Patient Safety

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Physiological Effects of Electricity

- **Objective:**

Know the importance of patient safety against electrical hazard

- **Outcome:**

Analyze different types of Physiological effects due to electrical hazard in hospital environment

Physiological Effects of Electricity

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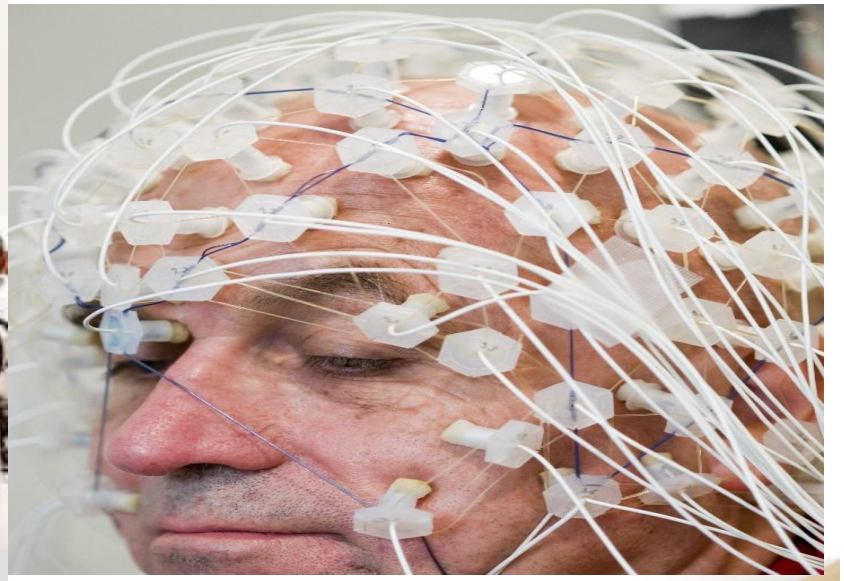
Physiological Effects of Electricity



Physiological Effects of Electricity

- Electrical Hazards

  Intentionally or Accidently

❖ Intentionally

High frequency current – Therapeutic and Surgical

Recording Signals

❖ Accidently

Defective Equipment

Faulty sockets

Operational Error (Human error)

Physiological Effects of Electricity

- The Physiological Effect is NOT due voltage, but the **CURRENT**

- Relation between Voltage and Current

$$I = V/R$$

- The current pathway and its resistance electrical shock

Physiological Effects of Electricity

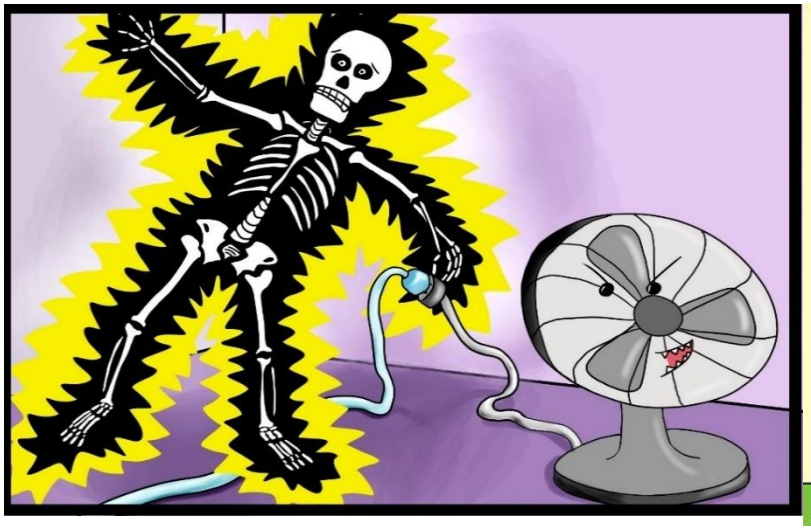
- **Power (P)** = Voltage x Current = V x I ≠ 0
- **Energy** = Power x Time

$$W = P \times t$$

So, the duration of current flow is also important.

Physiological Effects of Electricity

Activity Slide



Physiological Effects of Electricity

- Electric shock:

A sudden physiological stimulation when human body is a part of an enclosed current loop

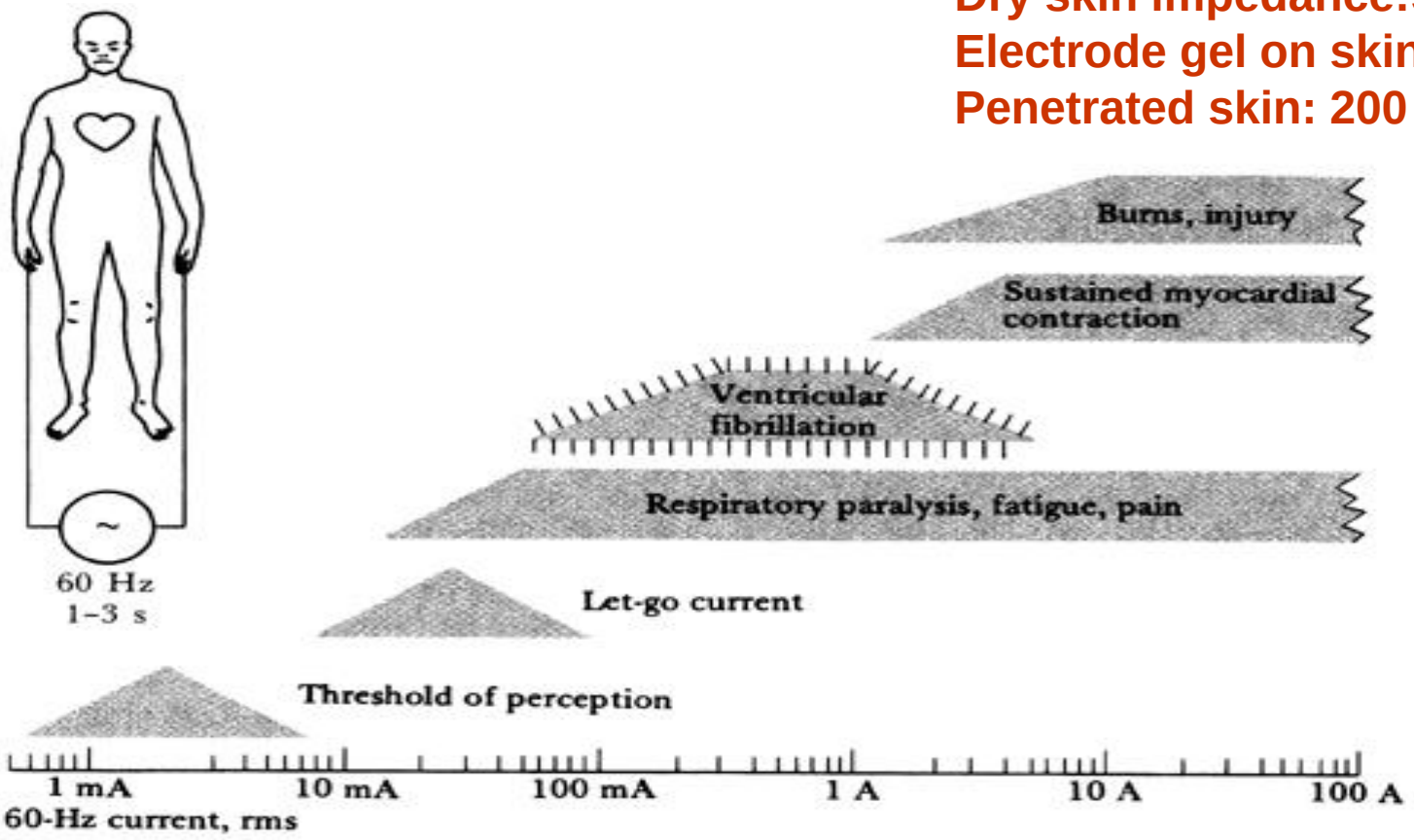
- One of three effects:

❖ Electrical stimulation of excitable tissue (muscles, nerve)
❖ Resistive heating of tissues
❖ Electrical burns / tissue damage for direct current and high voltages

Physiological Effects of Electricity

Physiological Effects of Electricity

Dry skin impedance:93 kΩ / cm²
Electrode gel on skin: 10.8 kΩ / cm²
Penetrated skin: 200 Ω / cm²



Physiological effects of electricity. Threshold or estimated mean values are given for each effect in a 70 kg human for a 1 to 3 s exposure to 60 Hz current applied via copper wires grasped by the hands.

Physiological Effects of Electricity

Current Intensity	Effect
• 1 mA	• Threshold of perception
• 5 mA	• Accepted as maximum harmless current intensity
• 10 - 20 mA	• Pain. Possible fainting, exhaustion, mechanical injury, heart & respiratory functions continue
• 100 - 300 mA	• Ventricular fibrillation will start but respiratory center remains intact
• 6 A	• Sustained myocardial contraction followed by normal heart rhythm. Temporary respiratory paralysis. Burns if current density is high

- **Threshold of perception**: The minimal current that an individual can detect. For AC (with wet hands) can be as small as 0.5 mA at 60 Hz. For DC, 2 ~10 mA
- **Let-go current:** The maximal current at which the subject can tolerate and voluntarily withdraw from the conductor . Muscle contractions, reflex withdrawals, secondary physical effects (falling, hitting head) may also occur

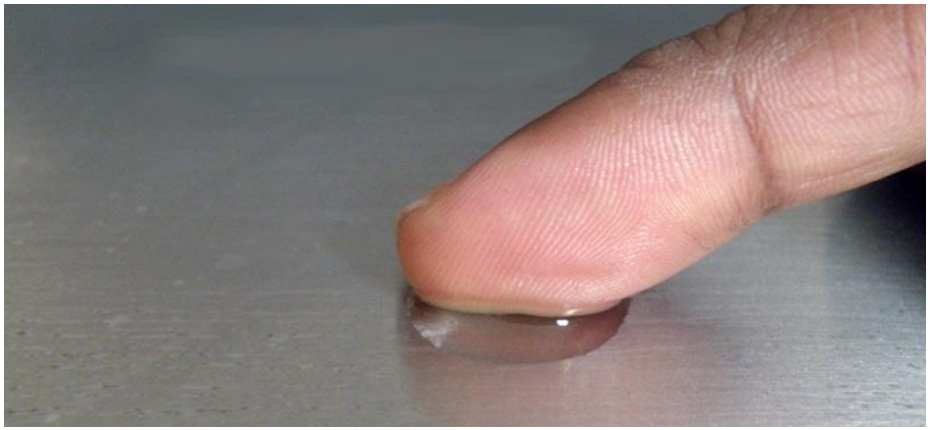
  Male: 16mA ; safe limit- 9mA

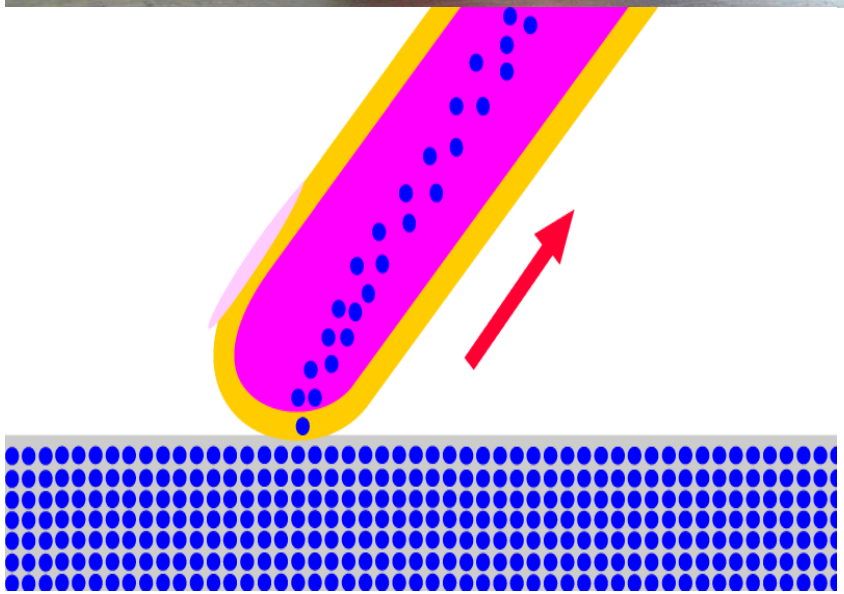
  Female:10.5mA ; safe limit-6mA
- **Physical Injury and Pain:** Above the Let go current the subject loses ability to control his own muscle action and is unable to release the grip on electrical conductor.

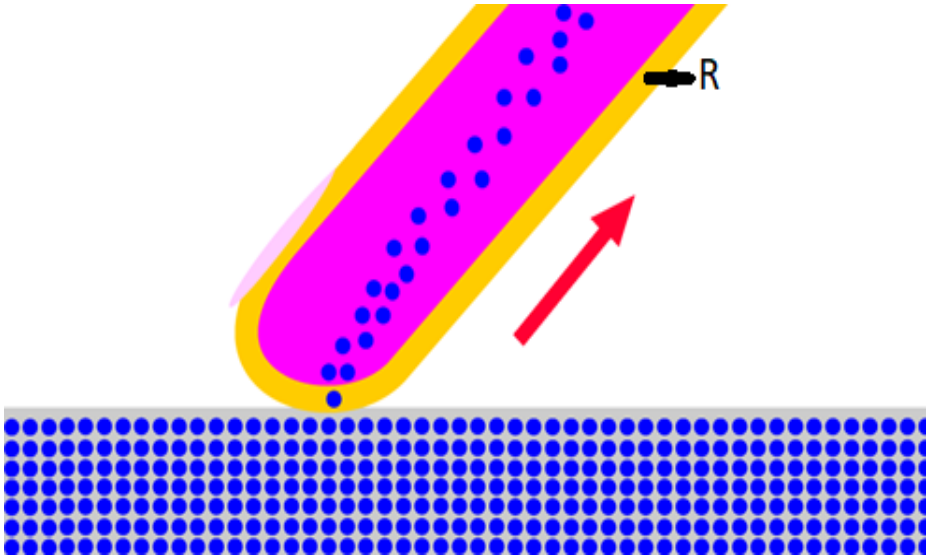
  Range: 20 – 100mA. Results in physical injury because of powerful contraction of the skeletal muscles. Heart and respiratory function continues.
- **Ventricular fibrillation above 100 mA** can cause heart muscles to contract uncontrollably, altering the normal propagation of the electrical activity of the heart. HR can raise up to 300 bpm, rapid, disorganized and too high to pump any meaningful amount of blood

- Pumping actions ceases, pulse disappear and fatal if not recovered within 5 min ventricular fibrillation –
- Normal rhythm can only return using a defibrillator.
- **Respiratory Paralysis / Pain /** Fatigue : **1-6A** , involuntary contractions of respiratory muscles can cause asphyxiation / respiratory arrest, if the current is not interrupted. Strong involuntary contraction of other muscles can cause pain and fatigue. Lead to Sustained myocardial contraction
- Burns and physical injury : Above 6 A, the entire heart muscle contracts and heart stops beating. This will not cause irreversible tissue damage, however, as normal rhythm will return once the current is removed. At or after 10A, however, burns can occur, particularly at points of entry and exit.

Physiological Effects of Electricity







Physiological Effects of Electricity

- The electrical resistance of the human body depends
  - Skin condition (dry, wet, type of gel or lotion used)
  - Parts of the body
  - Gender
- Resistance between two points x and y of a human body is

$$R_{xy} = r\frac{l}{A}$$

ρ – Resistivity that depends on material property

l - Length between x and y

A – Cross sectional area (area under the skin is important)

Physiological Effects of Electricity

- Dry skin has higher resistivity than wet skin
- Male usually have higher resistivity than female
- Thicker skin has higher resistance than thinner skin
- The resistivity of skin is much higher than that of muscle

Physiological Effects of Electricity

- Assesment

1.How is voltage related to current?

2. What happens to current when voltage increases?

3.Strength of electric shock depends on –

4.Write the value of Let go Current

5.Bring out the difference between ventricular fibrillation and myocardial