ELECTROCUTION

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I HAVE NO RELEVANT FINANCIAL RELATIONSHIPS TO DISCLOSE.
Case Presentation

- 61 year old man
Cause of Death

• Immediate Cause: Electrocution
• Manner of Death: Suicide
Prevalence - Deaths due to Electrocution

• Not common
  • 1000 per year
  • Lightning 150 per year
Electricity Distribution/Forms
Electrocution

• Types of electrocution
  • Low voltage  <600 V
  • High Voltage  >600-750 V

• Types of current
  • Alternating Current (electric power)
    • most common source of electrocution
    • 39-150 cycles/s are most lethal
  • Direct (batteries)
Sources of Current and Electrocution

• Residential Voltage: 110-120 V
  • Must make direct contact with body
  • Death by ventricular fibrillation
Factors

- **Amperage**
  - The amount of current flow
    - \( A = \frac{V}{R} \)

  - Resistance in residential current electrocution is the skin
    - Dry skin: 100,000 ohms
    - Dry calloused skin: up to 1 million ohms
    - Moist skin: 1000 ohms
    - Moist and thin skin: 100 ohms

  * Skin plays no significant role in High voltage electrocution
Death and Electrocution

• High Voltage electrocution
  • Death can be instantaneous
  • May cause irreversible respiratory paralysis

• Low Voltage electrocution
  • Loss of consciousness may not be occur immediately with ventricular fibrillation
Death and Electrocution

- Requires body acting as a circuit pathway from source to ground

- Vital organs susceptible to disruption by flow of electricity
  - Brain or spinal cord
  - Heart

- May remain conscious, speak or move for several seconds after fatal shock
Arcing

- Electricity may leap gap causing sparks
- Only occurs in high voltage electrocution
  - Air is poor conductor
- Resembles bright fast traveling sparks making rhythmic crackling sound
- Multiple small burns on skin or clothing
Arcing: Sources of Current and Electrocution

- Suburban/Urban High voltage lines: 7500-8000V
  - “Arcing”- current jumps to a person

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Distance Current Can Arc</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>Few mm</td>
</tr>
<tr>
<td>5000</td>
<td>1 cm</td>
</tr>
<tr>
<td>20,000</td>
<td>6 cm</td>
</tr>
<tr>
<td>40,000</td>
<td>13 cm</td>
</tr>
<tr>
<td>100,000</td>
<td>35 cm</td>
</tr>
</tbody>
</table>
Mechanism of Death

- Physiological Response to Electricity

<table>
<thead>
<tr>
<th>Amperage</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mA</td>
<td>Tingle</td>
</tr>
<tr>
<td>5 mA</td>
<td>Tremors</td>
</tr>
<tr>
<td>15-17 mA</td>
<td>Muscle contractions*</td>
</tr>
<tr>
<td>50 mA</td>
<td>Contractions of all muscle, respiratory paralysis, death**</td>
</tr>
<tr>
<td>75-100 mA</td>
<td>Ventricular fibrillation</td>
</tr>
<tr>
<td>~1A</td>
<td>Ventricular Arrest</td>
</tr>
<tr>
<td>7-12 A with 2000-2200V</td>
<td>Capital punishment electrocution</td>
</tr>
</tbody>
</table>

* Prevents releasing electrical source  
** Death will result if current is maintained
Injuries due to Electrocution
Injuries due to Electrocution

- High Voltage
  - Extensive burn injury

- Low Voltage
  - Little or no visible injury
  - Circumstantial scene evidence or witnesses important

**Diagnose electrocution based on:**
- Circumstances of death
- Negative autopsy
- Examination of electrical device
Scene Work Up

• Examine clothing
• Thorough examination of scene
  • Wet surface
  • Grounded appliance
  • Presence of GFCI (Ground-Fault Circuit Interrupter)
  • Properly wired outlet
  • Examination of equipment, cords, strips, etc.
• Consult qualified electrical specialist or fire marshal
Injuries- Conundrum

• Impossible to determine point of entry and exit of the current

• Appearance of burns
Autopsy Findings
Autopsy Findings

• Electrical burns
  • All high voltage electrocutions
    • Charring
    • Arcing: multiple small burns

• 50% of low voltage electrocutions

• Early onset of rigor mortis
Autopsy Findings - Low Voltage Electrocutions

- 50% of low voltage electrocutions
  - Point of entry / exit on the body
    - Erythematous (red), brown or yellow marks
    - Blistering
    - White chalky lesion
  - May see outline of current source

- Skin burn may
  - Crater-like appearance

- May see conductor material on skin or pieces of skin on conductor
Injuries

Blistering
Fractures and Electrocution

- Over 50 mA

- Propulsion of the body
  - Other blunt trauma possible
Manner of Death

- Accident

- Suicide

- Homicide
Lightning
Lightning

- Due to negatively charged undersurface of a thundercloud, send an electrical charge to the ground (form of Arcing)
Findings in Lightning Incidents

• Shredded clothes and shoes

• Burns on body that was in contact with metal

• Cutaneous burns

• Tympanic membrane rupture

• Death from high voltage direct current
Lightning

Lightning possesses

- 10 to 100 million volts
- Current of 10,000 to 100,000A
- Duration: less than one 10 thousandth of a second

- No burns, small burns or singeing of hair may be all that is seen

- May pass over surface of body and decrease amount of injury compared with current through body
Lightning

- <50% mortality rate

- Blast effect may throw victim
  - Causing blunt trauma injuries

- Tall objects attract lightning

- Tires and shoes inadequate for insulation since high voltage and amperage
Case of Lightning
Findings of Lightning
Lightning

- Metal objects on body may be melted or show arc marks
- Electronic devices may short circuit or ignite
- Iron or steel objects may become magnetized
Lichtenberg Figures

- Pathognomonic sign for lightning injury
THANK YOU!