

All Things Cold: Hypothermia, Altitude Illness and Frostbite

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Objectives

- Thermoregulation basics
- Management of human-sickles
- Understanding cold toes and how to say no to the surgeons



The Misguided Mountaineer



- 29 year old climber found at 4500m after falling in a glacial lake,
- He crawls out and is lost in an ensuing snowstorm
- Core T 26C, P 40, BP 80/50, RR 8
- PE: Difficult to arouse, clear lungs
- EKG: Sinus bradycardia

Thermoregulation 101

- **Heat Production**
 - Basal Metabolic Rate (100 kcal/hr)
 - Shivering (500 kcal/hr)
 - Physical activity (200-? kcal/hr)



Thermoregulation 101

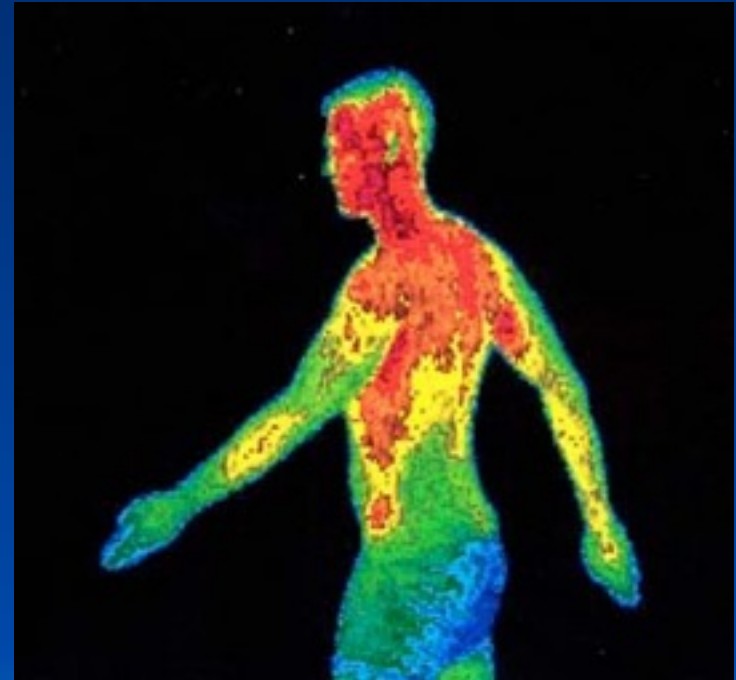


- **Heat Loss**

- Radiation (60% of all heat loss)
- Evaporation (sweat/lungs)
- Conduction (5-25X greater when wet)
- Convection (wind)

Thermoregulation Limitations

- Fuel availability
- Oxygen
- Hydration
- VO_2 max
- Fatigue
- Alcohol
- Medications/Drugs



Hypothermia: Kids

- Young children more prone to hypothermia due to:
 - Higher surface area/ body weight ratio
 - Diminished shivering
 - Tendency to play naked in snow and not care



Hypothermia: Clinical Presentation

Mild

33-35C

Shivering

Moderate

28-32C

Lethargy, unsteady
gait, confusion

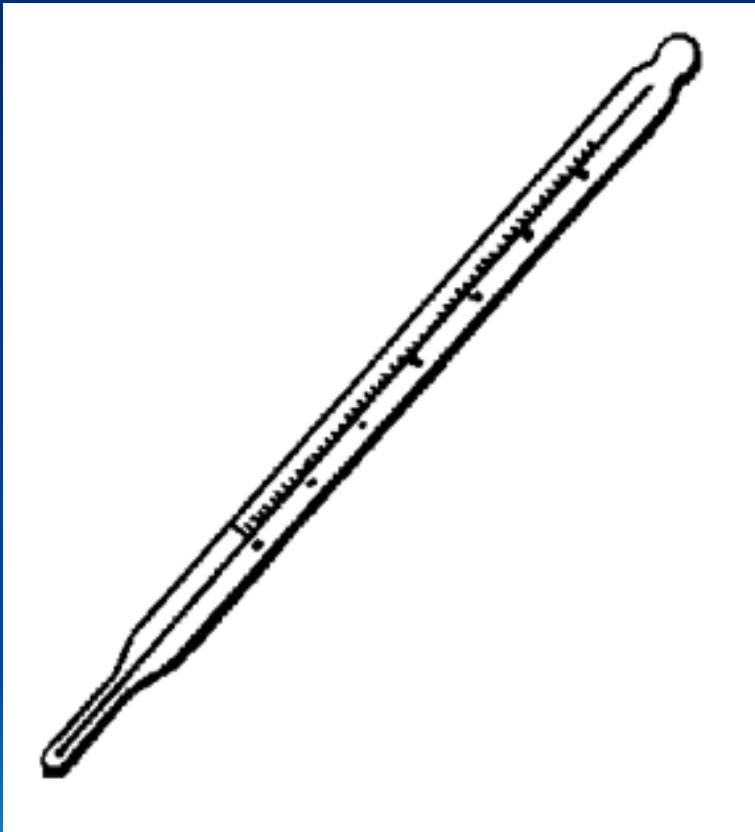
Severe

<28C

Respiratory
depression, cardiac
arrhythmias, stupor/
coma



How Cold Do You Feel?



- Your skin is your thermostat
- Lowest recorded temperature in survivor: 13.7 C (56F!)
- Cold people aren't dead until they are warm ($>35\text{C}$) and dead

Hypothermia: Field Management

- **Stop heat loss:**
 - Shelter against cold and wind
 - Remove wet clothing
 - Insulate
- **Increase Heat Production**
 - Blanket/sleeping bag
 - Warm water bottles at groin/neck/axilla or warm human
 - Warm oral fluids if able
 - Fuel/food
 - Oxygen if at altitude



Evacuation

- *Gently*



ED Management

- **Passive External Re-warming for all(remove heat sinks):**
 - Dry clothes
 - Blanket
 - Allow patient to raise his own body temperature



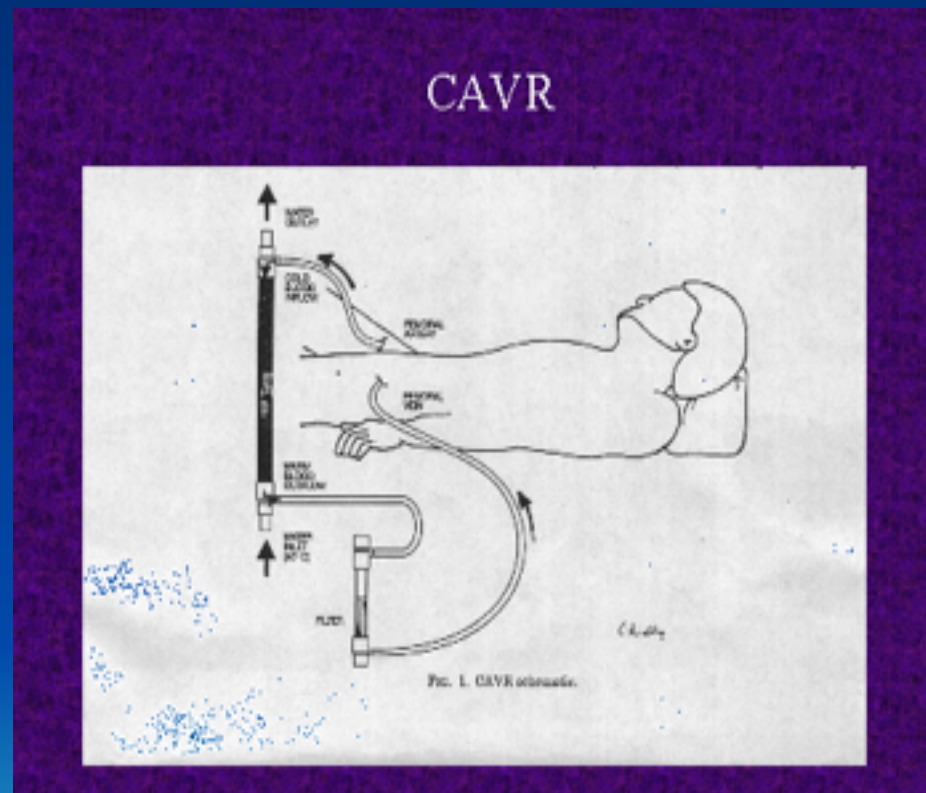
ED Management

- **Active External Re-warming: (< 33C)**
 - Convective heating blanket (“Bair Hugger”)
 - Radiant warmer (babies)



ED Management

- **Active Internal Re-warming:**
 - Minimally invasive: (<33C)
 - Warm IV fluids (42C)
 - Warm humidified air (42C)
 - Invasive: (significant cardiac arrhythmias)
 - Chest tube lavage
 - Peritoneal lavage
 - AV Bypass



Rates of Re-warming by Technique

<i>Technique</i>	<i>Max Re-warming Rate</i>
Humidified Air (42C)	Mask: 1 C/hr ETT: 2 C/hr
Warmed IVF (42C)	1 liter: 0.33 C/hr
Chest Tube Lavage	3-4 C/hr
Peritoneal Lavage	3-4 C/hr
AV Bypass	Up to 9 C/hr

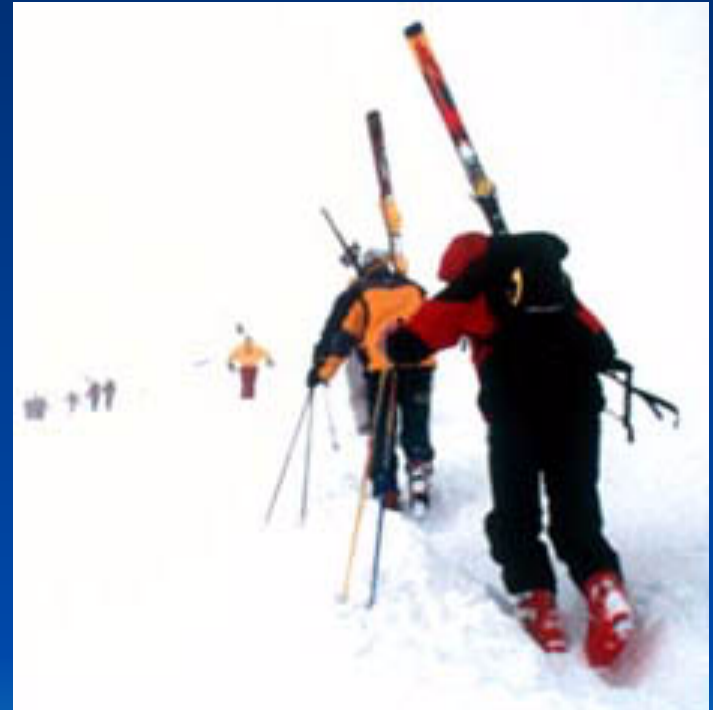
Complications of Hypothermia

- ***Rewarming shock:***
due to decreased systemic vascular resistance
- ***Pulmonary Edema:***
capillary leakage
- ***Renal Failure***
- ***DIC***-bleeding/clotting
- ***Infection***



Dress for the Weather

- Conserve energy
- Minimize sweating
- Layering:
 - Wicking layer
 - Insulating layer
 - Protective layer



Check out those tootsies

- 25 year old backcountry skier lost for 2 days
- New boots, wet snow
- Feet “numb”
- In ED, T 35C, other VS nl
- PE: mottled, white “woody” feet



Differential Diagnosis

- Frostnip
- Superficial frostbite
- Deep frostbite



Frostbite

- **Pathophysiology:**
tissue ischemia from
low blood flow
- **Contributing factors:**
 - Poor insulation
 - Moisture
 - Constriction
 - Dehydration



Clinical Presentation



- **Frozen**: white, hard, numb
- **Thawed < 24hr**: variably soft, +/-blisters
- **Thawed >24-48hrs**:
 - ***Superficial***: edema, clear blisters, pain, warmer, light purple
 - ***Deep***: little edema, no blisters, painless, dark, cold

Frostbite: Field Management

- Aggressive re-warming:
38-42C bath
- Ibuprofen
- Hydration
- Do **NOT** allow refreezing



Frostbite: ED Management



- Field protocol
- Irrigation
- Bulky dressing
- Medications:
 - Ibuprofen
 - Aloe Vera
 - Vasodilators:
 - Nifedipine (calcium channel blocker)
 - Phenoxybenzamine (alpha 1 blocker)

Frostbite Prognosis

- Better if:
 - Early edema
 - Early formation of clear blisters
 - Pain!
- Role of surgery: **NONE** early



In a nutshell...



- Hard to get cold humans warm: be aggressive
- Mantra of altitude illness: **DESCEND**
- Aggressively re-warm frostbite but do not allow refreezing





www.himalayanrescue.org







