Cold injuries; Hypothermia, frostbite

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Objectives

- Define Hypothermia, frostbite/frostnip, chilblains, trench foot
- Describe the anatomy and physiology of thermoregulation
- Describe risk factors predisposing individuals to cold related injuries
- Describe the assessment and management of cold related injuries
  - Hypothermia and frostbite

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What is Hypothermia?

Heat is lost faster than it can be produced

- Core Body Temperature (CBT) of < 35 degrees C (95 F)
  - Mild
    - 32-35 C (90-95 F)
  - Moderate
    - 28-32 C (82.4-89.9 F)
  - Severe
    - < 28 C (82.4 F)
  - Profound
    - < 20 C (68 F)

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Hypothermia is also defined by type.

- Therapeutic or induced
  - Cardiac arrest patient with ROSC (32 – 36 C)
  - Severe Sepsis patient
  - Head/brain Injury
- Accidental
  - Exposure to cold environment
    - Acute
      - Sudden exposure to extreme cold, such as falling into cold water
    - Subacute
      - Prolonged exposure to cold environment without adequate protection
    - Chronic
      - Living or medical conditions
        - The very young, the elderly and those with preexisting conditions (diabetes, cardiac disease) are more susceptible to hypothermia

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Death from hypothermia is listed as either primary or secondary.

Primary
- Cold exposure

Secondary
- Hypothermia exacerbates a preexisting condition
  - Trauma, diabetes, dehydration, malnutrition, alcoholism

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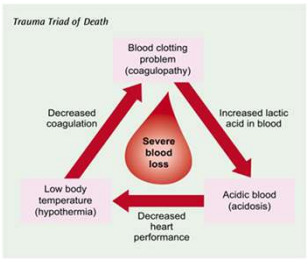
The significance of hypothermia in trauma



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How does the body produce and/or lose heat?

Body works very hard to maintain homeostasis. Normal body temperature of 37 C (98.6 F).
The body produces heat through
- Metabolism (processing of nutrients, water and CO2)
- Voluntary large muscle movement
- Shivering
- Increasing metabolic rate (endocrine)

- Thermoreceptors send information to the hypothalamus
  - Skin, muscles, central receptors in core(triggered by blood temp changes)
- The hypothalamus sends signals which bring about adjustments to maintain body temperature – thermogenesis
  - Skin – body's thermostat Skin plays vital role in body temperature regulation.
  - Can both conserve and liberate heat energy through skin
  - To liberate heat, blood flow to skin can increase up to 8 L/min and 60% of cardiac output.
  - In cold, blood flow can approach zero in certain areas.

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Thermoreceptors and hypothalamus cont.

- When skin receptors becomes cold - triggers shivering (no change in CBT)
- When muscle receptors are triggered- voluntary movement- increased metabolism- shivering increases- shunting of blood from skin- increased RR- increased HR
- (Shivering continues until store of glycogen is depleted or until CBT <90 F, once shiver stops there is a rapid cooling and drop in CBT)
- When core receptors are triggered- Shunting of blood to core- assuming nutrients are still available increased metabolism- shunting of blood away from muscles cause them to become stiff and movement difficult

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Heat exchange occurs based on the temperature gradient where the warmer object/environment gradually loses heat to the colder object/environment.

- Conduction
  - Direct physical contact
- Convection
  - Moving air or liquids
- Radiation
  - Electromagnetic waves
- Evaporation
  - Conversion of liquid to gas

Use these same principles to help with rewarming

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Those at highest risk to develop Hypothermia
- Children
- Elderly
- Homeless
- Mentally Ill
- Those at risk for increased heat loss
  - Impaired thermoregulation (EtOH, drugs, burns, sepsis, trauma)
- Those that fail to produce heat
  - Endocrine problems
  - Medications (phenothiazines, barbiturates)
  - Hypoglycemia and malnutrition

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SIGNS AND SYMPTOMS OF HYPOTHERMIA

Mild CBT 32 – 35 C (90 – 95 F)
- Shivering
- Fatigue
- Increased RR
- Increased HR
- Hunger
- Nausea
- Mild confusion
- Loss of sensation
- Some difficulty with speech and fine motor coordination
- Pupils slow to react
- "umbles" in early stages:
  - Stumbles
  - Mumbles
  - Fumbles
  - Grumbles

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Cont.

Moderate 28-32 C (82.4-90 F)
- Shivering stops
- Worsening of fine motor skills beginning of difficulty with gross motor skills
- Worsening confusion inability to do simple tasks/follow simple commands
- Slurred speech
- HR and cardiac output begin to decline and progressively decrease as CBT declines
- RR declines
- Cardiac dysrhythmias and cardiac arrest can occur anytime after 86-88 F
- Dilated pupils

Severe < 28 C (82.4 F)
- Extreme confusion (paradoxical undressing, extreme risky behavior, apathy, terminal burrowing)
- Labored slow shallow breathing
- Weak and/or irregular pulse
- Cardiac dysrhythmias (a-fib most common)
- Coma

Profound < 20 C (68 F)
- Unconscious
- HR and output have declined to less than 80% of normal and will progress to pulselessness

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Treatment

Basic principles

- Handle the patient gently.
- Passive rewarming
  - Remove the patient from the environment.
  - Remove (wet) clothing.
  - Dry the patient.
  - Wrap in warm blankets/insulate from cold
  - Cover head
  - Turn up heat in ambulance

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Active external rewarming

- Heat packs in the groin, armpits, and on the chest
- Maintain SpO2 >94% use warm humidified O2 if available
- Warmed IV fluids
  - Be conscious of after-drop
    - Cold acidotic blood from extremities
      - Drop in CBT
      - Drop in BP
      - Pulmonary edema
        - Consider advanced airway
      - Cardiac arrest (pulses/signs of life may be difficult to detect)
        - Start CPR
          - PEA
            - CPR only (warm IV fluid)
          - V-fib/pulseless V-tach
            - Single defibrillation single dose EPI
            - Antiarrhythmics are ineffective and may be dangerous
          - Asystole
            - Single dose EPI
- Continue resuscitation efforts well beyond the 30 min.
- Hypothermic patients are not dead until warm and dead

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Frostbite/frostnip/chilblains/trench foot

Freezing and non freezing local cold injuries

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Chilblains

- Caused by chronic exposure to damp, nonfreezing ambient temperatures
- Painful, inflammatory lesions on skin
- Hands, ears, lower legs, feet common sites
- Rash, burning, numbness, blisters, red/purple
- Tends to recur
- Rewarm, bandage, elevate

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Trench foot

- Caused by prolonged skin exposure to cool, wet conditions
- Skin becomes pale, mottled, anesthetic
- Sloughing, gangrene may occur
- Clean, warm, dry bandages; elevation


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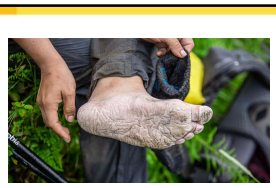




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Frostbite/frostnip

- Pathophysiology: Phase I
  - Exposure to cold
  - Vasoconstriction
  - Decreased blood flow to periphery
  - Ice crystal formation in extracellular space, ischemia
  - Cellular dehydration
  - Edema
  - Increased pressure, blood vessel damage
  - Worsened ischemia
  - Destruction of cellular components

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- Pathophysiology: Phase II
  - Tissue is rewarmed
  - Blood flow returns
  - Damaged capillaries leak fluid
  - Swelling occurs
  - Sludging of blood, thrombus formation occurs

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Frostbite/frostnip

- Local freezing of tissue
- Commonly affected areas:
  - Toes, feet
  - Hands, fingers
  - Nose (unprotected, decreased perfusion)
  - Ears
- Risk Factors
  - Poor clothing
  - Poor nutrition
  - Diabetes
  - Decreased tissue perfusion
    - Tobacco, tight clothing
  - Vasodilation
    - EtOH, medications

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Frostnip

- Extremity appears pale, discomfort present
- No extracellular ice crystal formation
- Symptoms resolve on rewarming
- Tissue loss does not occur

Frostbite

- Signs/Symptoms
  - 1st degree
    - Partial skin freezing; redness, mild edema; lack of blisters
  - 2nd degree
    - Full thickness skin freezing; substantial edema, formation of clear blisters
  - 3rd degree
    - Full-thickness skin and subcutaneous freezing; hemorrhagic blisters, skin necrosis, bluish-gray discoloration
  - 4th degree
    - Full-thickness damage affecting muscles, tendons, bones; little edema, initially mottled or cyanotic, eventually dry, black, mummified

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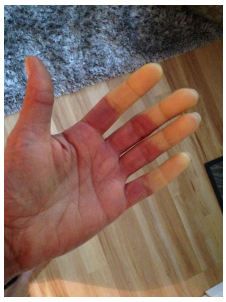
Frostnip


Frostnip through gloves in the midwest

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Frostbite

1st degree

2nd degree

3rd degree

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4th degree

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Frostbite

- Extent of injury frequently cannot be determined until rewarming occurs
- Management: Short transport
  - ABCs
  - Protect affected area
    - Bandage
    - Avoid rewarming, thawing
  - Prevent, treat hypothermia
    - Remove wet or constrictive clothing and jewelry
    - Dry patient
    - Warm IV fluids
  - Minimal analgesics (NSAIDS Tylenol, Advil, Motrin) for pain

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- Management: Long transport
  - Remove patient from cold
  - Remove clothing from affected area
  - Rewarm in water 100 - 105^{0}F until flushing/tingling present (if you can assure no refreezing)
  - Dry gently, bandage
  - Treat concurrent hypothermia
  - Analgesia for pain (NSAID Tylenol, Advil, Motrin) Narcotics once thawing is well underway

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- Do NOT:
  - Allow refreezing
  - Massage injured part
  - Allow patient to smoke, consume alcohol or caffeine
  - Puncture or drain blebs

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Questions

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