Wilderness Management of Temperature Related Disorders: Hyperthermia, Hypothermia & Frostbite

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Hot & Cold
Learning Objectives

• Discuss clinical presentation, *field* evaluation and management of patients with environmental hyperthermia, hypothermia & cold injury
Principles

• Prevention
• Assessment
• Decision
• Management
• Re-Assessment
• Decision
• Management...
Case Presentation

• Late July day in the city of Richmond. 4 person med station at a triathlon of 500 people.

• Daytime temperatures are >100 F with high humidity

• 2 racers come over to your area after they finish.
  • #1 is confused, talking about how cold he is. Skin is dry and he is drinking a beer to celebrate his finish.
  • #2 is alert, complaining of severe cramps, diffusely sweating.

• Traffic is blocked so evacuation is delayed
Hyperthermia
Risk Factors

- Elderly
- Neonates
- Obesity
- Alcoholism
- Dehydration

- Hyperthyroidism
- Medications
- Drugs of abuse
- Socioeconomic
- Confinement
TAKE HOME POINT:

Usually these illnesses occur in the extremes of age.

EXCEPTION

Organized events where you may be working as a standby

Healthy Athletes

Intoxicated Adults
Heat Illness - Physiology

- Under normal circumstances the body maintains its temperature within a range permitting normal physiology to occur.

- Small deviations in either direction may result in dramatic changes in physiology.
Heat Illness - Physiology

• Many of the reactions that occur at the cellular level of exothermic

• They combine to comprise our basic metabolic rate (BMR)
Heat Illness - Physiology

• At rest, a 70-kg human being generates approximately 100 kcal / hour

• Unopposed, this internal heat production would increase the body temperature 2 degrees Fahrenheit / hour
Heat Illness - Physiology

- Moderate activity generates an additional 300-600 kcal / hour
- Solar radiation adds an additional 150 kcal / hour
Heat Pathophysicsiology

- **Thermoregulation**
  - Overall heat load is dissipated to maintain body temp of 37 deg C
  - At less than 1 deg C, peripheral and hypothalamic thermoreg centers are activated
    - Vasodilation increases blood flow to skin by up to 8 liters per min
      - Initiates sweating
    - Evaporation of 1.7mL of sweat will consume 1 kcal of heat energy
    - At maximal efficiency, sweating dissipates 600 kcal per hr
    - Loss of salt and water leads to 2 ltrs or more per hr
Thermoregulation

The CNS receives information from thermosensors and triggers the thermoregulatory response

• HUH??????
Thermoregulation

- Heat illness results when the body’s thermoregulatory mechanisms are overwhelmed
- It is a spectrum of conditions from very mild to life threatening
Regulation of Body Temp

- Evaporation
- Radiation
- Conduction
- Convection
Evaporation

- Most efficient cooling mechanism
- Includes respiratory loss and sweat
- Accounts for 30% of heat dissipation at average external temperatures
- The major cooling mechanism as external temperatures reach 95°F and higher
Into Thin Air
Radiation

- Transfer of heat between the body and the environment via electromagnetic waves
- Over 50% of cooling when ambient temps are less than body temp
- The biggest reason to cover up well, especially the head, in cold temps
Heat Radiates
Conduction

• Transfer of heat between two objects that are in direct contact
• Heat loss is minimal except in certain circumstances
  – Water immersion – rapid heat loss when water is next to skin
  – Lying on the cold ground
http://www.youtube.com/watch?v=dylOGbJtw-4
Convection

- Heat transfer between the body and a moving gas or liquid – typically air and water
- The rate of heat transfer is dependent on
  - Speed of the air or water
  - Temperature of each substance
- In still air about 25% of heat is lost to convection
- Wind chill factor is secondary to convection
• Convection
  =
• Wind
Heat Illness

3 Stages of Injury

- **Acute**: activation of inflammatory mediators
- **Enzymatic**: abnormalities of coagulation leading to DIC
- **Late**: multi-system organ failure
  - Hepatic dysfunction
  - Renal dysfunction
  - CNS injury
  - Cardiovascular dysfunction
Heat Illness

Physiologic Response

• Shunting of blood
  – Vasodilatation, especially the skin
  – Splanchnic vasoconstriction
• Increased cardiac output
• Increased catecholamines activate sweat glands
• Hypothalamic-regulated reduction of heat production
Heat Illness

Pathophysiology

• Physiological responses deteriorate as cardiac output reaches its limit
• Electrolyte losses and dehydration worsen the progression to heat illness
• Heat illness occurs when the body is unable to maintain a normal body temperature
Heat Cramps

- Painful muscle spasms
- Typically unilateral and involve the calf muscle
- Caused by replacement of water/salt losses with hypotonic solution
- Relative hyponatremia with involuntary and sustained skeletal muscle contractions
Heat Cramp Treatment

• Mild cases
  – Oral salt replacement
  – Add ¼ to ½ teaspoon of table salt to a quart of water

• Severe cases: IV normal saline

• TAKE HOME: ORAL IS BETTER!!
Heat Syncope

- Orthostatic hypotension due to
  - Volume depletion
  - Peripheral vasodilatation
  - Decreased vasomotor tone
- Blood pools in the legs with resultant poor cerebral perfusion
- Often not profoundly dehydrated or hyperthermic
- Typically the poorly acclimatized or elderly
- Usually occurs in standing, stationary individuals
Heat Syncope Treatment

- Lie the patient flat
- Elevate the feet
- Remove from direct sunlight
- Oral rehydration
Heat Illness

- Heat edema
- Heat rash
- Heat cramps
- Heat tetany
- Heat syncope
- Heat exhaustion
- Heat stroke
Heat Exhaustion

• Patients present with flu-like symptoms / signs including fatigue, weakness, headache, dizziness, vertigo, nausea, vomiting, muscle cramps, tachycardia, hypotension, diaphoresis, etc.
Progression from heat exhaustion/stress to heat stroke

• Due to:
  – Thermoregulatory failure
  – exaggeration of acute-phase response
  – alteration of heat-shock proteins
Reminder, there is more to heat injury than just heat.
Heat Stroke

- A form of hyperthermia associated with a systemic inflammatory response leading to a syndrome of multiorgan dysfunction in which encephalopathy predominates

*NEJM 2002*
Heat Stroke

- The hallmark is **CNS dysfunction** including confusion, delirium, ataxia, seizures, hemiplegia, and coma

- Classic heat stroke
  - Heat waves

- Exertion heat stroke
  - Fit athlete
Incidence of heat stroke

- During heat waves in urban areas
  - 17.6-26.5 cases per 100k in US
  - 22-250 per 100k in Saudi Arabia depending on season
    - 50% mortality
- Very young or elderly, poor, socially isolated, no air conditioning
• In the summer of 2006, much of the United States and Canada went through another deadly heat wave. In this case, 225 people died.

• Chicago

• California
# Heat Illness

<table>
<thead>
<tr>
<th></th>
<th>Heat Exhaustion</th>
<th>Heat Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symptoms</strong></td>
<td>Nausea, vomiting, headache,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>dizziness, muscle cramps, malaise, etc.</td>
<td></td>
</tr>
<tr>
<td><strong>Signs</strong></td>
<td>Dehydration, tachycardia,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>hypotension, hyperventilation</td>
<td></td>
</tr>
<tr>
<td><strong>Sweating</strong></td>
<td>Present</td>
<td>Present or absent</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>Typically &lt; 104 F (40 C)</td>
<td>Typically &gt; 104 F</td>
</tr>
<tr>
<td><strong>CNS</strong></td>
<td>Normal</td>
<td>Abnormal</td>
</tr>
</tbody>
</table>
Hyperthermia

- The mainstay of treatment of heat stroke is rapid cooling and supportive care

- Patients may exhibit evidence of multi-organ failure

- Early recognition and initiation of treatment is the key to success
Heat Stroke - Pitfalls

• Failure to consider the diagnosis (altered mental status, etc.)
• Failure to measure the temperature
• Failure to initiate cooling methods quickly
• Overcooling
• Prescribing antipyretics
• Failure to evacuate early and/or call for help!!!
• http://www.youtube.com/watch?v=WyV_D4VzCLo&feature=related
Field Treatment

- ABC – BLS care
- Removal from hot environment
- Removal of clothing / gear
- Vital signs (BP/ HR/ RR/ rectal temperature?)

DECISION → evacuate? Call for help?
- Altered mental status = bad
- Obtunded = very bad
- Seizure = really, really bad
  - *Duration of hyperthermia may be the primary determinant of outcome!!!*

- Manage & Re-Assess!
Treatment

• The mainstay of treatment is rapid cooling and supportive care
  
  – Rapid cooling is defined as a rectal temperature of $\leq 38.9$ C (102 F) within a 1 hour of presentation to the emergency department
Treatment - Pharmacology

• Pharmacologic agents generally not helpful

• No role for anti-pyretic agents

• Shivering may be controlled with a variety of medications including chlorpromazine, meperidine, diazepam, clonidine – benzo’s are best
Treatment - Rapid Cooling

- H2O!!! Continual soaking or wrap in soaked garments in coldest water available; constantly fanning the patient
- Placement of ice packs in the groin, axilla, behind the neck
- IV fluids
- Spray patient with tepid water and fan
- Cooling blankets
Forms of Cooling

• Evaporation is our bodies best way of dissipating heat....but
• Conduction is the fastest treatment method of cooling
Case Presentation

• STOP!!!

• Assess: VS (temp?), mental status

• Decide: get out? Call for help? Manage here and re-assess?
Case Presentation

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Prevention
What if it is you?

- **Good hydration**
  - Hydrate with a goal of clear urine
  - Eat salt containing foods or add salt to water

- **Dissipate heat**
  - Wear loose fitting and light colored clothing
  - Avoid direct sunlight when possible
  - Douse with cool fluids or cool misting spray

- **Heat acclimatization**
  - Decreases heat injuries and improves performance
  - Adults increase time and intensity over 7 to 10 days
  - Children and elderly require 10 to 14 days
  - May acclimatize by going into a sauna or steam room
What if it was your partner?
What if it’s the rookie who thinks he’s invincible?
Or someone who just should not be near anything hot?
Prevention

• Identification

• Anticipate the scenario → check weather forecast!!!

• Adequate water supply

• Do not push too hard in hard environments
And Here It Is, Your Moment of Zen
Up To Date

• Marathon runners
  – Hyponatremia

• Triathletes:
  – Pay attention during the swim
Hypothermia
Case

• Mt. Rogers in southern Virginia near the 5700 ft peak in January. Going for an overnight hike with a friend from the rescue squad.

• You come across a couple who appear to be in trouble…

• They are lost, and one of them is laying in the snow, minimally responsive and confused, woefully underdressed…
Hypothermia - Cold Illness

• Similar to heat illness, hypothermia results when the body’s thermoregulatory mechanisms are overwhelmed.
Hypothermia - Risk factors

- Decreased heat production
  - DKA, malnutrition, age extremes, impaired shivering
- Impaired thermoregulation
  - CVA, CNS trauma, toxic ingestion, SAH, neuropathies
- Increased heat loss
  - Immersion, exposure, burns, homelessness
- Miscellaneous
  - Trauma, infections
Hypothermia - Heat Loss

- **Radiation**
  - Temperature gradient between person and environment
- **Conduction**
  - Direct contact - submersion, damp, water, ground
- **Convection**
  - Objects in motion - air, wind-chill
- **Evaporation**
  - Conversion from liquid to gas
Hypothermia - Physiology

• Changes in physiology manifesting as signs and symptoms correlate with core temperature
<table>
<thead>
<tr>
<th>Stages of Hypothermia</th>
<th>Characteristics</th>
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</thead>
<tbody>
<tr>
<td><strong>Mild hypothermia</strong></td>
<td>• Reduced cerebral blood flow; confusion and irrational behavior</td>
</tr>
<tr>
<td>(32°C to 35°C)</td>
<td>• Vasoconstriction; pale, cool skin</td>
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<tr>
<td></td>
<td>• Increased heart rate and mean arterial pressure</td>
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<tr>
<td></td>
<td>• Tachypnea</td>
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<tr>
<td></td>
<td>• Shivering present, except in infants and neonates</td>
</tr>
<tr>
<td><strong>Moderate hypothermia</strong></td>
<td>• Further decrease in level of consciousness</td>
</tr>
<tr>
<td>(28°C to 32°C)</td>
<td>• Shivering is absent</td>
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<tr>
<td></td>
<td>• Muscle rigidity</td>
</tr>
<tr>
<td></td>
<td>• Skin may be cyanotic and edematous</td>
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<tr>
<td></td>
<td>• Decreased respiratory drive</td>
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<tr>
<td></td>
<td>• Reduced mucociliary activity and viscous bronchorrhea</td>
</tr>
<tr>
<td></td>
<td>• Reduced ventricular compliance leading to hypotension and dysrhythmias, particularly bradyarrhythmias and atrial fibrillation</td>
</tr>
<tr>
<td></td>
<td>• Pupils become dilated</td>
</tr>
<tr>
<td></td>
<td>• May have academia, mild clotting abnormalities, and paralytic ileus</td>
</tr>
<tr>
<td><strong>Severe hypothermia</strong></td>
<td>• Usually comatose</td>
</tr>
<tr>
<td>(22°C to 28°C)</td>
<td>• Pupils fixed and dilated</td>
</tr>
<tr>
<td></td>
<td>• Reflexes are absent, including corneal or oculocephalic reflexes</td>
</tr>
<tr>
<td></td>
<td>• Ventricular dysrhythmias; significant hypotension or absent pulse</td>
</tr>
<tr>
<td></td>
<td>• Vasoconstriction elevates venous pressure; “cold diuresis”; profound academia and prerenal failure</td>
</tr>
<tr>
<td></td>
<td>• CO₂ retention and respiratory acidosis; possible noncardiogenic pulmonary edema</td>
</tr>
<tr>
<td></td>
<td>• Respiratory arrest is likely</td>
</tr>
<tr>
<td></td>
<td>• Hypoperfusion leads to erosions and ulcerations of the gastrointestinal tract</td>
</tr>
<tr>
<td></td>
<td>• Hematologic changes include hemoconcentration, sludging, thrombocytopenia, leucopenia, and disseminated intravascular coagulation</td>
</tr>
<tr>
<td><strong>Profound hypothermia</strong></td>
<td>• Asystole develops</td>
</tr>
<tr>
<td>(&lt; 22°C)</td>
<td>• The EEG is flat</td>
</tr>
<tr>
<td></td>
<td>• The core temperature of the lowest reported accidental hypothermia survival in an infant was 14.2°C</td>
</tr>
</tbody>
</table>

- 32-35 = 90-95
- 28-32 = 82-90
- 22-28 = 72-82
- 22=72=RIP
## Hypothermia

<table>
<thead>
<tr>
<th>Core Temperature (F)</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>99.6</td>
<td>Normal rectal temperature</td>
</tr>
<tr>
<td>98.6</td>
<td>Normal oral temperature</td>
</tr>
<tr>
<td>96.8</td>
<td>Increased metabolic rate</td>
</tr>
<tr>
<td>95.0</td>
<td>Maximum shivering&lt;br&gt;thermogenesis</td>
</tr>
<tr>
<td>93.2</td>
<td>Increased respiratory and heart rate, dysarthria, poor judgment</td>
</tr>
</tbody>
</table>
## Hypothermia

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<th>Core Temperature (F)</th>
<th>Characteristics</th>
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</thead>
<tbody>
<tr>
<td>91.4</td>
<td>Respiratory suppression, bradycardia, cold diuresis, ataxia, apathy</td>
</tr>
<tr>
<td>87.8</td>
<td>Shivering stops</td>
</tr>
<tr>
<td>86.0</td>
<td>Decreased arrhythmia threshold</td>
</tr>
<tr>
<td>80.6</td>
<td>Loss of reflexes and voluntary movement</td>
</tr>
</tbody>
</table>
# Hypothermia

<table>
<thead>
<tr>
<th>Core Temperature (F)</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.2</td>
<td>Hypotension and bradycardia then Afib</td>
</tr>
<tr>
<td>71.6</td>
<td>75 % decreased oxygen consumption</td>
</tr>
<tr>
<td>68.0</td>
<td>Pulse 20 % of normal</td>
</tr>
<tr>
<td>64.4</td>
<td>Asystole</td>
</tr>
<tr>
<td>Core Temperature (F)</td>
<td>Characteristics</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>60.8</td>
<td>Lowest adult survival</td>
</tr>
<tr>
<td>59.2</td>
<td>Lowest infant survival</td>
</tr>
<tr>
<td>48.2</td>
<td>Lowest therapeutic survival</td>
</tr>
</tbody>
</table>
Warm and Dead
Treatment

• ABC → BLS care
• Careful removal from cold environment (if possible)
• Removal of wet or cold/ frozen clothes
• Vital signs (BP/ HR/ RR/ rectal temperature?)
• DECISION → evacuate? Call for help?
  – Shivering?
  – Altered mental status = bad
  – Obtunded = very bad
  – ‘field re-warming’ is a misnomer!!!
• Manage & Re-Assess!
Treatment

- Prevent further heat loss & re-warm!!!
- Protect from the ‘ground sink’ – *place something between patient and ground!!!*
- Get patient into warm garments/ bags
- Healthy humans are warm entities!!! Huddle & cuddle!!!
- Pack groin/ neck/ axilla with hot or warm water bottles/ reservoirs if able (fire up the camping stove!!!)
- Warm po fluids & calories if awake!!!
Treatment

• Patients with severe hypothermia may look dead
  – Cold
  – Blue skin
  – Fixed and dilated pupils
  – No discernable pulse
  – No discernable breathing
  – Comatose and unresponsive to any stimuli
  – Rigid muscles
Treatment

• Remember, you are not dead until you are warm and dead
  – Check for a pulse for a long time
  – Initiate CPR if no pulse
  – Initiate rewarming
  – You will need to continue CPR while rewarming occurs
Treatment

- Evacuate? Call for help?
- Continue to manage & re-assess!!!
Treatment

- Cardiovascular
  - Osborn waves / J-waves (80% @ 86 F)
  - Prolonged PR, QRS, QT intervals
  - Atrial arrhythmias
  - ST changes
  - Ventricular arrhythmias
  - Shivering artifact
  - Bradycardia
  - Asystole
Treatment - EKG

~ 80% of patients at 86 degrees Fahrenheit

Circulation (2000)
Treatment

• Cardiovascular
  – Cardiac arrhythmias (atrial) usually resolve spontaneously with re-warming
  – Cardiac pacing and atropine are generally ineffective
  – Bretylium may be useful for ventricular arrhythmias
    • If you know this medication, then you are at least as old as I am.
Treatment

• Re-warming
  – Passive
  – Active - internal or external
  – No statistically significant evidence that any one method is better than the others
  – BUT!!!!
Treatment

• Passive re-warming
  – Cover the patient in dry, insulating materials in a warm environment
  – Used in mild hypothermia
  – 0.5 - 4 degrees Celsius / hour
Treatment

• Active re-warming (internal and external)
  – Direct transfer of exogenous heat to the patient
  – Used in cases of moderate to severe hypothermia
    (T < 90 degrees Fahrenheit)
• http://www.youtube.com/watch?v=5VWLHOOoHa0&feature=related
Treatment

- Active external re-warming
  - Heating pads
  - Warm blankets
  - Bair Hugger
  - 1 - 4 degrees Celsius / hour
Treatment

• Active internal (core) re-warming
  – Airway re-warming
  – Heated infusion
  – Heated irrigation
  – Extracorporeal re-warming (cardiopulmonary bypass)
  – 0.5 - 10 degrees Celsius / hour
Treatment - Afterdrop

• Re-warming causes blood vessels in the extremities to vasodilate resulting in shunting of cold blood from the periphery to the core resulting in a decrease in the core temperature

• Can be best avoided by rewarming the core rather than the periphery
Treatment

• There are no validated prognostic indicators of the potential for recovery from acute profound hypothermia
Frost Bite
Cold Injuries

• Trenchfoot and frostbite together have accounted for over 1 million US casualties in WWI, WWII, and the Korean War.
Non-freezing Cold Injury

- Chill blain
- Pernio
- Trenchfoot
Chilblain

- Results from intermittent exposure to temperatures above freezing, usually accompanied by high humidity and moisture; 1 to 6 hours of exposure.
- Swelling, tingling pain, numbness with pink-to-red flushing of skin.
• Extremities will be puritic as they warm up.

• Symptoms usually subside overnight; some superficial scaling may occur.

• No permanent damage occurs.
Wintergreen Resort
Pernio

- Continuum of events from chilblain.
- Exposure for >12 hours to cold/wet conditions.
- Tight-fitting footwear can shorten exposure time and increase severity of injury.
- Swelling is more severe; pain is more persistent.
- Thin, partial skin thickness, necrotic patches (from dorsum of the hands or feet).
- Plaques may slough without scarring, but may be particularly painful for months or years.
Pernio

APPALACHIAN TRAIL

FOOT TRAFFIC ONLY
Trenchfoot

- Epidemiology/ Clinical Appearance.
- Occurs from prolonged exposure to cold wet conditions or prolonged immersion of feet at temperatures as high as 17°C for >12. Shorter duration at or near 0°C result in same injury.
- Can occur at higher temperatures from prolonged water immersion.
- Blunt trauma of marching can produce more serious injury.
- First symptoms are often feet becoming cold, mildly painful, and numb.
- Tight boots increase risk of trenchfoot.
Trenchfoot

• **Trenchfoot (immersion foot)**
  - develops over hours to days from prolonged exposure to damp or wet cold at temperatures above freezing
  - after rewarming, a hyperemic phase occurs characterized by hot, red, painful, dry swollen feet
  - edema and bullae may develop, and in severe cases gangrene may ensue
  - the best therapy is preventive. Preventive measures include frequent sock changes and never sleeping with wet socks and boots
Trenchfoot

- Common symptoms are “cold and numb” or “walking on wood”
- Foot may appear swollen, with the skin mildly blue, red or black
- Limb is hot and often hyper-hydrotic
- Upon rewarming pain is excruciating and may not respond to pain medication, including morphine.
- As time progresses, liquefaction necrosis occurs distally, but tissue proximal may also be compromised.
- No sharp line of demarcation of dead and viable tissue.
- Nerve, muscle, and endothelial cells are most susceptible to this long-term cooling
Trenchfoot treatment

• Prevent further cold exposure.
• Do not massage.
• Dry extremity, warm torso, and allow slow passive rewarming of feet. Never immerse feet in warm or hot water.
• Elevate feet.
• Rehydrate.
• If vesicles develop do not débride
• Pain medication. The most effective approach is amitriptyline 50-150 mg at bedtime. Other analgesics are either completely ineffective, or (as with narcotics) do not actually relieve pain.
Trenchfoot treatment II

- Any blisters should be left intact. Ruptured blisters require excellent antisepsis.
- Avoid trauma.
- Early mobilization is vital to prevent long-term immobility.
- Return to duty is protracted; may require evacuation as it leads to weeks to months of pain and disability.
- Long-term sequelae are very common and include sensitivity to the cold (secondary Raynaud's), chronic pain, neurological impairment, and hyperhydrosis.
Trenchfoot

• Microvascular vasospasm with tissue ischemia is the apparent etiology of trenchfoot.

• Post-injury sequela include pain, numbness, loss of proprioception, and cold feet. Hyperhydrosis with subsequent perinechial fungal infections are common.
Frostnip.

- Exposed skin appears red or minimally swollen.
- Tissue is not actually damaged.
- Not true frostbite; freezing is limited to skin surface only.
- Signals imminent likelihood of frostbite developing.
Frostnip

- Hands, feet and face at highest risk

- Skin becomes blanched and numb with loss of sensation of cold and discomfort

- Reversible and resolves quickly with warming.

- May be treated at the scene
Frostbite

- Hands, feet and face at highest risk
- Freezing of tissues
- Superficial vs. deep
- Similar to burns
Frostbite - Treatment

• Re-warming in 105 degree water or soak in warmest water available

• Should only be done if re-freezing is unlikely \(\rightarrow\) AVOID RE-FREEZING!!!

• (Tetanus prophylaxis) and pain management
Frostbite - Treatment

• In general, blisters should be left alone (controversial) in the field

• Evacuate without walking on thawed toes/feet if injury is severe; walking/ skiing for 1-2 days with less severe injury seems to be OK.
Frostbite.

• Clinical Appearance.
  – Skin initially becomes numb and feels stiff or woody.
  – Mottled, bluish, yellowish, “waxy”, or “frozen.”
  – Depth of involvement cannot be determined initially, nor does degree affect initial therapy.
Frostbite grading

• First degree: Erythema/edema at distal involved sites, no vesicles.

• Second degree: Clear fluid filled vesicles, extend to distal areas.

• Third degree: Deeper vesicles, purple/hemorrhagic.

• Fourth degree: Involvement of deeper structures, may be difficult to determine initially.
Frostbite grading

- A more clinically useful grading typically divides injuries into superficial (first degree or superficial second) or deep (Second or higher degree)

- After re-warming, the appearance and location of vesicles will allow a more accurate assessment of the severity of injury.
Frostbite grading

• Second degree: Clear fluid filled vesicles, extend to distal areas.

• Third degree: Deeper vesicles, purple/hemorrhagic.
Frostbite grading

• Fourth degree: Involvement of deeper structures, may be difficult to determine initially.
Superficial Frostbite

- Involves only the skin with swelling, mild pain, and minor joint stiffness.
- No blisters form.
- Can be managed by non-medical personnel simply by rewarming.
Field Treatment

- Superficial (Blanched Cheeks, Nose, Ears, Fingertips).
  - Warm with palm of hand or warm wet cloth; warm fingers in armpits.
  - Emollients may help prevent skin from drying or cracking.
  - Do not massage, rub with snow, or warm part by an open fire or high heat source.
Deep Frostbite

- Involves deeper tissues to include bone.
- White-hard, anesthetic, blanched, and inflexible.
- Skin will not move over joints.
- Blisters form and are clear, fluid-filled, or hemorrhagic (latter indicating a more severe, deeper injury. Should be left in place; will slough in 7-10 days without consequence.
- Failure to form vesicles in an obviously deep-frozen extremity is a grave sign.
Deep Frostbite

- Upon rewarming, there is great pain, and a blue-gray to burgundy color change.

- Post-injury sequela include: Raynaud's, pain, paraesthesia, hyperhidrosis, loss of proprioception, cold/discolored feet, and gait modification.
Field Treatment

• Deep Frostbite.
  – Prevent from further cooling. Apply dry, sterile bandage and elevate.
  – Protect from refreezing during evacuation. Get definitive medical care
• http://www.youtube.com/watch?v=E6Jv9vDk8t8
Treatment

- Avoid thawing and refreezing, as this leads to the greatest damage to tissue and the poorest outcome.
  
  - Prolonged movement to hospital
    - (Environment to ambulance back to environment to helicopter).
Treatment

• The outcome of a frozen extremity is not directly related to overall time frozen, but more importantly to the method of rewarming and any subsequent refreezing.
Treatment

- If this requires walking on frozen feet then no attempt at rewarming should be initiated, and the patient should ambulate on the frozen extremities.
  - For S & R, this may be your only option for extraction from the environment.
- For transport, the patient’s extremity should be splinted and padded with dry dressings and protected from heat sources that would slowly rewarm the extremity.
Treatment

- Rapid rewarming (without the possibility of re-freezing) is the treatment of choice.
  - Immerse in gently circulating water (whirlpool bath) at 40º for at least 30 minutes longer than could be needed to defrost all affected tissues. If deep freezing of the leg or arm has taken place, then thorough surgical fasciotomy is mandatory prior to rewarming, to prevent lethal increase in deep tissue pressures as ice melts. Extremities are rewarmed until pliable and erythematous at the most distal areas.
Treatment

– Twice daily whirlpool baths at 40ºC with topical antibacterial added to the water, together with oral alcohol. The alcohol reduces the need for analgesia and may improve outcome. Other drug regimes remain unproven.

– After rewarming, edema will appear within a few hours and vesicles within the next 6-24 hours.

– Intensive mobilization is essential to avoid long-term immobility
Vesicles

- Frostbite vesicles are typically left intact.
- Debridement is not recommended
General Considerations

• Ibuprofen or Ketorolac should be given as systemic thromboxane/prostaglandin inhibitors.

• Systemic antibiotics and tetanus prophylaxis are indicated when there are dead tissues, as with any other contaminated wound, or when there is evidence of infection. Dry loose dressings should be applied.

• Daily hydrotherapy is recommended. Pain control with NSAIDS and narcotics will be needed.

• Sequela include contractures, cold sensitivity, chronic ulceration, arthritis, and hyperhidrosis.
Case

- Mt. Rogers in southern Virginia near the 5700 ft peak in January. Going for an overnight hike with a friend from the rescue squad.

- You come across a couple who appear to be in trouble…

- They are lost, and one of them is laying in the snow, minimally responsive and confused, woefully underdressed…
Summary

• Hyperthermia and hypothermia result when the normal thermoregulatory mechanisms are overwhelmed

• Severe hyperthermia (heat stroke) and severe hypothermia are life threatening emergencies
Summary

• Once your body reaches a temperature of extreme, it can no longer produce normal body functions.

• Remove from environment even if you cannot remove them from the scene.
Summary

• Patients with severe hypothermia may appear lifeless

• Re-warming may be passive or active (external or internal)

• Cardiac abnormalities are common and most will resolve with re-warming
Summary

• Preventing further temperature exposure is probably THE most important thing you can do as an EMS provider
The End