Common Environmental Disorders of Homeostasis: Hypothermia, Hyperthermia, and Dehydration

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Mechanisms of Heat Exchange

- Evaporation
- Radiation - sun’s rays
- Convection - wind
- Conduction - water, snow, ground
Evaporation

• Sweat evaporates cooling body
• Fluid evaporates from lungs as well
• High humidity prevents evaporation and thus cooling
• Some clothing aids and some impedes evaporation
Radiation

• Emission of heat as light (visible and non-visible spectrum)
• Examples: fire and sun
Convection

- Heat transfer due to flow within a medium
- Examples:
  - A cool breeze on a hot day
  - Cold currents in a warm ocean
Conduction

• Transfer of heat from a warmer to cooler object in contact with each other

• For example sitting on a hot rock or cold snow
Maintenance of Homeostasis

• System
  – Hypothalamus (thermostat)
  – Hands/head/feet (sensor)

• Regulation
  – Behavioral
  – Peripheral vasoconstriction/vasodilation
  – Shivering/Sweating
  – Metabolic heat production
What is hypothermia and how do you get it?

- Core body temperature below 95° F
- Mechanism of heat loss:
  - Convection to wind
  - Conduction to water
Recognizing Hypothermia

Mild (95°-90° F):

• Elevated HR and RR
• Shivering
• Decreased dexterity
• Unsteady gait
• Poor judgment
Recognizing Hypothermia

Moderate (90°-82° F):

- Depressed HR and RR
- Shivering stops
- Worsening mental status
- Arrhythmias
Recognizing Hypothermia

Severe (< 82° F):

- Muscle Rigidity
- Loss of voluntary movement
- Coma
- Arrhythmias
- Death (68° – 82° F): highly variable
Treatment: Prevention

- Intelligent planning
- Adequate Fluids
- Adequate Food
- Shelter

- Clothing that Provides:
  - Wind Protection
  - Water Protection
  - Wicking Layer
  - Insulation

- Focus on main sensory sites:
  - Head/neck protection
  - Hand/feet Protection
Treatment: Mild Hypothermia

- Add Dry Clothing
- Shelter from elements
- Purposeless exercise
- Re-warm and/or into sleeping bag (w/person if necessary)
- Warm liquids and food
Treatment: Moderate to Severe Hypothermia

- Persons unconscious/stuporous
- Require active re-warming because cannot generate enough heat to recover
- Handle gently: cold heart prone to arrhythmias
- Lots of heat needed - fire or boiling water in tent is ideal - with proper ventilation!
- Hot water bottles or rocks - groin, armpits, neck, chest
- Evacuation to a warmer environment
- Core re-warming in a hospital setting
Caveat

No one should be considered cold and dead until they are warm and dead!!
Localized Cold injury: A word about Frostbite

- Localized severe hypothermia = frostbite
- Associated with body hypothermia
- Treatment is slow re-warming of tissue
- Works best in first 24 hours
- Water bath is best: 100° – 108° F
- Usually 30-60 minutes adequate – until tissue pliable
- **Do not** re-warm if freezing may recur
Cold Water “Near Drowning”

- Appear dead – blue, cold, no detectable pulse or breathing
- Mammalian “dive reflex” may cause this
- Very cold water
- Infant or child usually
- May survive with prolonged CPR
Hyperthermia and Heat Illnesses
Hyperthermia, what is it?

• Core body temperature >98.6°F
• Characteristics:
  – Elevated HR and RR
  – Flushing
  – Dizziness
  – Fatigue
  – Seizures and altered mental status in severe cases
How do you get Hyperthermia?

- Evaporative cooling key when ambient temperature is above body’s
- Does not work in humidity > 75%
- Classic Hyperthermia: often elderly or sick unable to leave hot environment
- Exertional Hyperthermia: often young and healthy, strenuous exercise in hot environment
Treatment: Prevention

- Light colored, thin, breathable clothes
- Shed insulation (lose weight)
- Seek shade if possible
- Lots of cold fluids
- Avoid hottest part of day or season
- Take it easy when hot
Treatment: Mild Hyperthermia

- Rest in shaded, cool area
- Remove equipment and clothing
- Cold fluids with electrolytes
- Rapid cooling of body
  - Sponge or towel individual with cool water
  - Fan the individual
- May try to resume activity if good recovery
Treatment: Severe Hyperthermia
“Heat Stroke”

- Core body temperature > 105° F
- Similar symptoms to mild hyperthermia but worsening mental status and level of consciousness
- Treat as above plus:
  - Ice packs etc. to groin, armpits
  - Immerse in cold water bath
  - Be prepared for CPR
  - Evacuate to medical facility
Heat Illnesses: Localized forms

• Heat Rash
  – “prickly heat”
  – Red, raised rash
  – Sensation of prickling and tingling during sweating
  – Due to blocked sweat glands that become inflamed
  – Usually occurs when skin stays continuously wet
  – Mainly on areas of the body covered by clothing

  ● TREATMENT
    ● Gold Bond or talcum powder
    ● May use a hydrocortisone cream to relieve discomfort
    ● Stay dry, remove clothes
• Heat Illnesses: Localized forms

• Heat Cramps
  – Body temperature usually normal
  – Painful, involuntary muscle spasms
  – Caused by excessive water and electrolyte loss
  – Common during and after exercise in extreme heat
  – Usually in large (leg) muscles
  – Treatment is rest, passive stretching, massage, shade, cold fluids with electrolytes
Dehydration

- Definition: depletion of intracellular body fluid (ICF)
- Total body water (TBW) makes up ~60% body volume

$$\frac{2}{3} \text{ TBW} = \text{ICF}$$  $$\frac{1}{3} \text{ TBW} = \text{ECF}$$
Dehydration

- Sweat is hypotonic (less salty than blood and cellular fluid)
- Exercise with inadequate fluid intake → blood more concentrated/saltier (sucks up body water)
- Exercise w/excess pure water intake → blood becomes less salty, rarely cause hyponatremia (low sodium)
- Hyponatremia a potentially fatal problem
Dehydration – Contributing Factors

- Heat
- **Altitude**
- Exertion
- Inadequate fluid intake
- Caffeine and alcohol
- Medications
Signs of Dehydration

- Thirst
- Little urine output
- Dark yellow or orange urine
- Light headed – especially upon standing up
- Muscle cramps
- Pale skin
Treatment of Dehydration

- Fluids w/electrolytes: Sports drinks
- Gatorade or other sports drink (potentially dilute)
- Drink small amounts often for prevention
- If drinking a lot of pure water, eat/take in salt to prevent hyponatremia
- Evacuation for IV fluids rarely needed
- Very dehydrated persons often confused and may refuse fluids