Environmental Emergencies
Temperature Regulation

• Core temperature
  – The temperature of deep structures of the body, such as the liver, as compared to temperatures of peripheral tissues.
  – Core temperatures usually do not vary more than 1° – 2 ° from the normal 98.6°F or 37°C, where the body functions best
  – The body’s ability to maintain core temperatures is through *Homeostasis*
Homeostasis

• Homeostasis is the maintenance of a relatively internal environment.
• Homeostasis uses Negative Feedback which regardless of whether the temperature rises or falls at the “receptor” in the brain, a variation outside normal limits triggers an automatic response that corrects the situation.
• Thermoregulation also aids in maintaining body temperature
Thermoregulation

In this diagram the letter “A” represents the control center which is located in the brain. The letter “B” represents the response which is negative feedback.
Temperature Regulation

• Metabolism
  – The combination of all chemical processes that take place in living organisms, resulting in growth, generation of energy, elimination of wastes & other bodily functions as they relate to the distribution of nutrients in the blood after digestion

Metabolism = Generation of energy = Heat as a byproduct
Temperature Regulation

• Internal heat
  – Comes from routine cellular metabolism
  – Shivering can further generate heat through skeletal muscle contraction
  – Heat can be generated through strenuous exercise, greatly increasing metabolic rates

• Environmental heat
  – We receive heat via the *thermal gradient*
    • The difference in temperature between the environment & the body
  – If the environment is warmer than the body, heat flows from it to the body
**Temperature Regulation**

- **Controlled by hypothalamus**
  - Located in the base of the brain, functions like a thermostat & controls many metabolic activities

<table>
<thead>
<tr>
<th>TOO HOT!</th>
<th>Just right!</th>
<th>TOO COLD!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vasodilates</td>
<td></td>
<td>Vasoconstricts</td>
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<tr>
<td>🟢perspiration</td>
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<td>🔻perspiration</td>
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<td>🔻heat production</td>
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<tr>
<td>🟢cardiac output</td>
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<tr>
<td>🟢respiratory rate</td>
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</tbody>
</table>
Temperature Regulation

• Based on heat loss versus heat gained
• If heat loss exceeds heat gain ⇒ hypothermia
• Hypothermia
  – A state of low body temperature, specifically low body core temperature below 35ºC
  – Heat loss occurs by:
    • Radiation
    • Convection
      – Windchill
    • Conduction
      – Water chill; immersion
    • Evaporation
    • Respiration
Mechanisms Of Heat Loss

**Convection**
Body heat is lost to surrounding air, which becomes warmer, rises, and is replaced with cooler air.

**Respiration**

**Evaporation**
Body heat causes perspiration which is lost from the body surface when changed from liquid to vapor.

**Radiation**
Body heat is lost to nearby objects without physically touching them.

**Conduction**
Body heat is lost to nearby objects through direct physical touch.
Exposure To Cold

• Generalized hypothermia
  – Overall reduction in body temperature

• Local cold injury
  – Damage to body tissues in a local part or parts of the body
Generalized Hypothermia

• Mild hypothermia - 34°C – 36 °C
  – Shivering, not under voluntary control
  – Unable to do complex motor functions (i.e. skiing)
    but can still walk & talk
  – Periphery vasoconstricted

• Moderate hypothermia - 30°C – 34 °C
  – ‘Dazed’ consciousness – “I don’t care…”
  – Loss of fine motor coordination, particularly hands
  – Slurred speech, violent shivering
  – Irrational behaviour
    • Taking off clothes, unaware they are cold
Generalized Hypothermia

- Severe hypothermia - ≤ 30°C
  - Shivering stops as the body attempts to preserve glucose
  - As the patient eventually collapses, assumes a fetal position to conserve heat
  - Muscle rigidity develops due to ↓ peripheral bloodflow & ↑ lactic acid & CO₂ buildup
  - Skin pale
  - Pupils dilated
  - Patient bradycardic
Generalized Hypothermia

• Predisposing (co-morbid) factors
  – Cold environment
    • Immersion
    • Non-immersion
  – Age
    • Old
    • Young
      – Small with large surface area
      – Less body fat
Generalized Hypothermia

• Predisposing (co-morbid) factors
  – Medical conditions
    • Shock
    • Head injury
    • Burns
    • Generalized infection
    • Injuries to spinal cord
    • Diabetes or hypoglycemia
  – Drugs/Alcohol/Poisons
Signs & Symptoms of Hypothermia

- Obvious exposure
- Subtle exposure
  - Ethanol ingestion
  - Underlying illness
  - Overdose/poisoning
  - Major trauma
  - Outdoor resuscitation
  - Ambient temperature decreased
    - Home of the elderly patient
Signs & Symptoms of Hypothermia

• Cool/cold skin temperature
  – Abdomen

• Decreasing mental status or motor function
  – Poor coordination
  – Memory disturbances
  – Reduced or loss of sensation to touch
  – Mood changes
  – Less communicative
  – Dizziness
  – Difficulty speaking
Signs & Symptoms of Hypothermia

• Stiff or rigid posture
• Muscular rigidity
• Shivering - present or lack of
• Breathing
  – Early: rapid
  – Late: shallow, slow or absent
• Slowly responding pupils
• Pulse
  – Early: rapid
  – Late: slow, barely palpable; irregular or absent
Signs & Symptoms of Hypothermia

- Low to absent blood pressure
- Poor judgement - i.e., removes clothing
- Joint, muscle stiffness
- Skin
  - Early: red
  - Late: pale, cyanotic, stiff or hard
Signs & Symptoms of Hypothermia

- **Below 68°F (20°C)**
  - Fixed, dilated pupils.
  - Coma.
  - Flaccid muscles.
  - Slow respiration.
  - Slow or rapid heart rate.
  - Possible cardiac arrest.

- **68°F to 82°F (20°C to 28°C)**
  - Cyanosis.
  - Fixed, dilated pupils.
  - Unresponsive.
  - Barely detectable vital signs.
  - Irregular pulse.
  - Cardiac arrest.

- **82°F to 86°F (28°C to 30°C)**
  - Dilated pupils.
  - Diminished reflexes.
  - Stupor or coma.
  - Rigid muscles.
  - Slow breathing rate.
  - Hypotension.
  - Slow heart rate.

- **86°F to 90°F (30°C to 32°C)**
  - Cold, waxy skin.
  - Puffy face, possibly pink.
  - Confusion.
  - Muscle rigidity, no shivering.
  - Slow heart rate.

- **90°F to 95°F (32°C to 35°C)**
  - Cold, pale skin.
  - Alert and shivering.
  - Poor muscle coordination.
  - Rapid breathing.
  - Rapid heart rate.

- **95°F to 98°F (35°C to 37°C)**
  - Cold, pale skin.
  - Alert and shivering.
  - Poor muscle coordination.
  - Rapid breathing.
  - Rapid heart rate.
Windchill & Immersion Hypothermia
Emergency Medical Care -
Generalized Hypothermia

• SAFETY!
• Remove the patient from the environment
  – Protect against further heat loss or wind chill
• Remove wet clothing
• Avoid rough handling
• Do not let the patient exert themselves
• Administer oxygen
• Monitor core temperature, if possible
• Monitor cardiac rhythm, if possible
• Assess pulses for 1 - 2 minutes before starting CPR
Emergency Medical Care -
Generalized Hypothermia

• If the patient is alert and responds appropriately:
  – Actively rewarm:
    • Warm blankets
    • Hot packs to groin, axillary & cervical regions
    • Patient compartment temperature hot

• If the patient is unresponsive or responding inappropriately:
  – Passively rewarm:
    • Warm blankets
    • Patient compartment temperature hot
Emergency Medical Care -
Generalized Hypothermia

• Do not allow patient to eat or drink stimulants
• Do not massage extremities
Emergency Medical Care -
the Hypothermic VSA pt

• If VSA, initiate CPR
• If V-Fib, defibrillate up to 3 times

The patient is not dead
unless
they are warm & dead
Local Cold Injury

• Co-morbid factors
• Tend to occur on extremities; exposed ears, nose, face
• Frostbite
  – Localized condition in which specific body tissues freeze
  – Water lies in & around the cells. When water freezes, it forms ice swells, damaging the cells.
  – In severe cases this can lead to gangrene
Local Cold Injury

• Superficial frostbite
  – Affects the dermis & shallow subcutaneous layers

• Deep frostbite
  – Affects the dermal & subdermal layers of tissue
Local Cold Injury

• Signs & symptoms
  – Local injury with clear demarcation
  – Early or superficial injury
    • Blanching evident
    • Loss of feeling & sensation to the area
    • Skin remains soft
    • If rewarmed, tingling sensation
  – Late or deep injury
    • White, waxy skin
    • Firm to frozen feeling on palpation
    • Swelling may be present
    • Blisters may be present
    • If thawed, skin may appear flushed with areas of purple and blanching, or mottled and cyanotic
Emergency Medical Care -
Local Cold Injury

• General:
  – SAFETY!
  – Remove the patient from the environment
  – Protect the extremity from further injury
  – Administer oxygen
  – Remove wet or restrictive clothing
Emergency Medical Care -
Local Cold Injury

• If early or superficial injury:
  – Splint extremity
  – Cover extremity
  – Do not rub or massage
  – Do not re-expose to cold
Emergency Medical Care -
Local Cold Injury

• If late or deep cold injury:
  – Remove jewelry
  – Cover with dry clothing or dressings
  – Do not:
    • Break blisters
    • Rub or massage area
    • Apply heat
    • Rewarm
    • Allow patient to use affected extremity
Temperature Regulation

• If heat gain exceeds heat loss ⇒ hyperthermia
• Hyperthermia
  – Abnormal excess in body temperature
• Co-morbid factors
  – Climate
    • High ambient temperatures reduces the body’s ability to lose heat by radiation
    • High relative humidity reduces the body’s ability to lose heat through evaporation
  – Exercise and activity
    • Can lose more than 1L of fluid per hour through sweat
    • Loss of electrolytes (sodium, chloride and fluid)
Temperature Regulation

• Co-morbid factors to hyperthermia, con’t.
  – Age
    • Elderly
    • Newborn / infants
  – Pre-existing illness / conditions
    • Heart disease
    • Dehydration
    • Obesity
    • Fever
    • Fatigue
    • Diabetes
  – Drugs / medications
The Combination of Heat & Humidity
Signs & Symptoms of Hyperthermia

Three major categories:
- Heat cramps
- Heat exhaustion
- Heat stroke
Heat Cramps

• Most common
• Least serious
• Muscular spasms that occur when the body loses too much salt during sweating, not enough salt is taken in, when calcium levels are low or when too much water is consumed
Heat Cramps

• Signs & symptoms
  – Usually occurs in arms, legs or abdomen
  – Tachycardia
  – Diaphoresis
  – Faint, dizzy or exhausted
  – Nausea, vomiting
  – Mental status, temperature and BP are normal
Heat Cramps

• Treatment
  – Remove from environment
  – Administer saline solution PO *if conscious*
    
    ($\frac{1}{2} - 1$ tsp salt : liter of water)
  – Transport
Heat Exhaustion

- Occurs when volume and electrolytes lost through perspiration isn’t replaced, & remaining volume pools in vessels attempting to lose heat
- Most critical problem - dehydration
- Signs & symptoms
  - Headache
  - Extreme weakness, fatigue
  - Dizziness, faint
  - Decreased appetite, nausea, vomiting
  - Normal - slightly elevated body temperature
Heat Exhaustion

• Signs & symptoms, con’t.
  – Dilated pupils
  – Weak, rapid pulse
  – Rapid, shallow breathing
  – Pale, cool, diaphoretic skin
  – Possible heat cramps
  – Collapse
Heat Exhaustion

• Treatment
  – Remove the patient from the environment
  – Cool the patient
  – Administer saline solution PO if conscious
    (¼ - 1 tsp salt : liter of water)
  – Assess vitals & transport
Heat Stroke

• An acute, dangerous reaction to heat exposure
• Results when the body fails to cool itself sufficiently – perspiration stops!
• Body temperature can reach in excess of 105°F / 40.5°C
  – The body loses hypothalmic temperature regulation
• Heat stroke can cause brain damage
Heat Stroke

- Signs & symptoms
  - Deep, rapid breathing that becomes shallow
  - Dilated pupils
  - Rapid, strong pulse
  - Decreased BP
  - Altered LOC (dizziness, weakness to combativeness)
  - Hot, red skin
    - Initially can be very wet, followed by very dry skin
  - Seizures
  - Coma
Heat Stroke

• Treatment
  – SAFETY!
  – Remove the patient from the source of the heat
  – ABC’s
  – Patient compartment temperature to low
  – Begin cooling with irrigation saline and cold packs to axillae, groin, neck
  – Monitor temperature, if possible
  – Monitor cardiac rhythm, if possible
Bites & Stings

• Hymenoptera envenomation most likely encounter

• Signs & symptoms
  – History of bite or sting
  – Pain, erythema and/or edema at site
  – Weakness, dizziness
  – Chills
  – Nausea, vomiting
  – Angioneurotic edema
Bites & Stings

• Treatment
  – Scrape stinger out if present. Do not use tweezers
  – Remove jewelry
  – Place injection site below level of heart
  – Watch for anaphylaxis, treat as needed
Drowning & Near Drowning

• Drowning
  – Death from suffocation due to submersion

• Near drowning
  – Survival, at least temporarily, from near suffocation due to submersion
Drowning & Near Drowning

• Causes:
  – Exhaustion
  – Losing control, getting swept into deeper water
  – Losing a support
  – Getting entangled in water
  – Concurrent drug or alcohol ingestion
  – Poor judgement
  – Hypothermia
  – Suffering trauma
  – Diving accident
Drowning & Near Drowning

• Certain factors will impact survival rates:
  – Cleanliness of the water
  – Length of time submerged
  – Age & general health (co-morbid factors) of the victim
  – Water temperature
Drowning & Near Drowning

• “Wet” and “dry” drowning
  – Wet: occurs when fluid is aspirated into the lungs
  – Dry: occurs when laryngospasm cuts off respiration but does not allow aspiration of a significant amount of water into the lungs

• Fresh vs salt water drowning - water follows salt
  – Fresh water: less salt in the water than body fluids so water leaves the lungs & enters the blood
  – Salt water: more salt in the water than body fluids so water leaves the blood & enters the lungs

• “Secondary” drowning
  – Refers to complications (inflammatory & immune response) that arise minutes to days post-incident
Drowning & Near Drowning

*Never go out into the water to attempt a rescue unless you:*

- Are a good swimmer, and;
- Are specially trained in water rescue techniques, and;
- Are wearing a PFD, and;
- Are accompanied by other rescuers
Drowning & Near Drowning

• Treatment
  – SAFETY!
  – Always suspect a spinal injury in a diving accident
  – Hypothermia?
  – Full assessment
    • DO NOT use Heimlich maneuver to remove water from lungs
  – CPR & SAED as required