Cold and Sports Medicine

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Cold and Performance

Brief

• Lack of warm-up
• Increased injury

Long

• Decreased performance
• Accidents
• Poor athletes at risk
The “Jury” protects the competitive athlete

The Recreational Athlete is protected by himself and his companions.
Mountaineering

Objective Hazard = Act of God
Subjective Hazard = Climber control
Where trainer is likely to be involved

Adventure, Expedition, Survival, Marathon, Ultra Marathon, *Iron Man*
Core Temperature

• Constant 99 degrees Fahrenheit +/- 1
Skin Temperature

• Range from 50 degrees to -130 degrees Fahrenheit
• Maintaining Core constant
The Body Produces Heat

- Metabolic Rate
- Exercise

Result: Byproduct Heat
Different Fuels
Different Energy Levels

• Fat – Nine Calories, One Gram
• Carbohydrate – Four Calories, One Gram
• Protein – Four Calories, One Gram
Basal Metabolism

One Calorie – One Kilogram – One Hour
Exercise

• Sedentary – 2000 Calories/day
• Heavy Exercise – 7000 Calories/day
The Body is not efficient – Only 27%

63% of energy is heat, the byproduct of metabolic and muscular work
Where Our Energy Goes

- Basal Metabolism – 60%
- Physical Activity – 25%
- Thermic Effect of Food – 8%
- Non-Exercise Activity – 7%
T.E.F.

• Ingestion, digestion, absorption, and storage requires increased metabolism
• Carbohydrates and fat = 4%
• Protein = 30%
Exercise Produces Heat

• An-aerobic = 50 x Basal
• Aerobic = 20 x Basal
Rate of Energy Expenditure

- Resting = 100 Calories/hour
- Running (5mph) = 500 Calories/hour
- Climbing = 1000 Calories/hour
- Shivering = 250 Calories/hour
Body Balance

Heat Production = Heat Loss
The Body Loses Heat in Four Ways

- Conduction
- Convection
- Radiation
- Evaporation
Conduction is Usually = 15%

Conduction loss depends on the material in contact

- Air – almost 0
- Water – 25 x air
- Ice – 100 x air
- Metal – 1000 x air

“Take your crampons off”
Convection – Wind Chill

• Caused by the movement of surface air
• In proportion to the square root of air velocity

4 mph wind = 2\times\text{convection loss of 1 mph}
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The Climbers Rule: 30-30-30

@ -30 degrees, 30 mph wind exposure, flesh freezes in 30 seconds
Radiation – 60% Heat Loss

• Body gives off infrared radiant energy. This depends upon surface area, texture, color and temperature.
• “On a clear night, stand in the shade”
Evaporation

• When water is lost from sweating or the lungs, heat is absorbed in conversion to vapor – 0.58 Calories/gram of water
• Insensible loss 450-600 ml/day or 12-16 Calories/hour
• Core rise of 1 degree Centigrade needs 10 x Basal Heat Production dissipated largely through evaporation
Cold Water Immersion

- Specific heat of water (capacity) is 4000 x air
- 25 x heat loss in air
- Movement, in water, greatly increases heat loss up to 100 x air
Core heat is Mainly Lost Through the Skin

- Subcutaneous Fat = endogenous insulation
- Thin people lose 9x more than obese people
Control is Vascular

- Basal Cutaneous Blood Flow
  200-500 ml/minute
- **Vasodilation**, temperature = 106 degrees F
  7000-8000 ml/minute
- **Vasoconstriction**, temperature = 57 degrees F
  20-50 ml/min
Principle of Insulation

Trap warm, motionless air next to the body

- COLD - Clean, avoid Overheating, Loose, Dry

- VIP – Ventilate, Insulate, Protect
Protect High Blood Flow Areas

- Layers
- “When your feet are cold, put your hat on.”
- Warm? dress down – Cold? dress up
Man is a Homeotherm – A Tropical Animal

- Neutral Environment = 82 degrees Fahrenheit
- If ambient temperature drops by 15 degrees, the metabolic rate must increase 2x
The Arctic Fox

- Neutral Environment = -40 degrees Fahrenheit
- If metabolic rate doubles, he can go to -184 degrees Fahrenheit
Cold Injury

- Hypothermia – Systemic
- Frostbite – Local
Hypothermia occurs when heat loss exceeds production and Core Temperature Drops

- Acute (cold water immersion) – in minutes
- Chronic (exposure) – in hours
Hypothermia Has Occurred in every state in the Union in every month of the year.

Mortality is 0-50% and 19% of victims reach the hospital alive.
Death by Degrees

- 99 degrees +/- 1 degree Fahrenheit – Core
- 97 degrees Increase Metabolic Rate
A 3-4 degrees Fahrenheit lower Core temperature requires a 2x metabolic rate increase - 75% of metabolic energy is heat
95 degrees Shivering

- The body may increase heat production 4-5x,
- The Hypothermic is alert and will re-warm spontaneously
Mild Hypothermia

- 95 degrees – 90 degrees Fahrenheit
- Maximal vasoconstriction
- Confusion
- Walkers, fine hand motion impaired
- Passive External Re-warming is Successful (P.E.R.) endogenous thermogenesis
- Field Treatment by companions
  “La belle indifference”
Moderate Hypothermia

- 90 degrees – 82 degrees Fahrenheit
- Hypotensive, brady cardia, hypoventillation
- Shivering ceases
- Muscle rigidity develops
- Stupor becomes coma
- Becomes poikilothermic, if heat not added = death
- Hospital treatment, Active re-warming
- External AER, Internal AIR
Severe Hypothermia

- Below 82 degrees Fahrenheit
- Metabolic Icebox
- High mortality, Hospital Clinically dead
- “No one is allowed to be cold and dead”; they must be re-warmed to at least 82 degrees F
- EKG needed
- Very gentle handling
Re-warm

- Water bath – keep extremities out to avoid re-warming shock
- Heated IV (@ 107 degrees F raises temperature only 1/3 degree F)
- Peritoneal dialysis
- Shunts and Heart Lung machine
- Heated, Humidified Oxygen
- “Microwave”
Cold Water Immersion

• Ice water – death in 20-30 minutes

Titanic

• 712 rescued, all from life boats
• 1,489 die in water (all with life jackets) with rescue ship on the scene within 2 hours.
Prevention

- Dry suits, wet suits, rafts
- **HELP** – **Heat** **Escape** **Lessening** **Position**
- Huddle
- **DO NOT SWIM TO SHORE**
- At 50 degree F water, the average swimmer can only swim 1 km prior to death
- 100x heat loss
- PFD important to lowering heat loss
CPR or Not (WMS)

Chronic

• Any sign of life, NO CPR because you may trigger fibrillation. A cold heart cannot be de-fibrillated.

• No signs of life, CPR may be adequate perfusion for hypothermics, even if interrupted.

Acute

• CPR
The Wilderness

• The worst one to care for a hypothermic is another hypothermic
• Paradoxical disrobing occurs
• They will walk and stagger on for a long time, give up the goal.
• “Feed ‘em and Beat ‘em. You must feed ‘em first.”
Cold, Wet, and Windy Weather

Hypothermia does not require freezing; it is not a total body frostbite.
Frostbite

• 1812 – Napoleon left France with 385,000 troops to invade Russia.
• The next spring he returned with 3000; 250,000 deaths to cold injury.
Frostbite is the freezing of living tissue.

It is localized and is at most significance for the hands and feet.
Wind Chill requires protection to avoid frostbite

- 20 Degrees F @ 45 mph wind is equivalent to –40 degrees F @ 2 mph.
Skin temperature drop to 50-38 degrees F

Maximum Vasoconstriction of blood flow to skin
Cold Induced Vasodilation
CIVD

• Reflex which gives several minutes of vasodilation
• Varies by races, individuals and “acclimatization”
• All human flesh freezes the same
Freeze

- Skin temperature to 25 degrees F (internal radiant heat)
- Ice crystals, cell dehydration, ischemia, “toxic electrolyte concentration”
- Different tissues have different freezing points
  High nerves, vascular tissue
  Low muscle, tendon, bone
Special Situations

- Metal contact – “taste my sled runners”
- Supercooled liquid, gas, alcohol
- Low freezing point - 90 degrees F contact = instant frostbite
- “gin bottle in the arctic”
Treatment
Rapid Re-warming

Hospital Treatment
- Water bath at 104-108 degrees F
- Penicillin, to prevent a strep infection
- Tetanus toxoid
- NSAIDS
- Daily Hydrotherapy
- No early surgery (3-4 weeks) – await demarcation
Rapid Re-warming Protocol

• Decreases the Amputation Rate from 35% to 7%
• Major amputations are uncommon
• Germans in WWII had 15,000 amputations in two months
Worst Case Scenarios

• Warm by open flame, automatic heaters, etc.
• Freeze – Thaw – Freeze
• Walking on thawed feet (you can walk many miles on frozen feet)
• Infection increases tissue loss and leads to amputation early.
At Risk

- Vascular disease
- Previous frostbite
- Fatigue, dehydration
- Alcohol, smoking
- Fear, panic (retreating troops)
- Injury elsewhere on the body

The best prevention is a healthy body
Late Problems

- Hyperhydrosis
- Cold Sensitivity
- Epiphyseal Closure - Detoximity
Altitude - 10,000 – 29,000 Feet

- Colder
- Higher Winds
- Exposure
- Fatigue, Dehydration, Starvation
- Hypoxia
- Poor Decisions
- Delayed Evacuation
The Trainer

- May be the provider on the scene
- May be involved in “extreme” competition coverage
- May enjoy risky recreation
- May be mobilized and sent to Afghanistan
- May be assigned to cover winter sports in Lake Placid.