Cold Related Injuries

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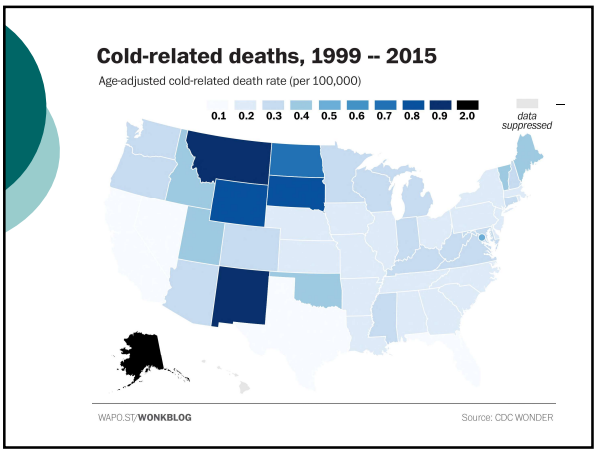
Outline

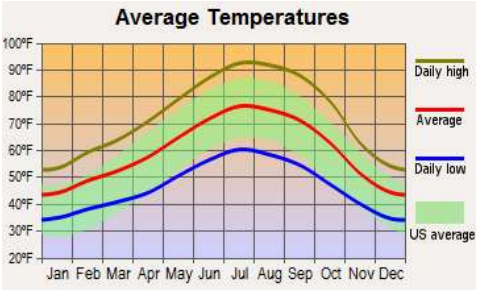
- Epidemiology
- Thermoregulation
- Cold related injury
  - Localized – Nonfreezing and Freezing
  - Primary Hypothermia

Epidemiology

- Most common in elderly, homeless and wilderness enthusiasts in cold weather environments
- Mortality is 10-15% in primary hypothermia
  - 20% with initial core temp < 32°
  - up to 40% with <28°
- ~1500 deaths per year in the US, 50% in the elderly



Chico Average Temperatures



Paradise Lake

Thermoregulation

- Definition:
  Ability to maintain a viable body temperature under a variety of climatic conditions

Thermoregulation

- Core temp tightly maintained between 36.1° and 37.3° by the hypothalamus
  - Core temp > 37° - vasodilation, sweating and seeking a cool environment
  - Core temp < 37° - vasoconstriction, shivering, piloerection and seeking a warm environment

Thermoregulation

- 4 Mechanisms of heat loss
  - Radiation
    - Between the body and its surroundings by electromagnetic waves
    - Normal process of heat moving away from body. ~65% of heat loss
  - Conduction
    - Between objects in direct contact
    - Ex: Cold ground or submersion in water

Thermoregulation

- Convection
  - Transfer of heat from a body to moving molecules such as air or liquid
  - Ex: Wind chill
- Evaporation
  - Water from the skin surface or humidified air in exhalation
  - Ex: sweating or wet clothing

Localized Cold Injuries

- Damage to tissues exposed to cold, usually localized to the extremities
- Two categories:
  - Nonfreezing cold injury – Chilblains, Trench Foot
  - Freezing cold injury - Frostbite

Chilblains

- Localized, inflammatory, bluish red, tender lesions
- Occurs after brief exposure, with full development in 12-24 hours
- Lesions are self limiting, resolve in a few days to a few weeks
- Treat with passive rewarming, drying affected area and analgesia

Chilblains

Trench Foot

- Tissue exposed to wet/cold conditions at temps from 0°-15° developing over hours to days
- Injury directly to soft tissues, especially peripheral nerves
- Progresses over three phases

Trench Foot

- Stages
  - During cold:Pale, mottled, anesthetic, pulseless, and immobile
  - After rewarming: Hyperemic phase with severe burning pain and reappearance of proximal sensation
  - 2-3 days post treatment: Edema and bullae may form as perfusion returns

Trench Foot


Trench Foot – Treatment and Dispo

- Treatment is supportive
  - keeping feet warm and dry
  - analgesia
  - close monitoring for infection
- Dispo
  - Can be discharged to warm environment, severe cases need admission

Frostbite

- Can occur on any skin surface, generally nose, ears, face and extremities
- Due to increased blood viscosity, extracellular ice formation, intracellular dehydration and lysis
- 4 degrees of injury, with prognostic implications

Frostbite

- 1st: Partial skin freezing, erythema, edema, no blisters or necrosis, occasional skin desquamation

Frostbite

- 2nd: Full thickness freezing, significant erythema/edema, clear blisters, desquamation with black eschar formation

Frostbite

- 3rd: Full thickness and subcutaneous freezing, hemorrhagic blisters, skin necrosis


Frostbite

- 4th: Full thickness, subcutaneous, muscle, tendon, bone freezing, cyanotic or deep red, eventually dry, black and mummified


Frostbite - Treatment

- In the field
  - remove wet clothing, place dry dressings
  - extremity elevation
  - prevent refreezing – most important as thawing and refreezing leads to worse outcomes

Frostbite - Treatment

- Rapid rewarming - key intervention – place affected extremity in gently circulating water at 37°-39° until the extremity is pliable and erythematous
- Facial injury can be treated warm moist towels
- Analgesia – Parenteral opiates

Frostbite - Treatment

- Clear blisters - debride to remove prostoglandin /thromboxanes - exacerbate injury
- Hemorrhagic blisters - leave intact
- Ibuprofen and topical aloe vera - to prevent inflammatory cascade

Frostbite - Treatment

- Antibiotics controversial vs. waiting for signs of infection
- Use of IV or intra-arterial TPA is being studied to limit microvascular thrombosis and decrease need for amputations

Frostbite - Disposition

- Only the most superficial injuries may be discharged home
- Admit for pain control, monitoring for possible infection with the most severe cases requiring surgical debridement or amputation

Hypothermia

- Primary Hypothermia defined as drop in core temp < 35° classically due to cold exposure
- Intoxication, hypoglycemia, anorexia or advanced age can decrease heat production or increase heat loss
- Response to decrease in core temp changes as temp decreases

Hypothermia

- Excitation phase <37°-32°
  - Increased HR/SBP/cardiac output
  - Peripheral vasoconstriction
  - Shivering
  - Piloerection "Goosebumps"
  - Seeking a warm environment
  - Usually normal cognition though can have confusion, impaired judgement and slurred speech

Hypothermia

- Slowing phase <32°
  - Decreased HR/SBP/cardiac output
  - Shivering stops when core temp below 30°-32°
  - Progressive multiorgan dysfunction and failure
  - Decreased drug metabolism

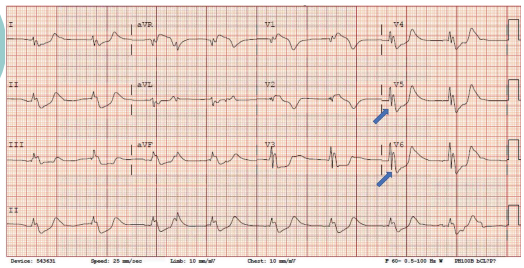
Hypothermia

- Significant cognitive decline during slowing phase:
  - Diminished reflexes
  - Depressed pupillary reflex
  - Bizarre behaviors such as paradoxical undressing
  - Lethargy leading to coma

Hypothermia

- Many possible ECG findings:
  - Bradyarrhythmias including sinus, atrial fibrillation, AV blocks and junctional rhythms
  - Osborne Waves (= J waves)
  - Prolonged PR, QRS and QT intervals
  - Shivering artefact
  - Ventricular ectopy
  - Cardiac arrest due to VT, VF or asystole

Hypothermia



Osborne (J) waves characteristic (but not pathognomonic) of hypothermia

Hypothermia - Treatment

- Diagnosis - H + P with a high index of suspicion
- ABC's and establishing a core temp
- Intubation for airway compromise
- The hypothermic myocardium very irritable, aggressive manipulation can precipitate arrhythmia

Hypothermia Pre-Hospital Care

- Remove from cold environment
- Remove wet clothing
- Passive rewarming: blankets, warm ambulance
- Avoid cold/room temp IVF
- Gentle movement of the patient to avoid irritation of the hypothermic myocardium

Hypothermia - AHA Guidelines

- Most arrhythmias will spontaneously convert with rewarming
- With perfusing rhythm
  - Mild (>34°) – passive rewarming
  - Moderate (30°-34°) – active external rewarming
  - Severe (<30°) – active core rewarming

Hypothermia - AHA Guidlines

- Without perfusing rhythm
  - Mild to Moderate – Begin CPR, attempt Defib, give IV meds at increased intervals (due to decreased metabolism), active core rewarming
  - Severe - start CPR, attempt meds and defib once, withhold meds and further defib until temperature >30° with active core rewarming

Hypothermia - Treatment

- No one is dead until they are warm and dead
- Continue resuscitation until core temp > 30°
- Contraindications to CPR
  - Chest wall compression impossible due to frozen chest
  - Other obvious lethal injuries present

Hypothermia - Rewarming

- Passive – warm blankets and warm environment, endogenous heat production must be intact
- Active External
  - Heating Blankets set at 40°
  - Forced air rewarming – ex. Bair Hugger
  - Warm water immersion – logistically difficult

Hypothermia - Rewarming

- Warmed IV fluids at 40°
- Inhalation rewarming at 40° via face mask or ETT
- Heated Irrigation with saline at 40°-45°
  - Gastric, Bladder lavage via NGT/Foley
  - Peritoneal lavage
  - Thoracic lavage via an anterior and posterior thoracostomy tubes

Hypothermia – Rewarming

- Heated Irrigation with saline at 40°-45°
  - Thoracotomy and direct myocardial lavage, when myocardial temp > 30° may attempt internal defib
- Extracorpeal Blood Rewarming
  - Hemodialysis
  - Cardiopulmonary Bypass

Hypothermia - Treatment

- Must exclude secondary hypothermia
  - Sepsis
  - Endocrine – Myxedema Coma, Hypoadrenalism
  - Hypothalmic/CNS injury
  - Metabolic – DKA, malnutrition
  - Severe dermal injuries – Burns, TEN, etc.
  - Drug/Alcohol – in conjunction with Primary
  - Iatrogenic – Rapid resuscitation with room-temp fluid/cold blood

Hypothermia – Treatment

- Labs and imaging to r/o secondary hypothermia, establish baseline for post resuscitative phase when complications occur: CBC, Coags, CMP, lipase, ECG, CXR, UA/Cx, BCx, TSH and Head CT

Hypothermia - Treatment

- Thiamine as many patients are alcoholics/malnourished
- IVF
  - Moderate amount in mild hypothermia as fluid shifts are reversed by rewarming
  - May need large amounts in severe cases secondary to decreased PVR and cardiac compromise

Hypothermia – Disposition

- Only mild accidental cases of hypothermia may be discharged home, provided the patient will be dc'd to a warm environment
- All other cases need to be admitted, severe cases to an intensive care unit for management of hypothermia and evaluation/management of underlying diseases

Take Home Points

- Maintain high index of suspicion
- Rewarming is the central intervention in all cold related injuries
- Remember ACLS changes when core temp <30°, do not stop CPR until core temp at least >30°
- Keep in mind causes of secondary hypothermia

References

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