

Median Lethal Dose (Ld50) Of Electric Current



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Abstract

Electric current constitutes potential hazards across the globe. In view of this, literatures were assessed for determination of lethal dose of electric current that would kill 50% of human (LD50), using cardiorespiratory pathological signs. The low LD50 value of electric current ($36.5 \pm 21.3 \text{mA}$) and voltage ($11.0 \pm 6.4 \text{V}$) respectively, suggest very serious toxicity. The vital toxicity signs were paralysis of respiratory muscle and ventricular fibrillation. Hence, electric current should be avoided since it is severely hazardous.

Keywords: Thunder; Lightning; Lethal dose; Treatment

Introduction

Electrical related deaths are more frequent among school age children as a result of high voltage and lightning strike [1]. Lightening, a transfer of an electrical charge, which results in discharge of static electricity, kills about 1000 people in the US every year [2]. Lightening causes muscular spasm, neurosis, thrombosis, damage of blood vessels, unconsciousness, cardiac arrest, hypoxia, respiratory arrest and death [3]. The types of lightning strikes are intracloud, cloud - to - ground and ground to cloud [4]. The most important resistor to the flow of current from lightening electricity is skin [5]. Estimated are 50,000 thunderstorms, 8 million lightning flashes [6], with mortality rate of 30% [7] and survival rate of 70% [8], affecting more people of less than 40 years of age [9]. The effect depends on the intensity of current, voltage, body exposure among others [10]. A voltage of 30V can cause ventricular fibrillation. Electric shock is a sudden violent response to electric current, which may lead to death (electrocution). Let go phenomenon for high voltage (7600V) could be tolerated for 100 milliseconds or less [11]. Lightning has been considered by some ethnic groups as myth, miracle and mirage [12], which is cruelty to animals, and may be caused by witches [13]. In view of traditional beliefs and toxicity effects associated with lightning and electric current, there is need for acute toxicity study of electric current, with a view to determining the resistance threshold of lightning and electric current in humans and animals.

Materials and Methods

Ohm's law states that current is equal to voltage over resistance. A mechanism of death in electric shock drowning as re

ported by Fish and Geddes [17] was used to determine the LD50 of lightening current and voltage [14-19]. Arithmetical method of up-and-down procedure was adopted for calculation of LD50 [16].

Results and Discussion

The results of median lethal dose for lightening current, voltage and resistance are presented in Table 1.

Table 1: Median lethal dose of lightening current, voltage and resistance.

Mechanism	Current (MA)	Voltage (v)	Resistance (Ohm)	Survival status
Ventricular fibrillation	100	30	0.3	X
Loss of muscular contraction of extremities in human	10	3	0.3	0
Paralysis of respiratory muscle	20	6	0.3	X
Loss of muscular contraction of extremities	16	4.8	0.3	0

$$LD_{50} \text{ for current (I)} = \frac{100 + 20 + 16 + 10}{4} = 36.5 \pm 21.3 \text{mA}$$

$$LD_{50} \text{ for voltage (V)} = \frac{30 + 6 + 4.8 + 3}{4} = 11.0 \pm 6.4 \text{V}$$

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}} = \frac{11}{36.5} = 0.3 \Omega$$

Estimated LD50 for current ($36.5 \pm 21.3\text{mA}$) and voltage ($11.0 \pm 6.4\text{ V}$) show that electric current is very toxic indicating that 100 mA can cause ventricular fibrillation, 20mA (respiratory muscle paralysis), 16mA and 10mA contraction of extremities [14,15]. More so, 606 electrical injuries and 21 deaths caused by greater than 1000 volts have been reported in Canada [1]. But the reported resistance (2000-5000 Ω) for lightning current can be resisted by calloused dry hand that have more than 100,000 Ω with internal body resistance of 300 Ω , suggesting low incidence of human killings by lightning current. But the total body resistance in water 300 Ω and voltage (30V) can kill human [7]. The estimated power of lightning is between 10,000 and 200,000 A with estimated voltage of 20 million to 1 billion V [15]. The resistance to lightning current is from 25-1000 ohms on sweaty palm to 1million ohms on dry calloused hand [2]. Lightning figure is a fractal positive electrical discharge reported in 30% of cases [16]. Using the above formula to calculate the resistance ($2 \times 10^3 - 5 \times 10^3 \Omega$) developed by human against lightning, current ($10^4 - 2 \times 10^7 \text{A}$) and voltage ($2 \times 10^7 - 1 \times 10^9 \text{V}$) [7] denotes that there is need for high resistance against the effects of lightning current and voltage [19], since lightning had caused 45 fatalities and unusual otolaryngitis [20,21]. But the lethality depends on frequencies of thunderstorm sounds and energies [22].

Conclusion

The LD50 of electric current is very low suggesting high level of toxicity. But because of high resistance shown to the current by human being, the incidence of killing by the current is low.

References

1. Nguyen BH, Mackay M, Bailey B, Klassen TP (2004) Epidemiology of electrical and lightning related deaths and injuries among Canadian children and youth. *Injury and prevention* 10: 122-124.
2. Cankaya H, Egeli E, Euliyaoghu Z (2002) Hearing loss caused by lightning strike: case report and review of the literature. *J Otolaryngol* 31(3): 181-183.
3. Celikoz B, Isik S, Turegun M, Selmanpakoglu N (1996) An unusual case of lightning strike: full thickness burns of the cranial bones. *Burns* 22(5): 417-419.
4. Cooper MA (1995) Myths, miracles and mirages. *Lightening Injury Facts*, pp. 1-11.
5. Courtman SP, Wilson PM, Mok Q (2003) Case report of a 13-year old struck by lightning. *Paediatr Anaesth* 13(1): 76-79.
6. Dalziel CF (1972) Effects of electrical shock on man. *IEEE Spectr* 9(2): 41-50.
7. Fish RM, Geddes LA (2009) Conduction of electrical current to and through the human body: a review. *Open Access J Plastic Surg* 9: 407-421.
8. Forth G (1984) Animals witches and wind: eastern Indonesian variations on the thunder complex. *Anthropos* 1984(84): 89-106.
9. Gibbs NF, Keel DM (2003) Burns from out of the blue lightning strike: *Postgrad Med* 2003; 113: 67-68. report and review of fee literature *J Dtutaryagol* 21: 181-183.
10. Kelley MC, Garstand M (2013) On the possible detection of lightning storm by elephants. *Animals* 3(2): 349-355.
11. Lee RC, Cravalho EG, Burke JF (1992) *Electrical Trauma*, Cambridge University Press, England.
12. Lichtenberg R, Dries D, Ward K, Marshal W, Scancon P (1993) Cardiopvascular effects of lightning strikes. *J Am Col Cardiol* 21(2): 531-536.
13. Lifschultz BD, Donoghue ER (1993) Deaths caused by lightning. *J Forensic Sci* 38(2): 353-358.
14. National Institute for Occupational Safety and Health (NIOSH) (2009), Worker deaths by electrocution. NIOSH publication No. 98-131.
15. Norman ME, Albertson D, Younge BR (2001) Ophthalmic manifestations of lightning strike. *Surv Ophthalmol* 46(1): 19-24.
16. Resink BI, Wetli CV (1996) Lichtenberg figures. *Am J forensic Med Pathol* 17(2): 99-102.
17. Saganuwan SA (2014) Arithmetic method of rough estimation of median lethal dose (LD50) using up-and-down procedure. *Toxicol Lett* 229: s127
18. Seidl S (2005) Pathological features of death from lightning strike. *Forensic pathol Rev* 4: 3-23.
19. Smooth AW, Bentel CA (1964) Electric shock hazard of underwater swimming pool lighting fixtures. *IEEE Trans Power Apparent System* 83(9): 945-964.
20. Wetli CV (1996) Keraunopathology. An analysis of 45 Fatalities. *Am J Forensic Med Pathol* 17: 89-98.
21. Todd DH, Meyers A (1994) An unusual otolaryngologic manifestation of lightning strike. *Otolaryngol Head Neck Surg* 110(1): 126-130.
22. Saganuwan SA (2018) The lethal frequencies of thunderstorm sound and energies: a mini review. *Curr Trend Biomed Engineer* 17(1): 1-2.



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