



When Lightning Strikes: A Journey to Death and Back

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VCU Medical Center
Every Day, A New Discovery.

Ranked #1 in Virginia by U.S. News & World Report

An aerial night view of a hospital helipad. A white helicopter with blue and yellow markings is landing on the helipad, which is illuminated by a large white cross. The surrounding area is dark, with some lights visible on the building and the helicopter's landing lights.

Top care

The VCU Medical Center earns No. 1 spot in the state and ranks nationally in four specialties.

[read more](#)

**BEST
HOSPITALS**
U.S. News & World Report
**NATIONAL
RANKED IN 4 SPECIALTIES
2012-13**

VCU
Medical Center
MCV Campus

VCU Total Artificial Heart Program

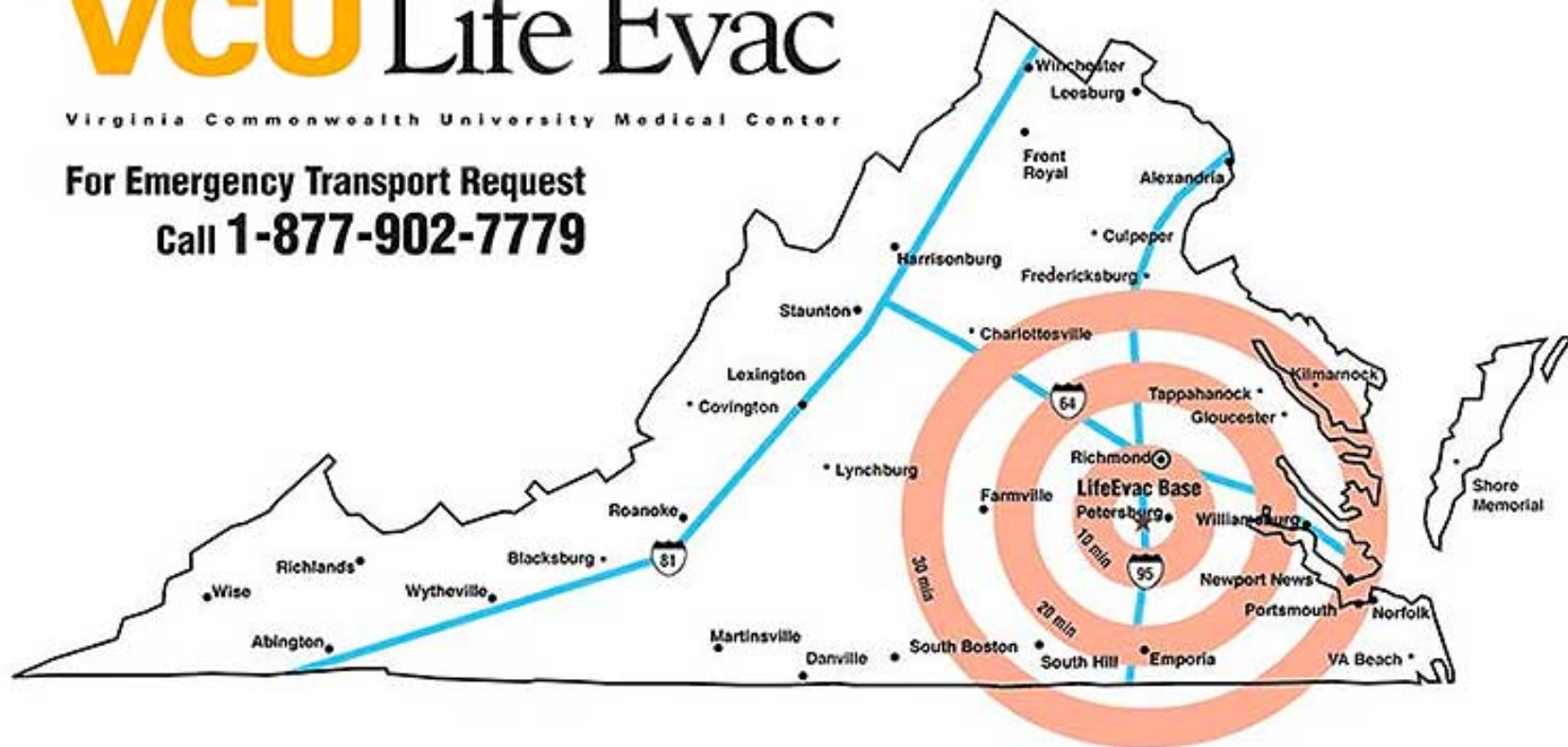




VCU Life Evac

Virginia Commonwealth University Medical Center

For Emergency Transport Request
Call **1-877-902-7779**





Lightning Injuries: Objectives

1. Statistical data
2. Mechanism of Injury
3. Injuries
 - a. Cardiac Injury
 - b. Neurological Deficits
 - c. Muscular-Skeletal / Burns
4. Treatments
5. Long term outcomes
6. Prevention

What are your chances?

- Winning the Lottery:

- 1 in 18,000,000



- Snake Bite or Bee Sting Death:

- 1 in 100,000



- Lightning Strike:

- 1 in 3,000

Statistical Data

- Continent with the most lightning strikes deaths?

- Africa



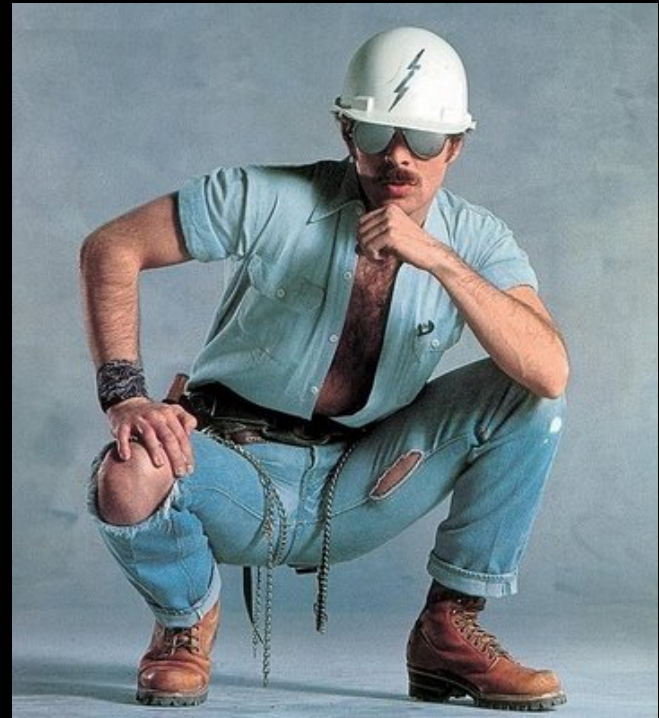
- States with the most lightning strikes deaths?

- Florida & Texas



At Risk Occupations

- Construction workers
- Farmers
- Military





911 Call



What is lightning?



How Does Lightning Occur?



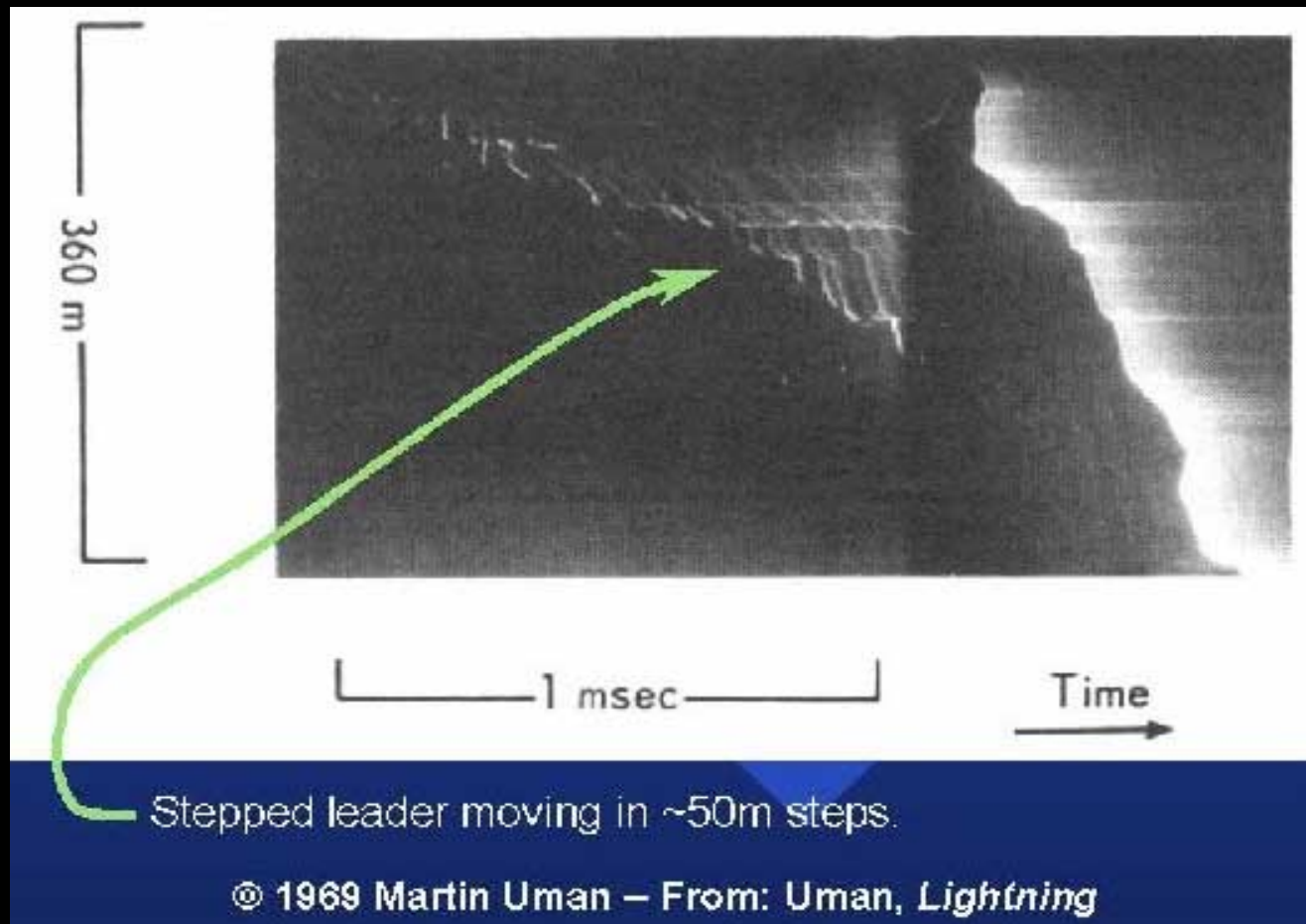
How Does Lightning Occur?



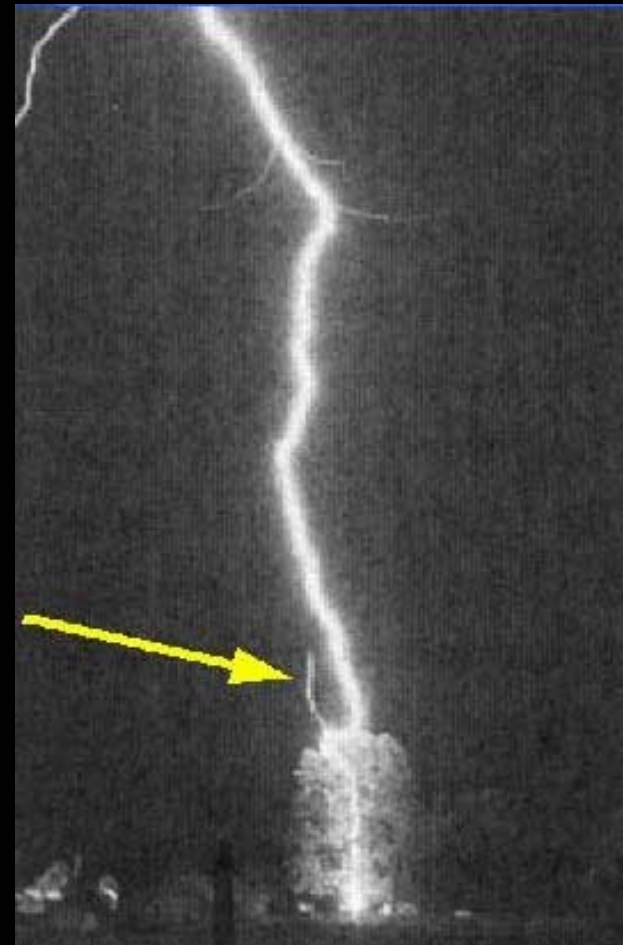
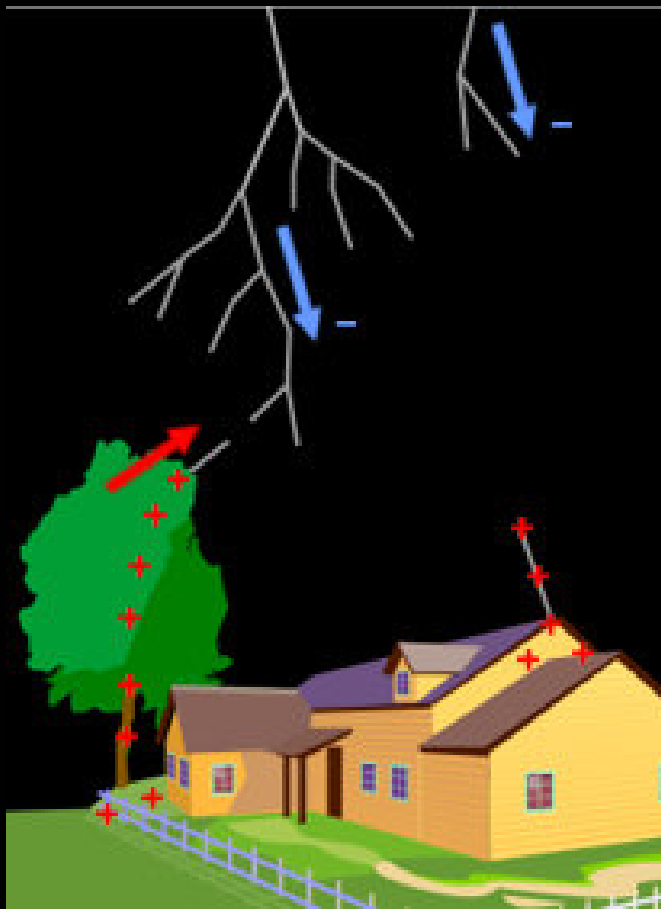
How Does Lightning Occur?



How Does Lightning Occur?



How Does Lightning Occur?



How Does Lightning Occur?

- Streamers can come from:
 - Trees
 - Antennas
 - Grass
 - Flagpoles
 - Telephone Poles
 - People
 - Tall Towers



How Does Lightning Occur?



How Does Lightning Occur?



How Does Lightning Occur?



www.gdargaud.net

How Does Lightning Occur?



How Does Thunder Occur?

- Air heats to 54,000 degrees Fahrenheit
- Air expands at an explosive rate
- A shock wave is created



How Far Away is That Lightning?

- Count the time between when you saw the lightning and when you hear the thunder.
- Every 5 seconds is equal to 1 mile.



Electrical Energy

Low Voltage:
(< 1000 volts)



High Voltage:
(> 1000 volts)



Electrical Energy

Lightning
current ranges
from 100
million to 2
billion volts.

The duration of
the strike may
be from
 $1/100^{\text{th}}$ to
 $1/1000^{\text{th}}$ of a
second.

Electrical Energy

Severity of
electrical injury
is dependent
on

- Time
- Voltage



Eyewitness Account

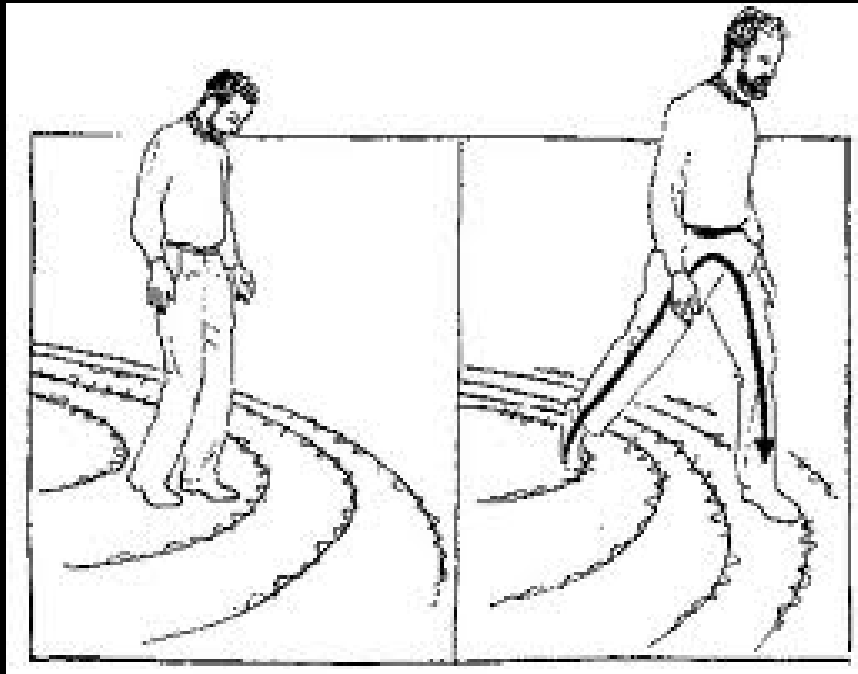


Mechanism of Injury

- Ground Current Injury/Step Voltage
- Flash Discharge
- Direct Strike
- Contact Injury
- Blunt Trauma

Mechanism of Injury

Ground Current Injury/Step Voltage:



- 50% of lightning injuries
- Current travels up one leg and down the other
- Usually not severe injury

Mechanism of Injury

Ground Current
Injury (Step
voltage)



Mechanism of Injury

- Flash discharge/
Side Flash/Side
Splash:
 - Lightning splashes
to objects around
first strike
 - Accounts 30% of
injuries
 - Multiple fatalities



Mechanism of Injury

- Direct strike:
 - Most lethal
 - Usually strikes the head
 - Uncommon, 5% of injuries



Mechanism of Injury



Mechanism of Injury

- Contact Injury:
 - Person is holding object being struck
 - Least common: 1 – 2 %



Mechanism of Injury

- Blunt Trauma/ Blast Injury:
 - Direct and non –direct injuries
 - Blast injuries from shockwave
 - Person is thrown by opisthotonic contraction





Physician Summary



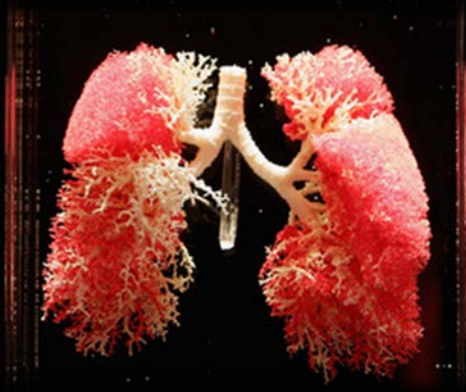
Pathophysiology

Resistance to
electricity from
greatest to
least:

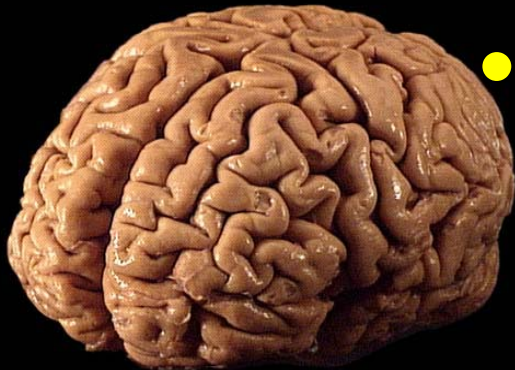


Bone
Fat
Tendon
Skin
Muscle
Blood Vessels
Nerves

Injuries



- Cardiac
- Respiratory
- Neurological
- Musculoskeletal
- Skin



Cardiac Arrest

- Most common cause of death
- Massive defibrillation (v-fib or asystole)
- Heart may restart, respirations won't
- 50 – 70% with arrest do not survive



Other Cardiac Findings

- Vasoconstriction:
 - Extremities cool, blue, mottled
- Hypertension
- Tachycardia
- EKG abnormalities
- Myocardial contusion



Neurological Involvement

- Acute:
 - Sympathetic response
 - Traumatic brain injury
 - Seizures
 - Keraunoparalysis



Neurological Involvement

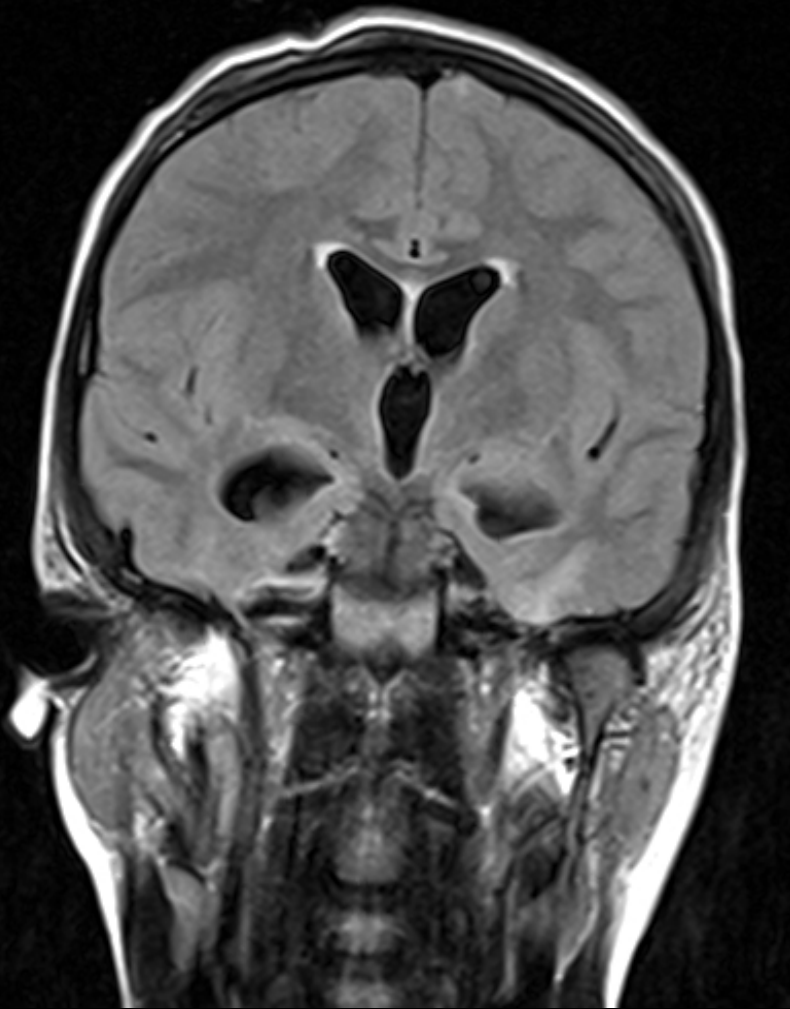
- Transient
 - LOC
 - Confusion
 - Amnesia
 - Headache
 - Numbness
 - Weakness



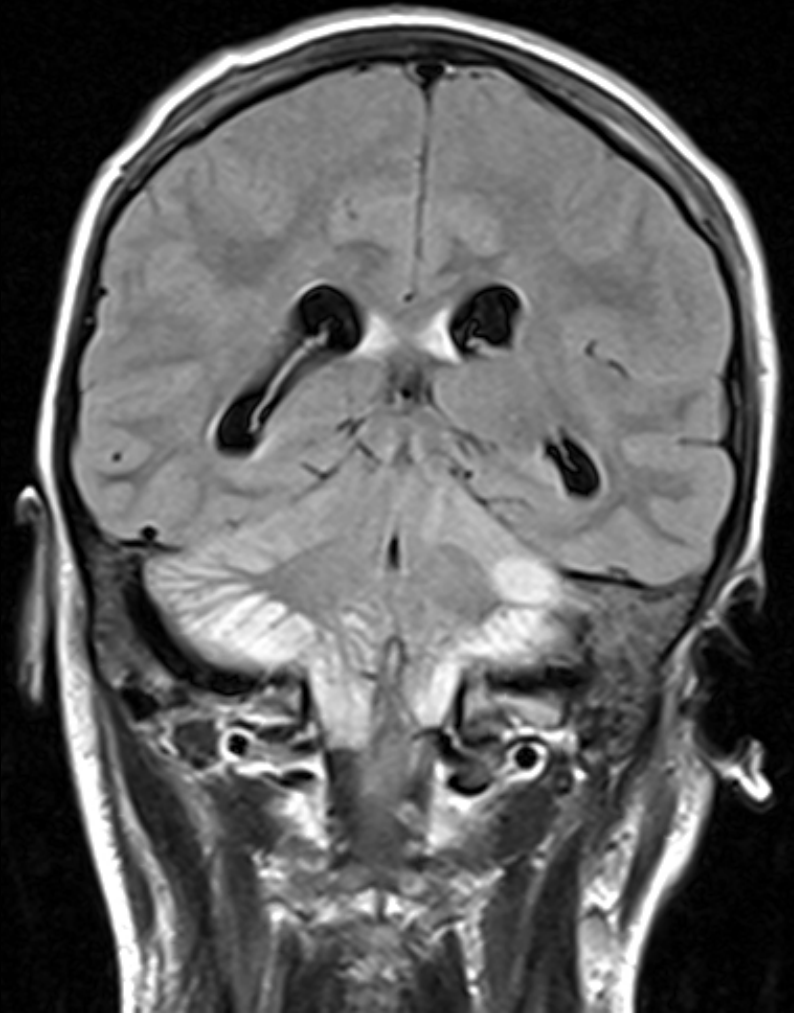
Neurological Involvement

- Immediate and Prolonged
 - Hypoxic ischemic neuropathy
 - Intracranial hemorrhage
 - Post arrest cerebral infarct
 - Post-hypoxic encephalopathy
 - Cerebral edema

Herniation Post Lightning Strike



Initial CT



5 days post strike

Neurological Involvement

- Chronic Neuro Symptoms:
 - Cognitive Changes
 - Depression
 - Mood Disorders
 - Sleep Disturbances
 - Headaches
 - Dizziness
 - Chronic Pain

Ears and Eyes



- Tympanic membrane rupture
- Temporary hearing loss

- Pupils fixed and dilated
- Caused by electrical damage
- May not indicate brain stem hypoxia



Ear Injury



Musculoskeletal



LEG FASCIOTOMY

Rhabdomyolysis
– Myoglobinuria





Burns Patterns

Flash

Linear

Punctate

Thermal

Feathering

Burns: Flash



- Flashover
- Follows external skin to ground
- Superficial

Burns: Linear



- Follows pattern of sweat
- Perspiration is vaporized

Burns: Linear



Burns: Linear



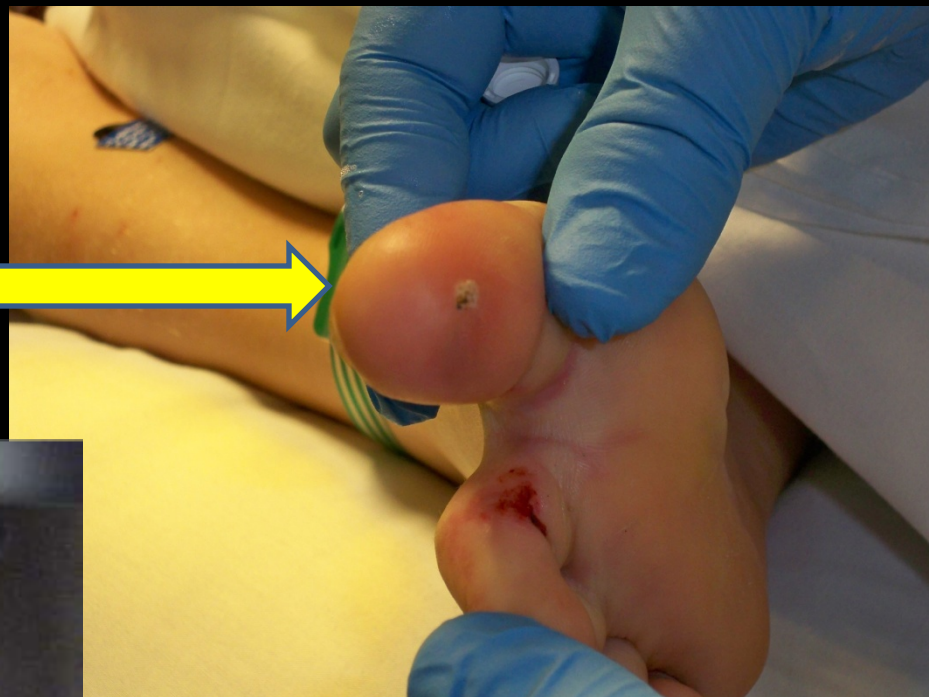
Burns: Punctate



- Current through dry skin
- Resembles cigarette burns

Burns: Punctate

“Tip Toe Sign”



Burns: Thermal

- Ignites clothing
- Heats metal



Necklace injury

Burns: Thermal



Necklace Injury



Post-mortem exploration



Burns: Feathering



Also called:

- * Lichtenberg Figures
- * Keraunographic Markings
- * Lightning Prints
- * Ferning

Burns: Feathering



Burns: Feathering



Treatment

- Your safety is the first priority





**Reverse
Triage!!!!**

Treatment

- AHA recommends: “vigorous resuscitative measures... even for those who appear dead on initial evaluation.”

Treatment

- ABC's
- Careful secondary survey.
 - Remove burning jewelry or metal
 - Scan for traumatic injuries
 - Immobilize
 - Careful neuro assessment
 - IV access (IO?)
- Rapid transport to ER



Treatment

In Hospital

- *12 lead EKG

- *Labs

- *X-ray

- *CT



Prevention



Side Flash

Prevention



- It's The Metal Shell That Protects You
- Just Don't Touch the Metal!

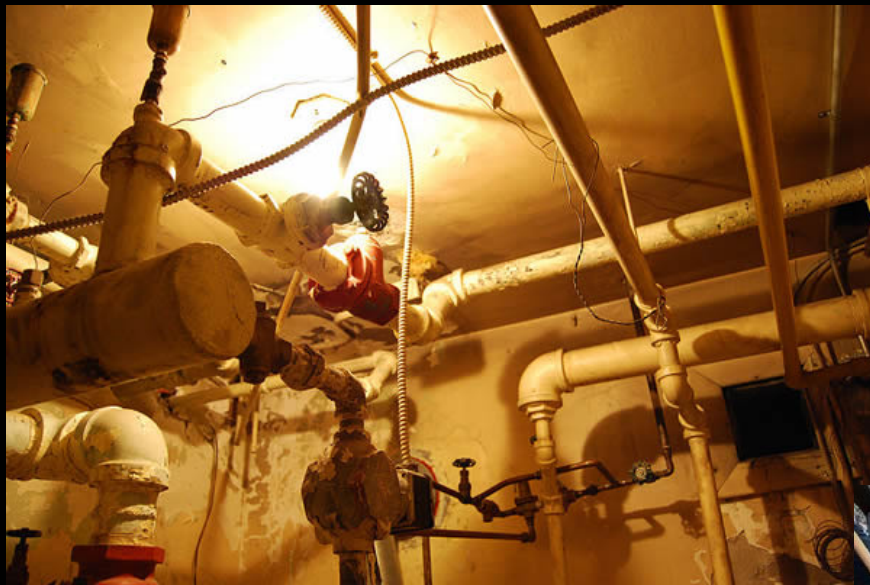
Note Current Arcing Across Tires

- Lightning Laughs At 2 Inches Of Rubber!

Prevention



Prevention



Prevention

6-10 miles



[C] Al Moller

An Amazing Recovery



THANK YOU

