Hypothermia and Cold-related Environmental Emergencies

Lecture 18

To Build a Fire

J. London ***He travels fastest who travels alone… but not after the frost has dropped below zero fifty degrees or more*** -- *Yukon Code*

Outcomes

At the completion of this lecture, the learner will be able to:

- Describe the incidence, morbidity and mortality associated with cold-related environmental emergencies emergencies
- Identify risk factors predisposing to cold-emergencies
- Discuss the physiology of "homeostasis" and the pathophysiology of environmental emergencies (5-10.7 - 5-10.84)
- Discuss the assessment findings associated with cold-related environmental emergencies (5-10.20 - 5-10.84)
- Correlate abnormal findings with clinical significance in patients with of cold-related emergencies (5-10.25 - 5-10.84)
- Integrate pathophysiology, physical findings, and treatment for patients with cold-related emergencies (5-10.33)

Cold-related Environmental Emergencies

- Hypothermia
- Frostbite
- Frostnip
- Trench foot
- Chilblains

Cold Injury

- Cause
  - Combination of :
    - Inadequate protection and
    - Cold environment
- Injury
  - Generalized (hypothermia)
  - Localized (frostbite)

Definitions of Cold Injuries

- Chilblains/ trench foot :
  - injury from nonfreezing environment
- Frostbite :
  - injury due to a freezing environment
- Hypothermia :
  - core $T^0 \leq 95^0$ (35^0 C)

Chilblains / Trench foot

- Symptoms
  - burning paresthesias, itching
- Signs
  - edema, erythema;
  - can blister
- Tx.:
  - gentle rewarming
  - skin moisturizers

Chilblains

- AKA pernio
- Idiopathic or secondary to underlying disease
- Inflammatory condition
  - Abn.vascular response
  - Exposure : cold / damp
- Pruritic and/or painful
- Red or violaceous
- Vasodilator (Nifedipine) response varies

Original #1: www.emedicine.com/derm/topic322.htm
#2:dermatlas.med.jhmi.edu/derm/display.cfm?Image

Trench Foot

- AKA immersion foot
- Sx:
  - tingling +/or itching
  - pain, swelling, cold
  - heavy feeling in the foot
- Signs:
  - Blisters
    - May be followed by skin and tissue dying and sloughing
- Prevention:
  - air-dry ; elevate feet
  - exchange wet shoes and socks

#1: original on page: Passchendaele,1917: www.firstworldwar.com/atoz/trenchfoot.htm
#2: vonhof.typepad.com/.../img_1406.html

Frostbite

Pathophysiology:

- Tissue freezing severity is due to :
  - Duration
  - Intensity
- Cold → ice crystals → cellular dehydration, protein denaturation, cell wall injury → damage to capillaries
- Rewarming → cell swelling platelet aggregation, endothelial cell damage → thrombosis, edema, compartment syndrome → ischemia, and tissue death
- Biochemical injuries : O2 free radicals, excess of prostaglandins and thromboxane → inflammation and tissue destruction
- Injury greatest: when cooling slow, exposure prolonged, when rate of rewarming is slow, and, especially, when tissue is partially thawed and then re-frozen

Frostbite Predisposing Factors

- Rescuers, firefighters, outdoor workers
- High-altitude recreation
- Predisposing conditions
  - Malnutrition
  - ASCVD
    - Nicotine
  - Diabetes
  - Extremes of age
  - ALOC (ETOH / drug use; psychiatric illness)
- Homelessness
- Wet or damp
- Previous cold injury
- Inadequate or constrictive clothing
- Vibrational hand or arm injury

Frostbite Symptoms

- Stinging, burning
- Numbness
- Stiffness and clumsiness
- Pain, throbbing, burning
- Extreme pain upon rewarming
- In deep frostbite:
  - Initial decrease in sensation
  - Eventually completely numb

Frostbite Signs

- Anatomical locations:
  - hands and feet most common
  - cheeks, nose, ears, penis, and even corneas
- Classified by degree - as with thermal burns:
  - 1st degree: "mild sunburn-like"
  - 2nd degree: "blistered sunburn-like"
    clear blisters → OK
  - 3rd degree: deep, purple blisters; gray skin
    hemorrhagic blisters → bad
  - 4th degree: full thickness

Frostbite Severity

- 1st degree: partial freezing
- 2nd : full skin thickness
- 3rd : both skin and SQ
- 4th : skin, SQ, muscle, tendon

Original page:
#1: : www.project-himalaya.com/gallery-everest
#2: medeverest.webnark.nl/.../ndmrozenia.html

Frostbite Prehospital Treatment

- O2/ IV/ monitor / bld draw / glu / CABCDEs
- IV fluid challenge (→ increased flow and tissue perfusion)
- Remove wet clothing
- Dry soft dressing (prevent further heat loss)
  - Gentle, loose dressing; may use blanket for mechanical protection during transport.
- Elevation
- Do ***not*** attempt rewarming if danger of refreezing present
- Consider:
  - Ketorolac 30 mg IM
  - Morphine 2 -10 mg IM or IV

Frostbite Emergency Dept. Tx.

Rapid rewarming (***40***-42°C or ***104***-107 F)

- Thawing complete when involved area flushes (usu. 20-40 min)

Medications

- Nifedipine 10 - 20 mg po
- Ketorolac 30 mg IM or Ibuprophen 400mg po may inhibit cyclooxygenase activity and prostaglandin synthesis
- Morphine 2 -10 mg IV
- Aloe vera cream
- dT Toxoid booster

Hypothermia

To Build a Fire
by Jack London

He travels fastest who travels alone . . . but not after the frost has dropped below zero fify degrees or more. - Yukon Code.

page: carl-bell-2.baylor.edu/.../JL/ToBuildAFire.html

Hypothermia

Types

- Primary
  - In the young, healthy
- Secondary
  - In the chronically ill

Hypothermia

Incidence in the US:

- 646 hypothermia-related deaths / yr (rate : 0.2 / 100,000)

Mortality:

- 0.49 persons per 100,000 population in south
- 4.64 persons per 100,000 population in Alaska

Age:

- Half of deaths occur in adults older than 65 yrs.
  - many elderly live in relative poverty / inadequate heating
  - predisposing diseases (CHF, DM, or gait abnormality)

Types

- Primary
  - In the young, healthy
- Secondary
  - In the chronically ill

Primary Hypothermia

Type : Primary
- Young
- Without chronic disease
- Exposure to the elements in:
  - Recreationers
  - Athletes
  - Laborers
  - Homeless
    (state of poverty in the US:
    32 million; 1 out of 6 children)

Secondary Hypothermia

- Type: secondary
  (brain +/or other organ-impaired)
  - Chronically ill
  - Elderly

Risks for Hypothermia

- Age
  - Infancy (high surface/mass ratio)
  - Elderly (cannot increase cardiac output,…)
- ALOC
  - Elderly (dementia)
  - ETOH
- Abnormal heat regulation
  - Elderly
  - Chronic illness
  - Medications

Heat Loss in Hypothermia

- Radiation : majority (60 %) of heat loss
- Conduction :
  - only 2-3 % in dry conditions
  - Increased when wet: 25-30 times greater in water
- Convection
  - normally 10 % of loss
  - greater if wind-chill factor involved
- Respiration
  - expired air : 25 % of heat loss
  - heat is lost upon warming of inspired cold air

Cold Physiology

- Cold diuresis
  - Cold --> peripheral vasoconstriction --> incr blood to core --> inc RBF --> diuresis
- "Hunter's response"
  - Local [feet] vasoconstriction , followed by rebound Cold Induced VasoDilatation (CIVD)
- Paradoxical core afterdrop
  - Warming vasodilates the periphery
  - Cold and lactic acid-rich blood dumped into core
  - Core pH and temp drop

Systemic Hypothermic Injury

- Definition: Core T^o < 35 C or < 95F
- Pathophysiology
  - As temp. drops
    - BMR drops
    - CO drops $\rightarrow \downarrow$ BP
- Coagulation factors : temperature dependant
- O2 - Hb dissociation curve
  - shifts to the left [worse O2 off-loading]

Metabolic Factors

- Heat production ↓
  - old age
    - ↓ hypothalamic functions
  - illness
  - drugs
  - malnourishment
- Hypoglycemia
- Sepsis
- Illness
  - MI
  - DM
  - Hypothyroidism
- Other
  - Brain tumor
  - Head trauma

Mild Hypothermia

- Core T°: 94 – 97 F or 34 – 36 C
- Favorable prognosis
- Clinical Presentation
  - Shivering
  - Lethargic
  - Mentally dull
  - Stiff
  - Uncoordinated
  - ↑ HR, BP
- Passive rewarming

Moderate Hypothermia

- Core T°: 86 – ***94*** F or 30 – ***34*** C
- Favorable prognosis
- Between 26 C (80 F) and 32 C: shiver ceases
- BP drops; HR drops
- Hypovolemia
  - interstitial shift
  - cold diuresis
  - may lead to thrombosis, DIC
  - Do NOT use LR; it is poorly metabolized by a cold liver

Severe Hypothermia

- Core T° : < 86 F or < 30 C
- Poor prognosis
- ALOC- profound confusion
- Loss of shivering
- Stiff
- Respiratory
  - Bronchorrhea
  - Hypoventilation
  - Loss of gag + cough
- J wave (***Osborn J wave***)
- Bradycardia – 1st presenting rhythm
- AF – 2nd rhythm
  - most common rhythm
- VF < 86 F
- Asystole

BLS / ACLS in the Hypothermic Heart

BLS
- if no pulse is present : CPR
- AED x 1

ACLS
- aggressive core rewarming.
- arrhythmias can convert with rewarming
- No aggressive Tx of minor arrhythmias (bradycardia, atrial
- or ventricular); may be harmful

A/ B :
- O2 100% , warmed, humidified
- Intubation : indications same as in normothermic pt. Avoid hyperventilation (hypoCO2 can → VF)

ACLS in Hypothermia

- VF / VT : Defibrillate with 2 J/kg (or the biphasic equivalent)
  - Success : unlikely if core T° is less than 32°C (89°F)
  - If unsuccessful repeat defibrillation attempts after each 1°C (1.8°F) rise in temperature
- Drugs
  - Amiodarone (***unlike*** Lidocaine) doesn't suppress automaticity
  - Drugs normally used in arrest (eg, lidocaine, epi, dopamine, procainamide [→ VF]) and should be avoided
  - Little or no effect core T° is less than 30°C (86°F)
  - Should ***not*** be used until core temperature is above 30°C.
- Hypotension
  - treated with volume and with rewarming.
  - IV fluids : NS only (do ***NOT*** use LR) ; heated to 40-42°C (***40***-42°C or *104*-107 F)

Cardiac Effects of Hypothermia

- Atropine, epi, dopamine : contraindicated in a cold pt with bradycardia and an ***Osborn J wave***
- For loss of automaticity:
  - ***Amiodarone*** ; not lidocaine
  - Single shock
- Irritability (arrhythmias):
  - can be increased by rough handling / interventions
  - < ***30*** C (***86***°F): Do NOT give meds; aggressively rewarm first
  - > 30 C (***86***°F): IV meds, but at longer intervals
    - Repeat defibrillations as core T° rises

Rewarming Techniques for Hypothermia

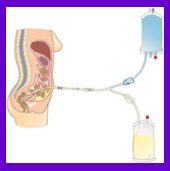
Passive

- Remove wet clothing
- Cover with warm blanket

Active

- Hot compresses to groin + axillae
- Radiant heat
- Convection heat: Bair hugger (Forced-air rewarming can rewarm as fast as 2.4°C/hr.) (4.4°F/hr)
- Warm humidfied O2 (proximity of carina [near SA node])
- Warmed IV NS
- Dialysis… ; fem-fem bypass (Venovenous rewarming)

Active Rewarming



Summary

We have discussed :

- Incidence, morbidity and mortality of cold-related injuries from nonfreezing trench foot to life threatening cold, intractable VF
- Risk factors predisposing to cold-emergencies
- Risks for losing "homeostasis" and the pathophysiology of local (frostbite) or systemic (hypothermia) injury
- The signs and symptoms associated with cold-related injuries that predict a poor outcome (eg.,
- Treatment for patients with cold-related emergencies
- Rapid rewarming (***40***-42°C or ***104***-107 F)
  - For frostbite
  - For hypothermia
    - > ***30*** C (***86***°F): warm heart