

Jurisprudential Analysis of Death Due to Electrocutation

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Abstract

Background: Minimum attention is given to electrocution deaths as we hardly come across these cases during autopsy. Electrocutation has great impact on morbidity and mortality which can be prevented by public awareness and by adopting safety measures. **Methods:** An autopsy-based retrospective study of three years conducted by history of the cases, inquest report and by doing meticulous autopsy of each of the cases at Dhaka Medical College Mortuary. **Results:** We observed 139 electrocution deaths (1.03%) out of 13400 autopsies. Male victims i.e 123 (88.48%) outnumbered the females i.e in 16 cases (11.51%). The most affected age group was 21-30 years i.e 71 cases (51.07%) followed by 31-40 years in 38 cases (27.33%) and 41-50 years in 18 cases (12.94%). The most common places of electrocution were on the roadside i.e in 91 cases (65.46%) followed by the house in 48 cases (34.53%). High tension electric wires the commonest causative agent i.e in 78 cases (56.11%) followed by home appliances in 48 cases (34.53%) and water pump in 13 cases (9.35%). Regarding distribution of entry and corresponding exit wounds, we observed presence of both entry and exit wounds in 86 cases (61.87%) followed by no entry wounds in 29 cases (20.86%) and entry wounds in 24 cases (17.26%) Most of the entry wounds were present in the upper limbs i.e in 98 cases (70.50%) followed by head-neck in 16 cases (11.51%) and chest-abdomen in 15 cases (10.79%). Maximum exit wounds were observed in the lower limbs i.e in 106 cases (76.25%) followed by no exit wounds in 24 cases (17.26%). Considering manner of death, we observed all the 139 cases of electrocution i.e 100% were of accidental. **Conclusion:** Though cases of death due to electrocution are found in minimum numbers along with other unnatural deaths annually, they can be prevented by proper awareness and measures effectively.

Key words: Electricity, Electrocutation, Death, Medico legal autopsy.

Introduction: Electrical energy is derived from chemical energy, mechanical energy or light energy¹. It may be brought about unpromptedly in the nature by lightning or artificially in the form of electric current. Artificial electric current could be of two types, direct (DC) and alternating (AC)². Contradictory to popular belief alternating current is more dangerous than direct current³. Now-a-days electricity is such a

fundamental part of life, that it is tough to imagine life without it⁴⁻⁸. Whereas, the commercial use of electricity as a source of power began in 1849⁹. Electricity is in use for various purposes in modern world¹⁰⁻¹². Electricity is being used widely and astronomically in household, industrial and transport purposes¹³. The passage of substantial electric current through the tissues can cause skin lesions, organ

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damage and death. This injury is commonly called “electrocution”¹⁴. There are three types of electrical injuries noted depending on the nature of contact and strength of electric current as (1) Contact injury (2) Spark burns/injury (3) Flash burns¹⁵. Electrical injuries occur due to high tension wires falling on the ground or the person; short circuit of electricity; faulty electrical appliances like iron, heater etc¹⁶. Clinical manifestations range from transient troublesome sensations without apparent injury to massive tissue damage. Some electrocutions are fatal at once¹⁷. Electrical deaths can come about in any ways depending upon the type and magnitude of the electric current that the victim is exposed to¹⁸. Cause of death due to electrocution includes ventricular fibrillation, inhibition of the respiratory center in the brain and sometimes due to complications of electrical injury such as infections, burns, wounds etc¹⁹. Deaths due to electric shock are invariably subjected to medico legal autopsies²⁰. Majority of the deaths are accidental as the victim comes under contact with the electric source²¹. Due to good safety measures accidental deaths are rare in other parts of the World though rarely they do occur⁴. In Western countries, however, suicides by electrocution are often encountered²²⁻²⁵. Due to rapid expansion of industrial sectors, unplanned urbanization, frequent use of electricity, and less awareness of safety issues in a low income country like Bangladesh electrical injuries are becoming an emerging health problem. To describe the enormity and nature of burn with electrocution, a number of papers have been published²⁶⁻²⁸. This study was done to evaluate the injury patterns and medico legal aspects of death as a result of electrocution.

Aims and Objectives:

1. To evaluate the injury patterns in electrocuted victims
2. To evaluate the death profiling in relation to fatal electrical injuries

Materials and Methods

This is a cross-sectional study of three years from 1st January 2009 to 31st December 2011 done at the Department of Forensic Medicine & Toxicology of Dhaka Medical College which actually revealed 139

cases (1.03%) of death due to electrocution of the total 13400 autopsies. All the cases were brought to the Dhaka Medical College Mortuary for medico legal postmortem examination. Thorough, detailed and complete autopsy was performed for each of the cases. Information regarding age, sex, residence of the deceased, date & time of incidence, date & time of death were collected from police inquest reports, hospital records and case files. All these informations were compiled, tabulated and analyzed systematically.

Results

As a whole, we observed 139 cases (1.03%) of electrocuted victims out of the total 13400 medico-legal autopsies. Most of the cases were observed in the year 2011 i.e 54 cases of the total 4645 autopsies comprising (1.16%) followed by 46 cases (1.01%) of the total 4525 autopsies in 2010 and 39 cases of the total 4230 autopsies comprising 0.92%. This observation clearly reflects an annual increase in the total number of deaths due to electrocution (Table I).

We observed 123 male victims (88.48%) which outnumbered 16 female victims (11.51%) out of the total 139 electrocuted victims. We observed 50 (92.59%) male victims and 4 female victims (7.40%) in 2011 out of the total 54 cases. In 2010, we observed 39 (84.78%) male victims and 7 (15.21%) female victims out of 46 cases of electrocution. And in 2009, we observed 34 (87.17%) male victims and 5 (12.82%) female victims out of the total 39 electrocuted victims (Table II).

Maximum cases were observed from the age group 21-30 years i.e 71 cases (51.07%) followed by the age group 31-40 years i.e 38 cases (27.33%), 41-50 years i.e 18 cases (12.94%) and 6 cases (4.31%) from both the age group 11-20 years and 51 years & above. We observed no electrocuted victims from the age group 1-10 years in our study (Table III).

Roadsides i.e in 91 cases (65.46%) were the commonest place of occurrence followed by houses in 48 cases (34.53%) of the total 139 electrocuted victims (Table IV).

High tension electric wires were the most common causative agents of electrocution i.e in 78 cases (56.11%) followed by home appliances in 48 cases .

(34.53%) and water pumps in 13 cases accounting for 9.35% of the total 139 electrocution deaths (Table V). Considering distribution of entry and exit wounds, we observed both entry and exit wounds in 86 cases (61.87%) followed by no entry or exit wounds in 29 cases (20.86%) and only entry wounds in 24 cases comprising 17.26% of the total 139 electrocuted deaths (Table VI).

In relation to site of entry wounds, we observed 98 cases (70.50%) in the upper limbs followed by 16 cases (11.51%) in the head-neck, 15 cases (10.79%) in the chest-abdomen, no entry wounds in 8 cases (5.75%) and only 2 cases in the lower limbs comprising 1.43% of the total 139 cases (Table VII)

In connection with site of exit wounds, we observed 106 cases (76.25%) where exit wounds were found in the lower limbs followed by no exit wounds in 24 cases (17.26%), chest-abdomen in 5 cases (3.59%) and upper limbs in 4 cases accounting for 2.87% of the total 139 electrocuted victims (Table VIII).

In our study, as per manner of death we observed all the cases i.e 139 cases of electrocuted deaths were of accidental in nature. We found no suicidal or homicidal cases (Table IX).

Table I : Year-wise distribution of the electrocution deaths

Year	Total No of Autopsies	No of cases of electrocution	Percentage%
2009	4230	39	0.92%
2010	4525	46	1.01%
2011	4645	54	1.16%
Total	13400	139	1.03%

Table-I : Observation revealed 139 cases(1.03%) of electrocution of the total autopsies

Table II: Sex-wise distribution of electrocuted victims

Year	Total No of deaths from electrocution	No of male victims and Percentage%	No of female victims & Percentage%
2009	39	34 (87.17%)	5 (12.82%)
2010	46	39 (84.78%)	7 (15.21%)
2011	54	50 (92.59%)	4 (7.40%)
Total	139	123 (88.48%)	16 (11.51%)

Table-II : Males outnumbered the females in this study

Table III: Age-wise distribution of the electrocuted victims (N=139)

Year	1-10 years	11-20 years	21-30 years	31-40 years	41-50 years	51 years & above
2009	0	1	21	10	5	2
2010	0	3	19	16	7	1
2011	0	2	31	12	6	3
Total	0 (0%)	6 (4.31%)	71 (51.07%)	38 (27.33%)	18 (12.94%)	6 (4.31%)

Table-III : Age group of 21-30 years tops the list i.e in 51.07%

Table IV: Place of Occurrence (N=139)

On the Roadside	In the house
91 (65.46%)	48 (34.53%)

Table-IV : Victims were mainly found beside roads in 65.46%

Table V: Causative agents of electrocution (N=139)

High tension wires	Home appliances	Water pump
78 (56.11%)	48 (34.53%)	13 (9.35%)

Table-V: High tension wires were observed to be the main causative agent in 56.11%

Table VI: Distribution of entry and exit wounds (N=139)

Characteristics	Number	Percentage%
Entry wounds	24	17.26%
Both entry and exit wounds	86	61.87%
No entry or exit wounds	29	20.86%
Total	139	100%

Table-VI : Both entry and exit wounds were observed in 61.87% cases

Table VII: Distribution of site of lesion (entry wounds) (N=139)

Part of the body	Number	Percentage%
Upper limbs	98	70.50%
Lower limbs	2	1.43%
Head -neck	16	11.51%
Chest-abdomen	15	10.79%
No entry wounds	8	5.75%
Total	139	100%

Table-VII : Upper limb involvement was mostly seen (70.50%) as entry wound

Table VIII : Distribution of site of lesion (exit wounds) (N=139)

Part of the body	Number	Percentage%
Upper limbs	4	2.87%
Lower limbs	106	76.25%
Head-neck	0	0%
Chest-abdomen	5	3.59%
No exit wounds	24	17.26%
Total	139	100%

Table-VIII : Lower limbs were the main site of exit wound (76.25%)

Table IX: Distribution of manner of death due to electrocution (N=139)

Manner of death	Number	Percentage%
Accidental	139	100%
Suicidal	0	0%
Homicidal	0	0%
Total	139	100%

Table-IX : Manner of death was accidental among all the cases of electrocution (100%)

Discussion:

We came across the total of 139 cases (1.03%) of death due to electrocution out of the total 13400 medico legal postmortem examinations. Maximum cases were observed in the year 2011 i.e 54 cases (1.16%) of the total 4645 autopsies followed by the year 2010 i.e 46 cases (1.01%) of the total 4525 autopsies and the year 2009 where we observed 39 cases of electrocuted victims of the total 4230 medico-legal autopsies comprising 0.92%. This study revealed an annual increase in the total number of electrocuted deaths. Similar Indian study shows 43 cases (1.45%) of death due to electrocution in the year 2002 out of the total 3034 medico-legal autopsies, whereas in the year 2001, there were 34 cases of the total 2722 autopsies accounting for 1.28% of the total²⁹.

Regarding distribution in relation to sex, this study revealed 123 (88.48%) male victims which outnumbered 16 female victims comprising 11.51% of the total 139 cases of electrocution deaths. Similar Indian study revealed 30 (88%) male victims and 4 (12%) female victims of the total 34 cases of

electrocuted victims in the year 2001 and 38 (88%) male victims and only 5 (12%) female victims of the total 43 cases²⁹.

Most of the cases were observed from the age group 21-30 years i.e 71 (51.07%) which outnumbered 38 cases (27.33%) from 31-40 years, 18 cases (12.94%) and 6 cases (4.31%) each from the age group 11-20 years and 51 years & above. We came across no cases of electrocuted victims from the age group 1-10 years. Similar study was done in India which revealed 10 cases from the age group 21-30 years followed by 5 cases from 31-40 years, 4 cases from 41-50 years and 3 cases from the age group 11-20 years and 51 years & above respectively. In that study there were also no victims from the age group 1-10 years³⁰.

In relation to place of electrocution, we observed 91 victims (65.46%) were electrocuted on the roadside and 48 victims (34.53%) in the house. Similar study was done in India which revealed, most of the victims were electrocuted on the roadside i.e 68% and the remaining victims were electrocuted in their house³⁰.

In our study, high tension electric wires the commonest causative agent of electrocution i.e in 78 cases (56.11%) followed by home appliances in 48 cases (34.53%) and water pumps in 13 cases (9.35%) out of the total 139 cases of electrocution. Similar study revealed that the commonest causative agent of electrocution was also high tension electric wires (60%) and the remaining victims got electrocuted in their house³¹.

In relation to distribution of entry and exit wounds, we observed presence of both entry and exit wounds in 86 cases (61.87%) followed by no entry or exit wounds in 29 cases (20.86%) and only entry wounds in 24 cases comprising 17.26% of the total 139 cases of electrocution cases. Similar study revealed entry and corresponding exit wounds of the electrical injuries were observed in 72% of the cases while there were no entry or exit wounds in 20% cases and only entry wounds were present in 8% of the total electrocuted victims³².

Considering site of entry wounds, we observed 98 cases (70.50%) in the upper limbs followed by 16 cases (11.51%) in the head-neck region, 15 cases (10.79%) in the chest-abdomen region, no entry

wounds in 8 cases (5.75%) and only in 2 cases (1.43%) entry wounds were found. Similar study revealed the upper limbs were the frequently observed site of entry (56%) followed by head-neck region (16%)³².

In relation to the site of exit wounds, we observed 106 cases (76.25%) in the lower limbs, followed by no exit wounds in 24 cases (17.26%), chest-abdomen in 5 cases (3.59%) and upper limbs in 4 cases (2.87%) of the total 139 cases of electrocuted victims. Similar study revealed exit wounds were mainly found in the lower limbs (44%) followed by the upper limbs (24%) and chest-abdomen region (4%). There were no exit wounds in 7 cases (28%)³³.

As per manner of death due to electrocution, we observed all cases i.e 139 cases were of accidental in nature. There were exactly no suicidal or homicidal cases of electrocution. Considering manner of death due to electrocution, a distinct pattern is seen all over the World. In the Western World, accidental deaths caused by electrocution are not common owing to the good safety measures and high level of awareness³¹. Although accidental electrocutions are reported rarely in the developed countries, electrocution takes place among leading causes of occupational deaths in the United States with an average of one death per day in the work place^{32,33}. A study from South Australia reported an average of 3.2 electrical deaths per year³⁴. In Sweden, accidental electrocutions have been on a decreasing trend over 25 years, proving that preventive strategies to reduce electricity related fatalities were effective³⁵. However, many cases of suicides³⁶ as well as homicides³⁷ are also reported. It is in contrast to studies done in West where suicidal cases were as high as 2/3rd³⁸.

Conflict of interest

There is no conflict of interest as per declaration of the authors.

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Conclusion

Electric current passing through the human body can produce various effects ranging from a localized muscular spasm to instantaneous death of the victim. All electrocution deaths should be properly investigated as there might be question of compensation to be paid as well as for adopting future safety measures, though most of the deaths are accidental in nature in the present study. Public awareness and adoption of good safety measures can reduce the mortality from fatal electrocution in context of a developing country like Bangladesh.

References

1. Hunt JL, Mason Ad Jr, Masterson TS, Pruitt BA. The Pathophysiology of acute electric injuries. *J Trauma*. 1976; (16); p.p: 335-340
2. Rao NG. Textbook of Forensic Medicine and Toxicology, 1st ed Reprint, 2006, Jaypee Brothers Medical Publishers (P) Ltd. EMCA House, 23/23B, Ansari Road, Daryaganj, New Delhi 110 002, India; p.p: 253-256
3. Ahmad MU. A Short Textbook of Forensic Medicine, 1st ed, Reprint, 1989, MMM Publications Dhaka; p.p: 204-207
4. Tirasci Y, Goren S, Subasi M, Gjukan F. Electrocution related mortality: A Review of 123 Deaths in Diyarbakir, Turkey between 1996 and 2002. *Tohoku J Exp Med*, 2006; (208); p.p: 141-145
5. Shrigiriwar M, Bardake R, Dixit PG. Electrocution: A six year study of Electrical Fatalities. *JIAFM*, 2007; (29); p.p: 50-53
6. Mathihran K, Patnaik AK. Modi's Medical Jurisprudence and Toxicology. 23rd ed, New Delhi Lexis Nexis Butterworths, 2008; p.p: 653

6. Mathiharan K, Patnaik AK. *Modi's Medical Jurisprudence and Toxicology*. 23rd ed, New Delhi Lexis Nexis Butterworths, 2008; p.p: 653
7. Reddy KSN. *The Essentials of Forensic Medicine and Toxicology*, 27th ed, Hyderabad, K Saguna Devi, 2008,p.p: 295
8. Vij K. *Textbook of Forensic Medicine and Toxicology*, 4th ed, New Delhi, Elsevier, 2008, p.p: 237
9. Robinson DW, Masters FW, Forrest WJ. *Electrical Burns : A review and analysis of 33 cases, Surgery*. 1965; (55); p.p: 385-390
10. Lucas J. *Electrical fatalities in Northern Ireland. Ulster Med J*, 2009; (78);p.p: 37-42
Electrical Burns : A review and analysis of 33 cases, Surgery. 1965; (55); p.p: 385-390
10. Lucas J. *Electrical fatalities in Northern Ireland. Ulster Med J*, 2009; (78);p.p: 37-42
11. Dokov W. *Forensic characteristics of suicide by electrocution in Bulgaria. J Forensic Sci*, 2009, (54); p.p: 669-671
12. Tugeu H, Keya A, Ulukar MO, Tugeu I, Celasun B, Yuksek. *Voltaj elektrik yaralanmasina bagli olum: Iki olgu sunumu. Gulhane Tip Dergisi*, 2004; (46); p.p: 335-339
13. Mukherjee JB. *Mukerjee's Forensic Medicine and Toxicology*. 5th ed, 2018, Academic Publishers, 5 A Bhawani Dutta Lane, Kolkata 700073, India; p.p: 333-339
14. Knight B. *Knight's Forensic Pathology*, 2016, CRC Press Taylor and Francis Group, Boca Raton, FL 33487-2742; p.p: 325-338
15. Bardale R. *Principles of Forensic Medicine & Toxicology*. 2nd ed, 2017, Jaypee Brothers Medical Publishers (P) Ltd 4838/24, Ansari Road, Daryaganj; New Delhi 110 002; India; p.p: 314-321
16. Subrahmanyam BV. *Forensic Medicine, Toxicology and Medical Jurisprudence*, 1st ed Reprint, 2008, CBS Publishers & Distributors, 4596/1-A, 11, Daryaganj, New Delhi 110 002, India, p.p: 102-103
17. Dega S, Ganeswar SG, Rao PR, Ramani P, Krishna DM. *Electrical Burn Injuries: Some unusual clinical situations and management. Burns*. 2007; 33(5): p.p: 653-665
18. Siegel JA, Mirakovits K. *Forensic Science the basics*, 3rd ed. 2016, CRC Press Taylor and Francis Group, Boca Raton, FL 33487-2742; p.p: 319-325
19. Mallik CC. *A Short Textbook of Medical Jurisprudence*, 3rd ed, 1993, The New Book Stall, 5/1 Ramnath Mazumdar Street, Calcutta 700 009, India; p.p: 545-548
20. Umadethan B. *Principles and Practice of Forensic Medicine*, 2nd ed, 2016, CBS Publishers and Distributors Pvt. Ltd, New Delhi 110 002, India; p.p: 235-239
21. Sharma RK. *Concise Textbook of Forensic Medicine & Toxicology*, 2nd ed, 2008, Elsevier, New Delhi, 110 065, India; p.p: 74-75
22. Chan P, Duflou J. *Suicidal Electrocution in Sydney – A 10 year Case Review. J Forensic Sci*, 2008;(53); p.p: 455-459
23. Toro K, Kristof I, Kardos M. *Suicidal Hanging on High Voltage Line Pylon. J Forensic*, 2008; (53): p.p: 1200-1203
24. Eren B, Turkmen N, nFedakar R, Serel B. *Suicidal electrocution using a homemade electrocution device. Kathmandu Uni Med J*, 2007; (5); p.p: 102-104
25. Fernando R, Liyanage S. *Suicide by Electrocution. Med Sci Law*, 1990; (30); p.p: 219-220
26. Mashreky SR, Rahman A, Khan TF, Svanstrom L, Rahman F. *Epidemiology of childhood electrocution in Bangladesh: Findings of national injury survey. Burns*, 2010, (36): p.p: 1092-1095
27. Mashreky SR, Rahman A, Chowdhury SM, Khan TF, Svanstrom L, Rahman F. *Non-fatal burn is a major cause of illness: Findings from the largest community based national survey in Bangladesh. Injury Prevention*, 2009;(15); p.p: 397-402

28. Mashreky SR, Hossain MJ, Rahman A, Biawas A, Khan TF, Rahman F. Epidemiology of electrical injury : Findings from a community based national survey in Bangladesh. *Injury*, 2012; 43(1); p.p: 113-116
29. Hussain IB, Khan MT. Related Deaths Due to Electrocution –A Comparative Study, *Int. Jour of Basic and Applied Medical Sciences*, 2015, 5(1); Jan-Apr;p.p: 114-121
30. Ragui S, Meera T, Singh KP, Devi, Devi AS. A study of electrocution deaths in Manipur. *J. Med Soc*, 2013; 2013; (27); p.p: 124-126
31. Koumbourlis AC. Electrical injuries, *Critical Care Medicine*, 2002; (30); p.p: 424-430
32. Cawley JC, Homce GT. Occupational electrical in the United States, 1992-1998 and recommendations for safety research. *J Safety Res*, 2003; (34); p.p: 241-248
33. Taylor AJ, Mc Gwin G, Valent F, Rue LW 3rd, Fatal occupational electrocutions in the United States. *Inj Prev*, 2002, (8); p.p: 306-312
34. Wick R, Gilbert JD, Simpson E, Byard RW, Fatal electrocution in adults- a 30 year study. *Med Sci Law*, 2006; (46); p.p: 166-172
35. Lindstrom R, Bylund P, Eriksson A. Accidental deaths caused by electricity in Sweden, 1975-2000. *J Forensic Sci*, 2006; (51); p.p: 1383-1388
36. Toro K, Kristof I, Kardos M. Suicidal Hanging on High-Voltage Line. *J of Forensic Sciences*, 2008; (53); p.p: 1200-1203
37. Tyagi A, Shankar S, Chawla H, Yadav K, Kumar H, High voltage electrocution injury – A case report, *Int J For Med and Tox Sci*, July 2019, 4(2); p.p: 63-65
38. Giri S, Waghmode A, Tumram NK, Study of different facets of electrocution deaths : a 5-year review. *Egyp J For Sci*, Jan 2019, 22(1); p.p: 66-71