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Goals

- Discuss basic Pathophysiology driving injuries
- Field management
- Avoidance
- Son's advice



Lightning vs High Voltage

Lightning:

- Millions of DC volts
- Very short duration
- Severe burns/muscle damage rare
- Cause of Death:Asystole or apnea

High voltage:

- >1000 volts AC or DC
- Prolonged
- Severe, deep tissue damage: "invisible"
- Cause of Death:Ventricular fibrillation



Types of Strike

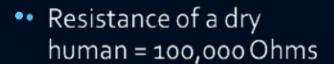
- Direct strike you are the electrode
- Contact strike touching the electrode
- Splash strike arcing off of the electrode
- Ground current



Brief Physics Review

- Ohm's Law:Voltage = Current * Resistance
 - (V = I*R)
- Joule's Law:

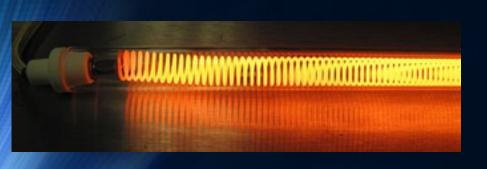
Heating Power α Current² * Resistance (P α I²*R)



- Resistance of wet human
 = 1,000 Ohms
- Ideal gas Law $\frac{PV}{nT} = R$

(R is a constant, in this case n is essentially constant)

 Any increase in Temperature, increases Pressure and Volume



Direct strikes

- Majority of strikes are to upper torso
- Sheep studies in Australia - Dr. Cooper
- Some enters eyes and ears - affects brainstem producing apnea and myocardial stunning
- Lichtenberg figures



Blunt Injuries

- Diffuse muscle spasm
- Due to concussive effects of change in Temperature:
 - Ruptured Eardrums (common)
 - Liver/spleen shearing
 - Long bone fractures (rare)



Field Management



- Stay out of strike zone
- ABCDE's
- CPR in field until respiration/pulse
- Oxygen
- IV: gentle hydration
- Cardiac monitor

Prevention

- Non-metallic shelter
- Insulation from ground
- Avoid tall and/or metal structures
- Stay dry
- Crouch, but don't lie down



HYPERTHERMIA

Hyperthermia is elevated body temperature due to failed thermoregulation that occurs when a body produces or absorbs more heat than it dissipates.

Human Thermoregulation 101

HEAT PRODUCTION

- Basal Metabolic Rate (BMR) (100 kcal/hr)
- Shivering (500 kcal/hr)
- Physical activity (200+ kcal/ hr)
- Medications

HEAT LOSS

- Radiation (60%)
- Evaporation (sweat/lungs)
- Conduction (cold/wet surface)
- Convection (wind)
- Medications

What causes hyperthermia?

Risk Factors:

- Dehydration
- Lack of acclimatization
- Humidity
- Exercise
- Impaired temperature regulation (Alcohol)



- Average daytime July temp in Qatar 106 F
- Players burn 700-900 kcal/hour

Heat Illnesses

- Heat Exhaustion
 - Nausea/vomiting
 - Cramps
 - Sweating/chills
 - Dizziness



- Heat Stroke
 - Core temp: >40-41C
 - AMS
 - Profuse sweating or dry (late finding)



Field Management



- Shade
- Fan ideally with mist or wet cloth covering
- Ice bags/cool water immersion
- Cool oral liquids
- Wipe sweat to renew evaporative surface area

ED/EMS Management

- Cool IV fluids
- Warm mist and fan
- If comatose: intubate and paralyze decrease BMR
- Treat seizures with benzodiazepines



Prevention

Hydration

 Loose clothing with a loose weave +/- dark colored

Avoid alcohol

Acclimatization, if possible

Timed exertion, if possible



"Why do Bedouins wear Black Robes in Hot Deserts" *Nature* **283**, 373 - 375 (24 January 1980)

