary care teaching institutes in Western India. The study includes 89 deceased persons died due to electrocution brought for postmortem examination.

Result: The majority of the victims were male (77, 86.52%) as compared with female (12; 13.48%) and the male: female ratio was 6.41:1. The most common age group involved was 21–30 years (30.34%). The upper extremity was by far the most common site involved (71deaths; 79.78%) followed by the lower extremity (25, 28.09%). Most of deaths were caused most frequently by accidental touching of electrical wires (29 cases, 32.58%)

Conclusion: Electrocution deaths comprised 1.53% of the total autopsy cases conducted during the study period. Prevention is the gold standard and it can be achieved with proper awareness about handling of electrical appliances.

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INTRODUCTION:

Electricity is a fundamental part of the modern civilized community. Electrical burns are responsible for considerable morbidity and mortality and are usually preventable with simple safety measures.[1,2] Almost all fatalities by electrocution are accidental, while homicides and suicides from electricity are rare or uncommon.[2]The main effect of electricity is shock produced by its current and the injuries due to electrocution depend on many factors such as voltage and frequency of current, duration of contact with body, atmospheric conditions, and route of current in the body.[3] Though the human body is a bad conductor of electric current but the wetness of skin or ground increases the chances of electrocution, which is commonly observed in rainy seasons.

The total no of accidental death by electrocution in India was 9606 during 2014. Maharashtra state being the second among top ten states which contribute 14.29% of the total no of accidental death in India.[4] Such death due to electrocution are common but an RTI query revealed alarming trend in Maharashtra. Nearly 5000 people were electrocuted in past six and half year across the state. Victims also included 296 employees of the Maharashtra State electricity distribution company limited. [5]

In India, the voltage of domestic supply is usually 220 V to 240 V. Death due to electrocution are rare at less than 100 V and most of deaths occur at voltages above 200 V.[6] Majority of the electrical injuries are as a result of ignorance, misuse or carelessness.[7] The present study has been taken up to analyze the various epidemiological factors related to electrical fatalities in this part of our state to generate public awareness.

MATERIALS AND METHODS

This study is a retrospective investigation of electrocution deaths in Western Indian population. Data for this study was gathered from

autopsy reports and hospital records. Victims of lightning were not included into the study. Data was obtained from Department of Forensic Medicine between January 2006 and December 2016. Records of medico-legal deaths were used in our study. The information regarding death taken from autopsy reports and medical records for all deceased of any ages with a diagnosis “deaths due to electrocutions”. The independent variables such as age, sex, type of electric mark, body region distribution, place and season of occurrence, contact details, the duration of hospitalization before death, existence of the multiple trauma due to a fall from a height, the manner of death and potential risk factors involved for fatal injury.

RESULT

A total of 89 cases of death by electrocution were identified during the 11 year study period from January 2006 to December 2016. All deaths were accidental. The majority of the victims were male (77, 86.52%) as compared with female (12; 13.48%) and the male: female ratio was 6.41:1. (Table1,2) The most common age group involved was 21–30 years (30.34%), followed by 11-20 years (29.21%) and 31–40 years (24.72%) (Table 2).

Table 1 Incidence of electrocution death

Year	Total no of autopsies	Electrocution cases
2006	438	5
2007	463	11
2008	501	5
2009	426	6
2010	536	8
2011	529	7
2012	467	11
2013	594	10
2014	600	8
2015	574	11
2016	667	7
Total	5795	89

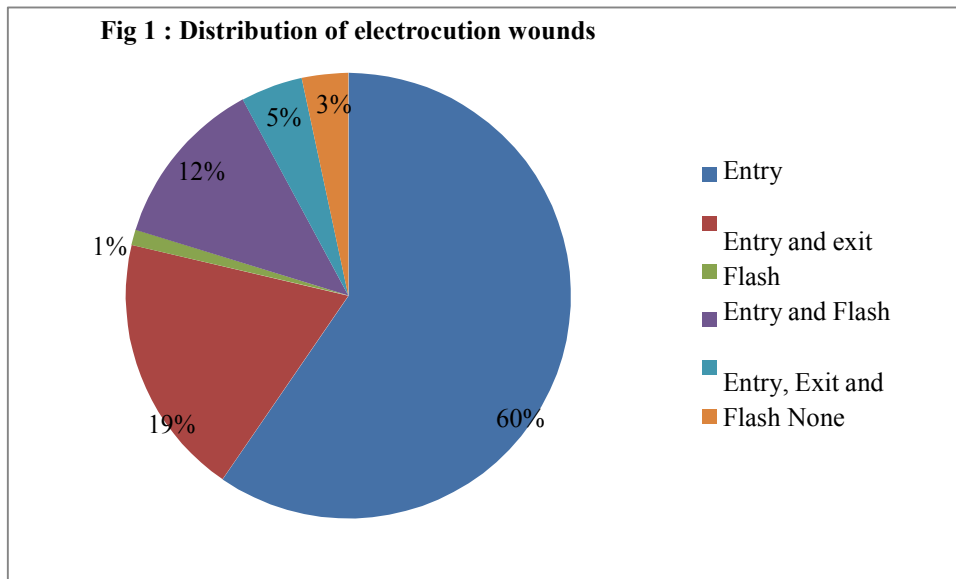


Table 2 Age and sex distribution of electrocution

Age	Male	%	Female	%	Total	%
0-10	6	6.74	0	0	6	6.74
20-Nov	21	23.6	5	5.62	26	29.21
21-30	25	28.09	2	2.25	27	30.34
31-40	18	20.22	4	4.49	22	24.72
41-50	5	5.62	1	1.12	6	6.74
51-60	1	1.12	0	0	1	1.12
>61	1	1.12	0	0	1	1.12
Total	77	86.52	12	13.48	89	100

Fig 2: Distribution of electrocution wounds as per body part involvement

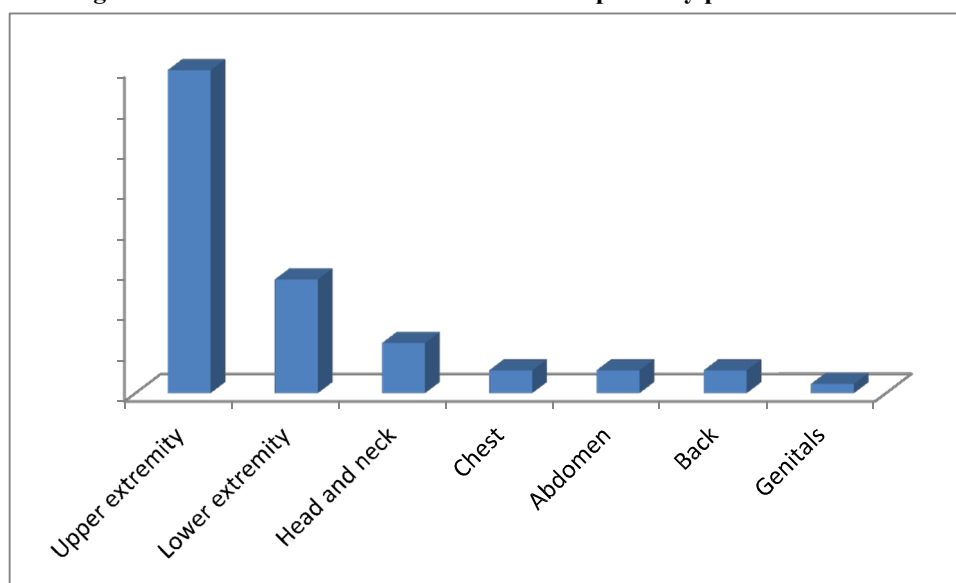


Table 3. Distribution of entry and exit wounds

Characteristics	No of cases	%	No of injuries
Entry	53	59.55	97
Entry and exit	17	19.1	50
Flash	1	1.12	10
Entry and Flash	11	12.36	42
Entry, Exit and Flash	4	4.49	27
None	3	3.37	0
Total	89	100	

Table 4. Distribution of lesion sites

Part of body involved	No of cases	%
Upper extremity	71	79.78
Lower extremity	25	28.09
Head and neck	11	12.36
Chest	5	5.62
Abdomen	5	5.62
Back	5	5.62
Genitals	2	2.25

Table 5 Cases according to manner of accident

Manner of death	Male	Female	Total	%
Work	12	0	12	13.48
Home	28	10	38	42.7
On road	16	0	16	17.98
Ground	6	0	6	6.74
Gutter water	3	0	3	3.37
Other	5	0	5	5.62
Not known	7	2	9	10.11
Total	77	12	89	100

Table 6 Type of material causing electrocution.

Type of material	N	%
Electric wire	29	32.58
Electric cable	22	24.72
Home appliances	9	10.11
Water heater	5	5.62
Water pump	6	6.74
Xerox machine	1	1.12

Electric pole	2	2.25
Transformer	3	3.37
Not known	12	13.48
Total	89	100

Table 7: Comparison of variables with Electrocution

Variables	Male	Female	Total	%	
Surround	Dry	41	5	46	51.69
	Wet	25	6	31	34.83
	Not Known	11	1	12	13.48
Association with trauma	Present	23	2	25	28.09
	Absent	54	10	64	71.91
Petechial	Present	61	8	59	66.29
Hemorrhages	Absent	16	4	30	33.71
Carbonization	Present	20	1	21	23.6
	Absent	57	11	68	76.4

Among the victims, only contact electric mark entry was present in 53 cases, both entry and exit (grounding) electric mark in 17 and association of flash injury in 16 cases, no electrical burn marks in 3 cases. (Table 3 & Fig 1) The upper extremity was by far the most common site involved (71deaths; 79.78%) followed by the lower extremity (25, 28.09%) (Table 4 & Fig 2). Places of occurrence were investigated, 38 of them (42.70%) occurred at home, 16 (17.98%) on road, 12 (13.48%) during the electrical work and details not available in 7 cases. Considering the contact details, deaths were caused most frequently by touching electrical wires (29 cases, 32.58%), followed by touching electrical cables (22 cases, 24.72 %), while using home appliances (9 cases, 10.11%), touching electrical water pump (6 cases, 6.74%), touching electrical water heaters in the bathroom (5 cases, 5.62%) transformers (3 cases,3.37%) and by touching electrical pole (2 cases,2.25%). (Table 6) Among 46(51.69) cases, the surrounding area, at the site of incident, was found to be dry, while it was damp or wet in 31(34.83) cases (33.33%). Fifty-nine cases exhibited epicardial and or pleural petechiae; 21

cases had carbonization at electrocution wound. Small superficial injuries like abrasions and bruises were commonly described in 25 cases, but other more severe injuries were rare. (Table 7)

DISCUSSION

Electrocution fatalities are uncommon and are usually due to failure of tripod of life as ventricular fibrillation from a direct effect on the heart, respiratory paralysis from a direct effect on respiratory muscles or from cardio-respiratory arrest following damage to autonomic nervous centers within the brainstem [2]. Death may also be caused by electrocution burns or subsequent multiorgan failure. Electrocution can also lead to accidental mechanical injuries like head injury due to fall from height or multiple fractures leading to morbidity or mortality. The effect of electricity depends on the voltage, type of current (direct/alternating), the area and duration of contact, skin resistance and path of current flow through tissues and organs [8]. Skin resistance is an important factor in determining current flow and is influenced by the wetness or dryness of the skin and the region of the body in contact with an electrical conductor [9]. The incidences of death due to fatal electric injuries in our study were 1.53%, which is almost similar with the incidences observed by Pathak et al (2.56%), Gupta et al(2.02%) [10,11] In this study, majority of the victims were men (87%) of age group [e.g., from 11 to 40 years (75%)], which is consistent with the findings of most of the other authors.[11,12]. The reason for such a marked male predominance in a variety of studies from different communities probably includes the fact that only males are involved in the electrical works. Present study contributes 36% of victims from below 20 years of childhood age group. In children electrical accidents are due to playing near power lines, removal of entangled kite from live wires, accidental touch to electrical pole while playing [13].

Most of the victims were electrocuted at homes (42.7%) while they were working with some electric source, which was also observed by the other

authors in their studies. [11, 14] Household cases of electrocution are increasing year after year due to increased utility of electrical appliances without taking proper pre caution in the domestic front.

From our study, it was noted that electrical injuries are only entry wound in 53(59.55%) cases, only exit wound in (3.22%) and both entry and exit wounds in 21,(23.59%) cases. Flash burns were found in 16, (17.98%) cases. In 3.37% cases no electric burn was found. Such cases were seen in the rainy season and wet surrounding, first being the easy passing of current in damp material and second being the lowered resistance of skin of the victims due to wetness. These cases certainly became cases of negative autopsies. In such cases the cause of death was ascertained by inference after full legal and medical investigations and circumstantial evidences. These results are consistent with studies by various authors [11,12,15,16].

In our study all electrocution deaths had occurred by accident. However, higher rate of suicide by electrocution were reported by Karger et al 2002 in 10 cases among 37 deaths (27%).[17] One of peculiar incidence the morcha was going with banner placed on steel rod with 3 feet height; four people among them got electrocuted and died as the steel rod touched the overhead electric wire. ‘Petechial hemorrhage’ represents a non-specific but typical finding in electrocution irrespective of the mechanism leading to death. Unlike electrical burns, petechiae also indicate the vital origin of the events. The relevance of this typical morphological sign in the examination of possible electrocution fatalities is therefore emphasized. Karger et al.[17] reported that 26 cases (74%)and Shah et al[2] reported 57 cases (48.3%) of the 118 cases in their series had petechial hemorrhages. However, in our study we found petechiae documented in 59 cases (66.29%) of the 89 cases.77.77% of entry wounds were observed in the upper limb and 43.75% of exit wounds in the lower limb by Bharath et al.[18] Similar findings were observed by Sheikazadi et al.[16] and Ragui[19] We also observed that most of the entry wounds were on the upper extremities (n=71, 79.78%) while exit wounds were located in the lower extremities (n=25, 28.09%).

The National Electrical Code describes high voltage as greater than 600 volts AC. Most utilization circuits and equipment's operate at voltages lower than 600 volts, including common household circuits (220/240 volts); most overhead lighting systems used in houses, industries or office buildings and department stores; and much of the electrical machinery used in industries, such as conveyor systems, and manufacturing machinery such as weaving machines, paper rolling machines or industrial pumps. Electrocuting deaths occur mostly at a voltage between 110 to 380 volt, which is the voltage range of houses and industrial electricity. Electrocuting occurs when a human is exposed to a lethal amount of electrical energy. To determine contact with an electrical source occurs, characteristics of the electrical source before the time of the incident must be evaluated. For death to occur, the human body must become a part of an active electrical circuit, having a current capable of over stimulating the nervous system or causing damage to internal organs. Employee suffering from electric injuries during the course of employment is eligible to get compensation or in case of death the compensation to be paid to relatives with terms and conditions to be fulfilled.

RECOMMENDATIONS:

- 1) Regulations and safety campaigns have been progressively implemented aimed at minimizing unintentional deaths from electrocution, whether in the workplace or at home.
- 2) Parents and other adults need to be alert to possible electric dangers in the home and proper knowledge regarding use of different household electrical appliances. Damaged electric appliances, wiring, cords, and plugs should be repaired or replaced.
- 3) Electrical repairs should be attempted only by people with the proper training.
- 4) Hair dryers, radios, and other electric appliances should never be used in the bathroom or anywhere else because they might accidentally come in contact with water.
- 5) Young children need to be kept away from electric appliances and should be taught about the dangers of electricity as soon as they are old enough.

CONCLUSION

Electrocution deaths comprised 1.53% of the total autopsy cases conducted during the study period. Males outnumbered females and 21 to 30 years' age group is found to be most vulnerable age group for fatalities in the present study. Prevention is the gold standard and it can be achieved with proper awareness about handling of electrical appliances. There are some limitations also of our study. First, we have studied the cases retrospectively so have to rely on the observations seen by the others, which may vary from person to person. Second, if this study were done prospectively then we could have discovered and analyzed some more issues related with this topic.

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