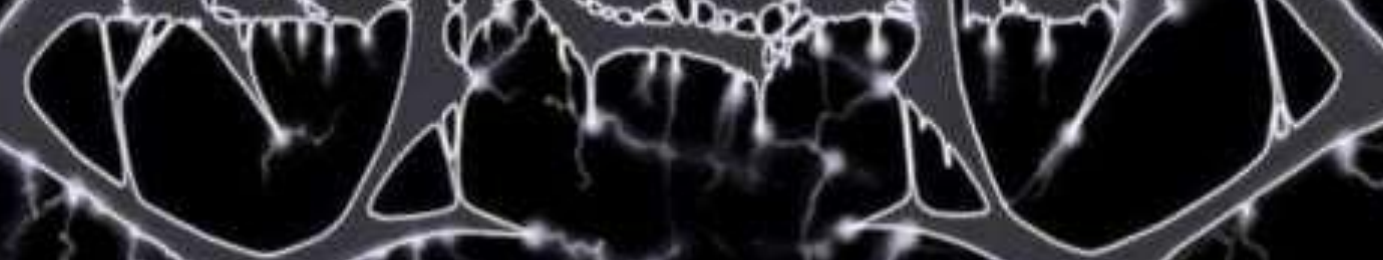


THE REVOLUTION



A man in an orange t-shirt is shown in a state of shock and distress. He has a wide-eyed, open-mouthed expression and is holding two live electrical wires, one in each hand. The wires are sparking and emitting smoke, suggesting a recent electrical accident. His hair is spiky and stands on end, and there are dark, smudged marks on his face, possibly from soot or ash. The background is a dark, smoky blue with wisps of white smoke or steam rising around him. The overall scene is dramatic and emphasizes the danger of electricity.

Electrocution

Forensic Medicine

Definition

- Is death caused by electrical shock , either accidental or deliberate is called electrocution .
- Electric shock of a human body with any source of electricity that causes a sufficient current through the skin, muscles or hair .
- typically the expression is used to denote an unwanted exposure to electricity, hence the effects are considered undesirable .



- **Electrocution may be due to**
 - Low Voltage (<1000 Volts)
 - High Voltage (>1000 Volts)
 - Lightning (up to 100,000,000 Volts)





- Electrical current through the body can cause breathing or heart to stop and can also cause burns.
- The current which causes electrocution usually comes from low or high voltage electricity and lightning .





- Sources of low and high voltage electricity which may cause injuries can be found in appliances and cables found in the home, office, shops or workplace, however, these are often insulated by non conducting materials such as plastic or rubber to prevent injuries from occurring.

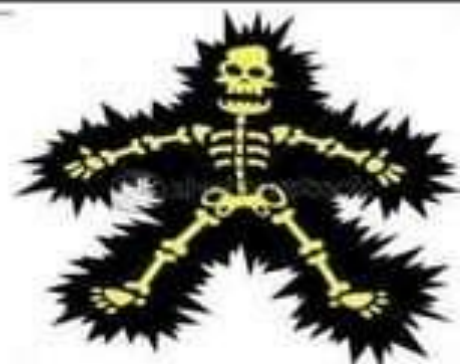


- Water conducts electricity so using wet hands or standing on a wet floor when handling an electrical appliance may increase the risk of an electrical injury.





Factors determining the damage caused by electricity



The amount and type of damage caused to the body by electricity depend on :

- Type of Current (AC or DC)
- Amount of current (Amperage)
- Voltage
- Resistance (Ohms)
- Duration of event
- Route of current



Type of Current

There are two Types of current :

- **Direct current (DC):** is the unidirectional flow of electric charge. Direct current is produced by sources such as batteries .
- **alternating current (AC):** is the flow of electric charge periodically reverses direction, whereas in direct current (DC) the flow of electric charge is only in one direction.



- the minimum current a human can feel depends on the current type (AC or DC) and frequency.
- the current may ,if it is high enough , cause tissue damage or fibrillation which leads to cardiac arrest .
- Alternative Current (AC) is more dangerous than Direct Current (DC) at lower amperage as it is more likely to cause cardiac arrhythmias.



- **Alternative Current also causes tetanic spasm of muscles of hand, preventing the victim from releasing his/her grasp**
- **Alternative current is more likely to cause death an estimated four to six times than Direct Current.**



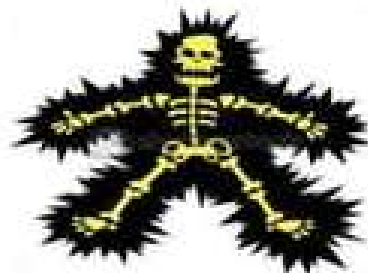
Amount of current

Amount of Current	Effect
1 mA (milliAmperes)	Barely perceptible tingle
16 mA (milliAmperes)	Current can be grasped and released
16-20 mA (milliAmperes)	Muscular paralysis
20-50 mA (milliAmperes)	Respiratory paralysis
50-100 mA (milliAmperes)	Ventricular fibrillations
>2000 mA (milliAmperes)	Ventricular standstill



Voltage

- In High Voltage more than 1000 Volts death being more common and injuries more sever than low voltage .
- Electrocution rare when voltage less than 80 V
- High voltage electrocution may occur by arcing



- Arcs generate extremely high temperature up to 50000 C
- Deaths may occur at low voltage if humidity reduces resistance or if contact is prolonged.



Resistance

- The voltage necessary for electrocution depends on the current through the body and the duration of the current, Ohm's law states " that the current drawn depends on the resistance of the body."



- " Under dry conditions, the resistance offered by the human body may be as high as 100,000 Ohms wet or broken skin may be drop the body's resistance to 1000 Ohms "
- Skin has moderate resistance variable based on thickness and wetness.



- " high voltage electrical energy quickly breaks down human skin reducing the human body's resistance to 500 Ohms .
- Body tissue have variable resistance between 500 Ω and 1,000 Ω (Ohms)
 - Bones, fat and tendon have high resistance
 - Nerves, blood, mucous membrane & muscles have low resistance



Exposure of different parts of body to same voltage will produce different amperages.

- Very low resistance of moist mucous membranes predisposes children to accidental exposure causing severe oro-facial injuries
- Electrical energy converted into thermal energy as the electricity crosses resistance thus injury affect the skin .



Duration of event

- Minimum 9 seconds contact is required at low voltage to produce a 1st degree skin burn
- Skin burn most likely to occur if hold on
- The risk of death due to ventricular fibrillation increases with duration the current passes
- Deaths have been reported with as low as 24 volts when contact is maintained for several hours



Route of current

- Most common route current passes is from hand to foot or hand to hand
- Current passes from point of contact to nearest earthed point
- Passage of current through heart or brain increases mortality



- Passage of current through thorax associated with 60% of mortality
- If connection from one leg to another the mortality is 20%
- Passage of current across the chest cause cardiac arrest



Lightning



Lightning

- Lightning is a form of high voltage current electricity a bolt of lightning is produced when the charged under surface of a storm cloud discharge its electrical charge to earth .
- lightning conductor is a metallic object mounted on top of an elevated structure, such as a building electrically bounded using a wire or electrical conductor which interface with ground through an electrode, engineered to protect the structure from lightning strike.



Lightning rod or lightning conductor



Mechanism of lightning injury :

Lightning current inflicted on a person in one of several ways :

- Direct strike.
- Contact injury.
- Side splash/ flash.
- Blunt injury.



Direct Strike

- it occurs when the lightning stroke attaches directly to the victim, this is most likely occur when a person has been unable to find a safer location and probably occurs no more often than 3 to 5% of injuries.
- While it is intuitive that direct strike might be the most likely to cause fatalities.



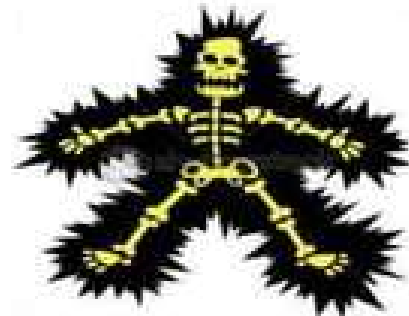
Contact Injury

- It occurs when the person is touching or holding an object to which lightning attaches such as wire fencing or indoor hard wired telephones or plumbing, transmitting the current to the person.



Side Flash or Splash

- It is the most frequent cause of injury 30 to 35% .
- Side flashes occur when lightning that has hit an object such as a tree or building travels partly down that object before a portion “jumps” to a nearby victim. Standing under or close to trees and other tall objects is a very common way in which people are splashed.
- it occurs also from person to person.





Blunt Injury

- persons may suffer from (non-electrical) blunt injury by being close to the concussive force of the shock wave which can induces intense muscle contractions that can 'throw' the victim.



■ Post-mortem Appearances:



The clothes are usually burnt or torn at the point of entrance and exit .

- In some cases the clothes may be stripped of the body and thrown to some distance .
- In exceptional cases:
 - _clothing is not damaged even if the person is killed by lightning . conversely Clothing may be burnt without any injury to the person .
 - The expanded displaced air causes disruptive or blast like lesions e.g ruptures of organs , fractures ...etc
 - Rigor mortis may appear soon and pass off quickly.

- The burns maybe :
- 1/ liner : the are often found in moist creases and folds of the skin .
- 2/ Arbores or Filigree burns: they are superficial thin irregular and tortuous marking on the skin
- 3/ surface burns : they are true burns and occur beneath metallic objects worn or carried by the person which are fused by the flash . Internal findings are those of asphyxia
- Causes of death : Involvement of CNS with paralysis of respiratory canter causes death .



Medico-legal aspect

Less than half of person struck by lightning are killed .
Death is always due to accident sometimes
appearance left of human body closely resemble
those produced by criminal Violence .

Thus a person maybe found dead in an open field or on
highway and body may show contusions ,fractures
..etc in such cases the diagnosis should be based on
the history of a thunderstorm in the locality ,
evidence of effect of the lightning in the vicinity of
the body and fusion of metallic substance



Mechanism of Death



Mechanism of Death

1st it should be noted that after a person sustains a fatal electric shock , the victim may remain conscious for several seconds , giving them time to shout out , move away from or even unplug or turn of the source of electrocution

- Death results due to :
- fatal cardiac dysrhythmia :

Many electrocution deaths result from a fatal cardiac dysrhythmia induced by electrical current entering the body .



- **Direct effect of current on the heart, causing ventricular fibrillation**
- **Ventricular fibrillation:**
- **Commonest mechanism of death**
- **Associated with passage of current through the heart**
- **Current acts on cardiac myocytes, nodal tissue and conduction tracts**



- Direct effect of current on the respiratory muscles causing respiratory paralysis
- Paralysis of respiratory centers : Occurs rarely when the current passes through the brainstem causing disruption of neural function of the respiratory center due to direct effect of current or due to resultant hypothermia
- Muscular paralysis including diaphragm may cause death via asphyxial mechanism .



- Death may also be caused by
 - Thermal effects of the current: in high voltage electrocution can also result in severe electrothermal injuries thus causing death .
 - Trauma caused by the current
 - Drowning associated with exposure to electrical current:
Reported cases where individuals in swimming pool drowned following contact with electric shock
 - Multi-organ failure complicating primary stress due to current
 - In some cases in low voltage electrocutions a shock that might not be lethal in and of itself may lead to 2ry injury and death .





Autopsy Findings



Autopsy Findings

- Electrical injuries can be separated into three main groups
 - Direct tissue damage caused by current
 - Thermal damage from conversion of electrical to thermal energy
 - Traumatic injuries from muscular contractions causing bone fractures or injuries from falls



Skin changes

- Characteristic skin lesions
 - low voltage injuries at entry and exit points
- Present in 57 – 83 % of cases.
- The occurrence and severity of burns is dependent on
 - Amount of current flow per unit time
 - Voltage
 - Duration of exposure
- No lesions when low voltage passed for short duration



- The entry mark shows imprint of the conductor
- Pattern of electrical burns may indicate torture or homicide
- No marks seen if the contact point was broad
- Water considerably reduces resistance and also cools the skin preventing injury



- Stages of development of skin lesions:
- The current passes through the skin producing heat which causes boiling and electrolysis of tissue fluids.
- A well moistened skin may not show electrical burn, while a thick dry skin may show well-marked electrical burn.
- The electric mark (Joule burn): It is specific and diagnostic of contact with electricity and is found at the point of entry of the current.
- These marks are round or oval, shallow craters. one to 3 cm. in diameter, and have a ridge of skin of about one to 3mm high .



- Occasionally, the mark may have a distinctive pattern, that of the shape of the conductor. Rarely, the mark may be present as a circular hole, penetrating skin, muscle, and even bone, so as to simulate a bullet wound.



- These electric marks are produced by the conversion of electricity into heat within the tissues.
- They are commonly found on exposed parts of the body, especially on the palmar aspect of the hands

Burns

1/ Flash or Spark Burns:

- The intense heat which may result from flash-over produces burns, which resemble thermal burns
- The burns may be as small as pinpoint, or deeply seated and contracted if contact is prolonged or very high voltage is applied.
- If the area of contact is relatively large, e.g. when a hot wire is grasped with a wet hand, or when a person is electrocuted in bath tub, death may occur without any visible skin burning.
- High voltage burns may be very severe with charring of the body. Multiple individual and confluent areas of third degree burns are seen. Very high voltage currents produce massive destruction of tissue with loss of extremities and rupture of organs.



- When bone is involved, periosteum may be elevated or superficial layers of the bone may be destroyed or fracture may occur.
- Sometimes, multiple lesions are found in the region of flexures of a limb where the current has passed across the joints, instead of passing around it. high tension electrical currents may produce multiple discrete lesions due to arcing from the conductor to the body without direct contact.



- Multiple burnt or punched-out lesions are produced due to the arc dancing over the body surface over large areas which present 'crocodile flash burns'.
- Flash-over often produce 'arc eye'. There can be blast effect from very high voltage discharges.





2/Electric burns or splits:

- The splits are dry, hard, firm, charred, insensitive, with ragged edges, and their form is round, oval, linear, or of irregular shape.
- The depth of the lesion is much greater than appears on the surface. Shedding of the superficial layers of the skin is common, and some of this may be found attached to the conductor.
- Wrinkling of the skin may be found and occasionally localized oedema of a limb. Aseptic necrosis develops, which often extends beyond the burns in area and depth and may lead to sloughing.

- **Exit Marks:** These are variable in appearance, but they have some of the features of entrance marks.
- There may be more damage of tissues, and they are often seen as plits in the skin at points where the skin has been raised into ridges by the passage of current; splitting of these ridges may be continuous or interrupted.



Classical lesion





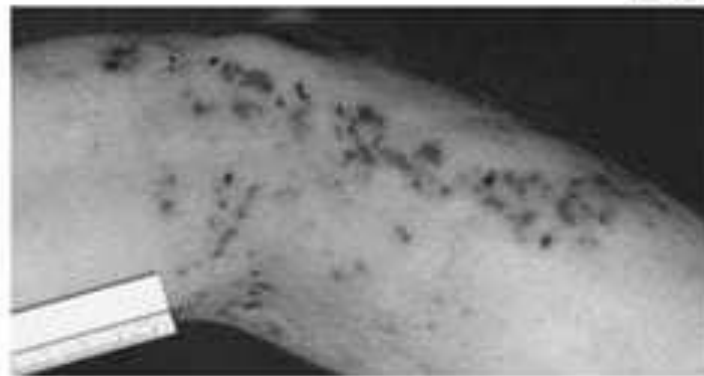
Arm with third degree burn from high-voltage line.



Series of lesions of "spark"



Deep charring of the foot



Multiple punctate burns of the arm

Post-mortem Appearances



External

- The face is pale, the eyes are congested and the pupils dilated.
- Rigor mortis appears early, and post-mortem lividity is well developed.
- In some cases, the lesions may extend through subcutaneous tissues and involve muscles and bone.
- A number of grayish-white circular spots, which are firm to the touch and free from zone of inflammation may be found at the site of entrance and exit.



- Severe convulsions caused by electrical discharge may cause fractures of the spine or limbs.
- In some cases, external lesions may be absent and frequently they are so slight as to require careful search. The clothing, including shoes, gloves and headgear should be examined for burns. Occasionally, only the hair is singed. Arcing of the current may produce characteristic pit-like defects on the surface of the hair.



- Any metallic objects on the body will produce corresponding burns on the skin because it becomes heated by the passage of the current.
- The color varies depending on the composition of the conductor, i.e., brown or black if of iron, or yellow-brown if of copper.
- This metallization is due to the volatilization of the metal, particles of which are driven into the skin. Metallization produced by low or medium voltage may be detected under



Internally

- The appearances are usually those of asphyxia.
- The lungs are congested and edematous
- Heart may show scattered foci of myocardial necrosis with sub-endocardial hemorrhage and contraction bands. These are non-specific findings.
- CNS findings are non-specific with reports of cerebral oedema, petechial hemorrhages, demyelination and cellular vacuolation
- Vascular injuries may result in damaged vessel intima and media that may lead to subsequent thrombosis or rupture or aneurysm if the individual survives .
- High amperage has an explosive effect and may produce injuries resembling bullet, stab or cut wounds.
- Small balls of molten metal, derived from the metal of the contacting electrode, so-called current pearls, may be carried deep into the tissues



- Soft tissue and visceral injuries may result from fall due to electricity causing muscular contractions.
- Heat generated by the current may melt the calcium phosphate, which is seen radiologically as typical round density foci ('bone pearls' pr 'wax drippings').
- Long bone fractures, vertebral crush fractures and joint dislocations may be caused directly by muscular contractions or secondarily from fall.
- A foetus may survive the electrocuted mother or a surviving mother may abort after electric injury. Occasionally, no lesions can be found either externally or internally.
- Death in these cases may be due to vagal stimulation.



Medico-legal Aspects

- Death by electric currents are usually accidental from defective electric appliances or negligence in the use of equipment. In industry, deaths may result from contact with live overhead cables or from handling of charged lamps, tools or switchgears.
- Rarely, death may occur during convulsive therapy to mental patients but cases of suicide, and even homicide have occurred. The viscera should be analyzed to know whether the victim was impaired at the time of the accident. Suicide is rare. A person usually winds wires round his fingers or wrists, which are then connected to the mains supply by means of a plug and the current is switched on.



- **Judicial Electrocution:** Death penalty is carried out in the electric chair in some states in the U.S.A. The condemned man is strapped to a wooden chair and one cap-like
- electrode is put on the shaven scalp which is moistened with a conducting paste and the other on the right lower leg, and a current of 2,000 volts and 7 amperes is passed for
- one minute through the body. After titanic spasm and loss of consciousness, the same current is passed through the body a second time for one minute.



electric chair



Conclusion

- Team approach with a clear description of the death scene, including photographic documentation of the body, scene and any nearby electrical devices or conductors.
- A complete autopsy with careful examination of clothing and body surfaces for subtle electrical burns is required.



- Clothes may show burns corresponding to contact with metallic conductors and torn clothing with burned shoes may implicate lightning.
- Careful examination of all body surfaces, including the flexor surfaces of the fingers, with photography and histological sampling of possible electrical burns is required.



**Not only Smile cost less
than Electricity
it Also BRIGHTENS ur day**

THANK YOU

