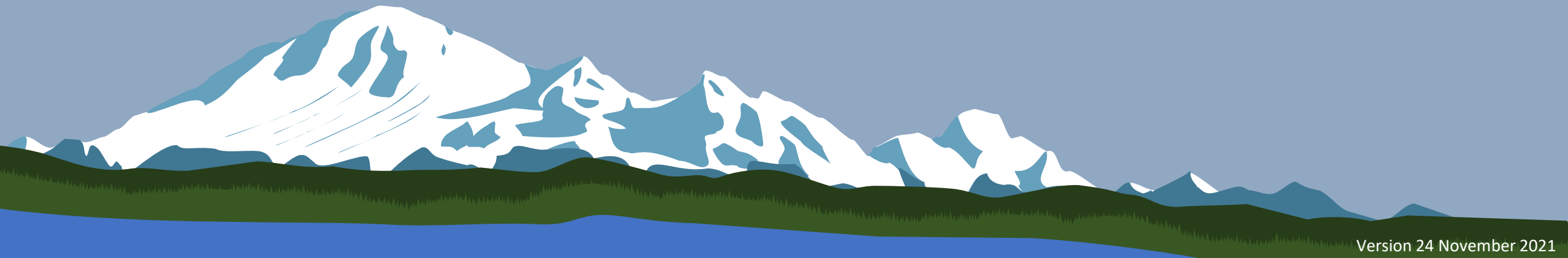
Cold Injuries

Mount Baker and Chief of Seattle Council
Winter Skills Adventure Program



Version 24 November 2021

Hypothermia and Frostbite

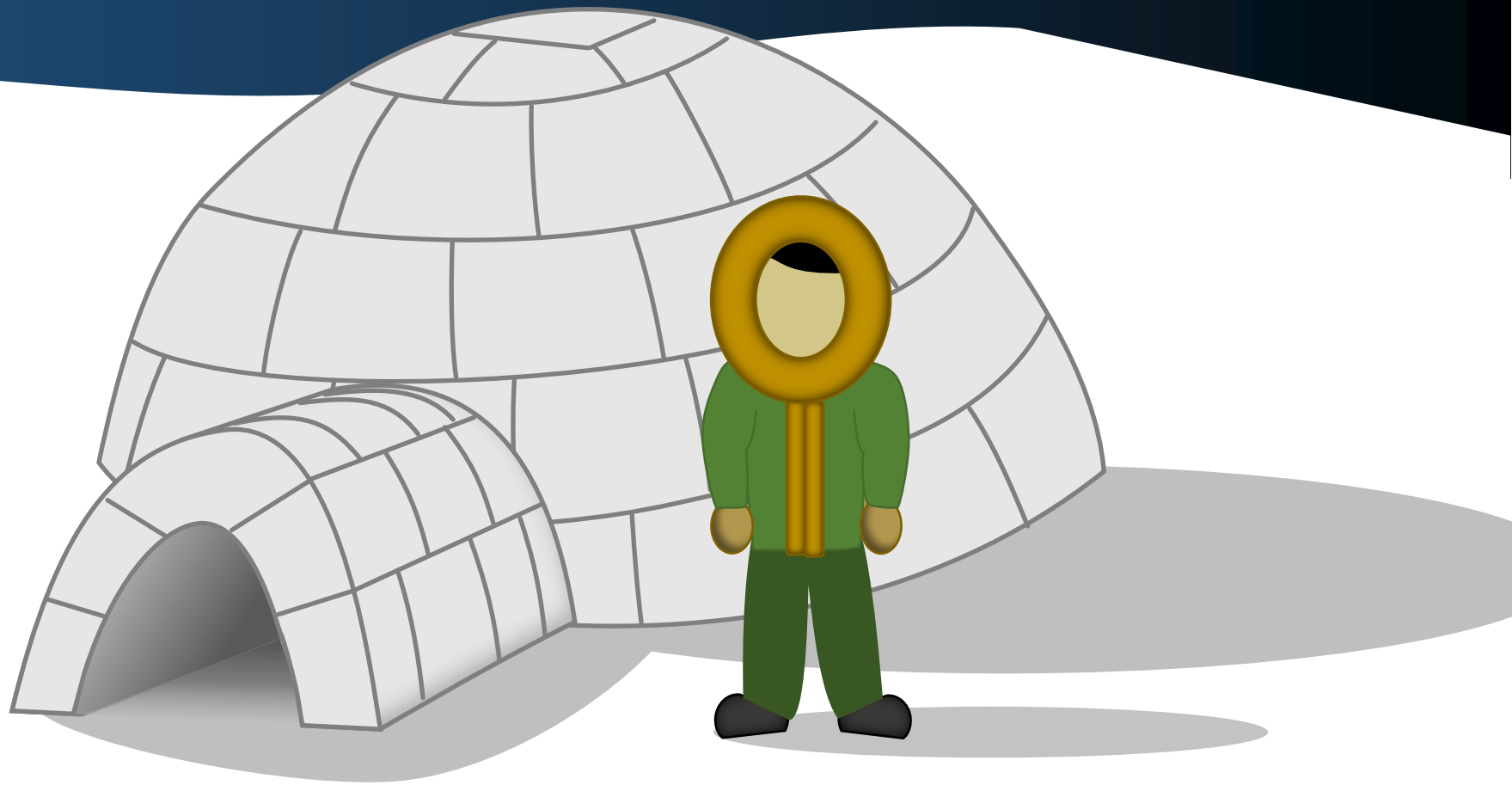
Objectives

Review at Home

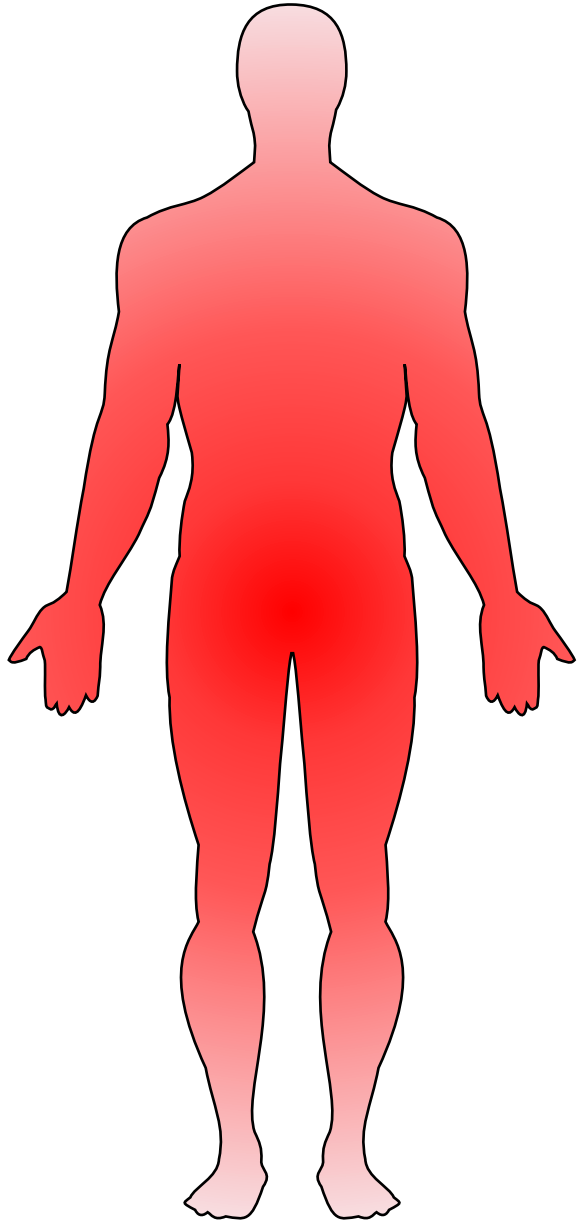
1. Describe the mechanisms of heat loss versus heat gain.
2. Define hypothermia.
3. List the signs and symptoms of mild and severe hypothermia.
4. Demonstrate the emergency treatment of and describe the long-term care for mild and severe hypothermia.
5. Describe the prevention of hypothermia.
6. Describe situations that would require an evacuation versus a rapid evacuation.

WFA Curriculum and Doctrine Guidelines
Prevention and Treatment of Frostbite: 2019 Update
Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update

Mechanisms of Heat Loss and Gain

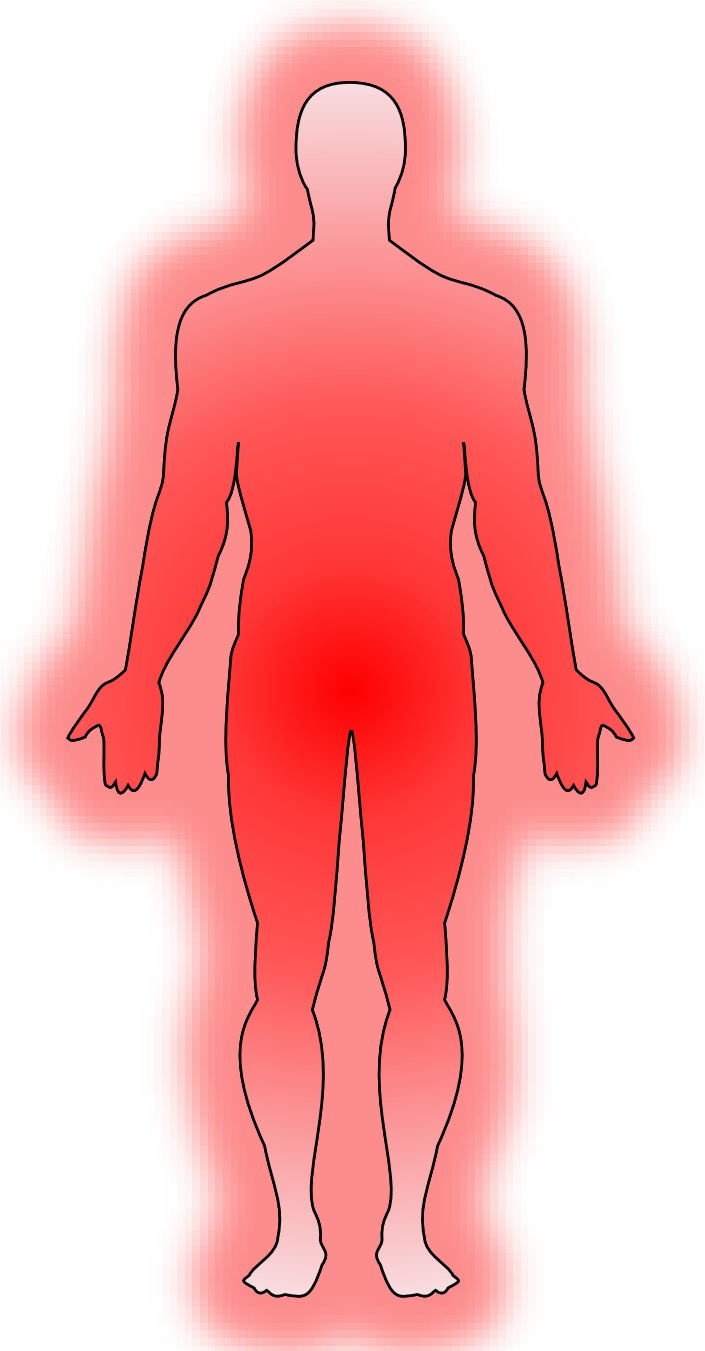


Mechanisms of Heat Loss



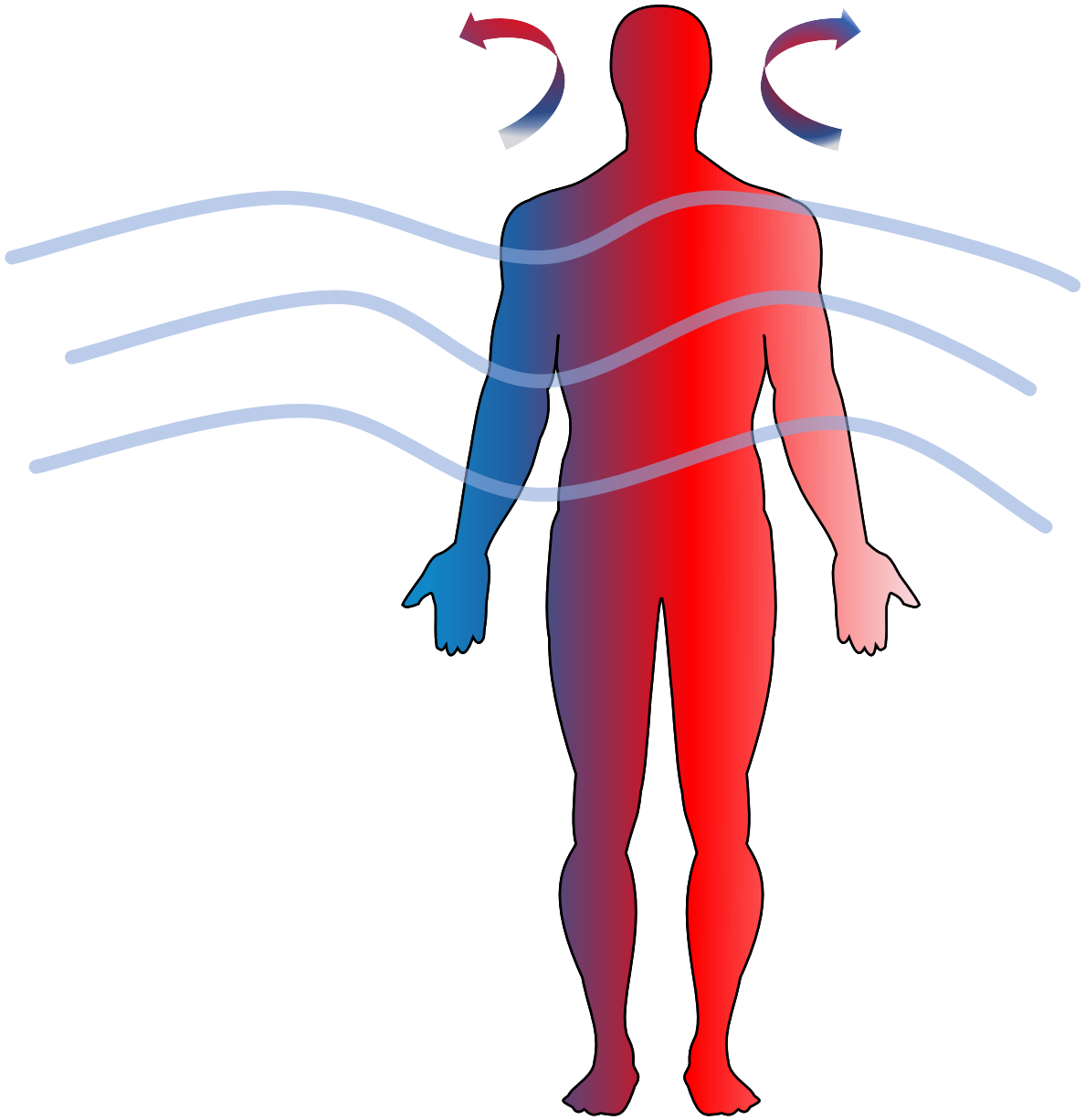
Mechanisms of Heat Loss

- **Radiation** (from skin)



Mechanisms of Heat Loss

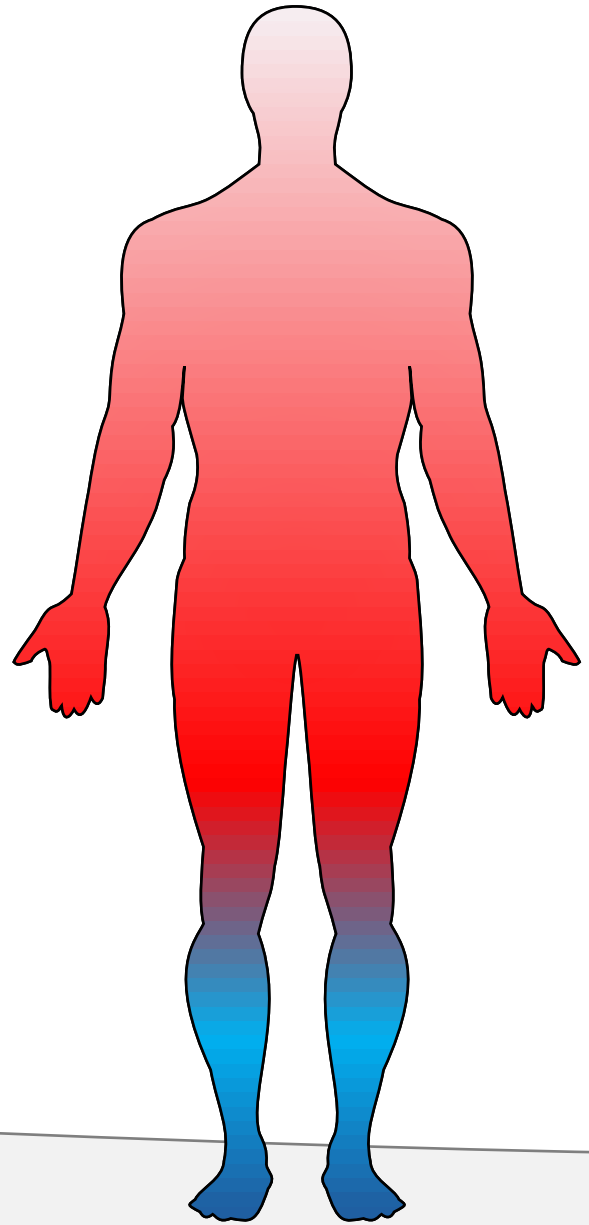
- Radiation (from skin)
- **Convection** (air/wind/water)



Mechanisms of Heat Loss

- Radiation (from skin)
- Convection (air/wind/water)
- **Conduction** (contact with ground/water/fuel)

- Avoid lying on bare, cold ground

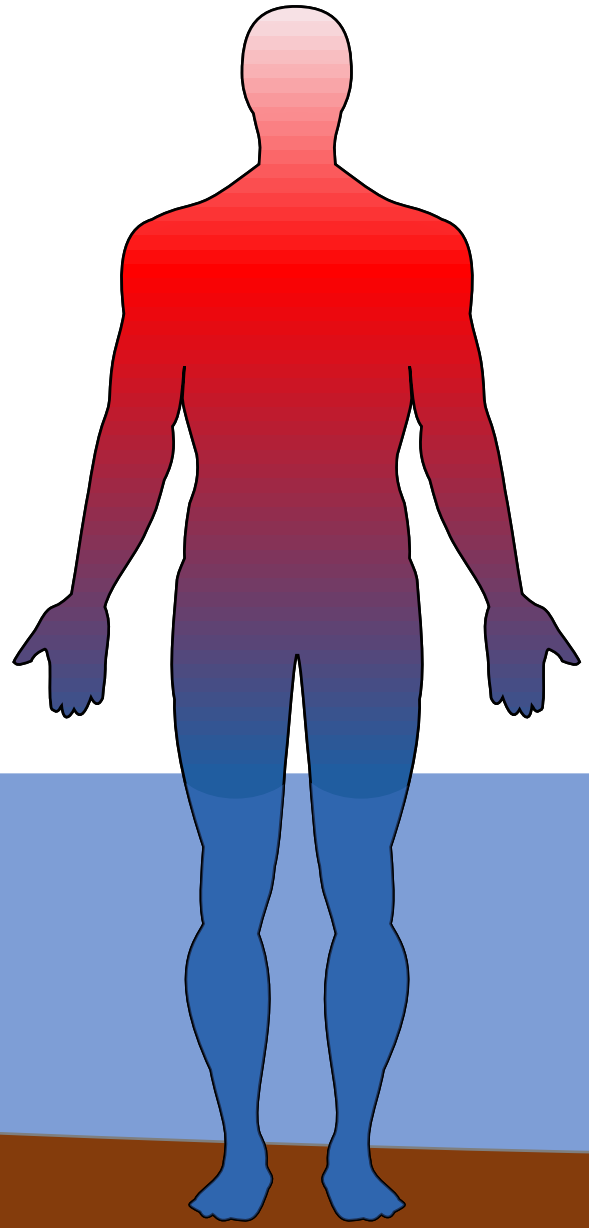


Mechanisms of Heat Loss

- Radiation (from skin)
- Convection (air/wind/water)
- **Conduction** (contact with ground/water/fuel)

- Avoid lying on bare, cold ground
- Water conducts heat about 25x faster than air

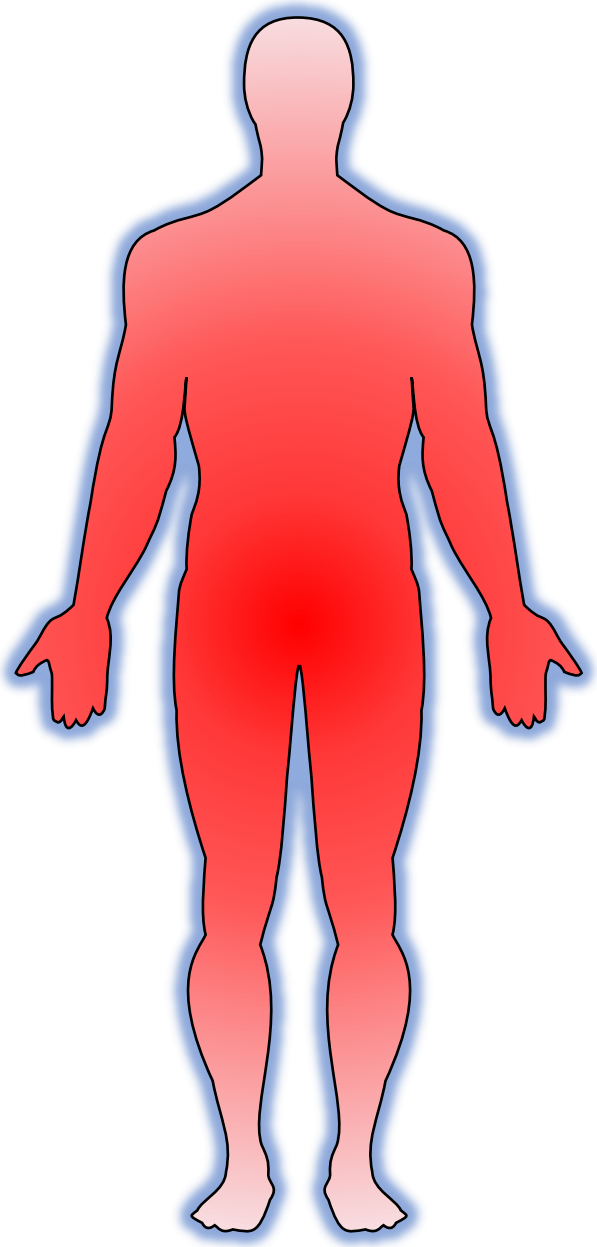
- Metal is even worse
- Supercooled liquid fuel on skin = Frostbite



Mechanisms of Heat Loss

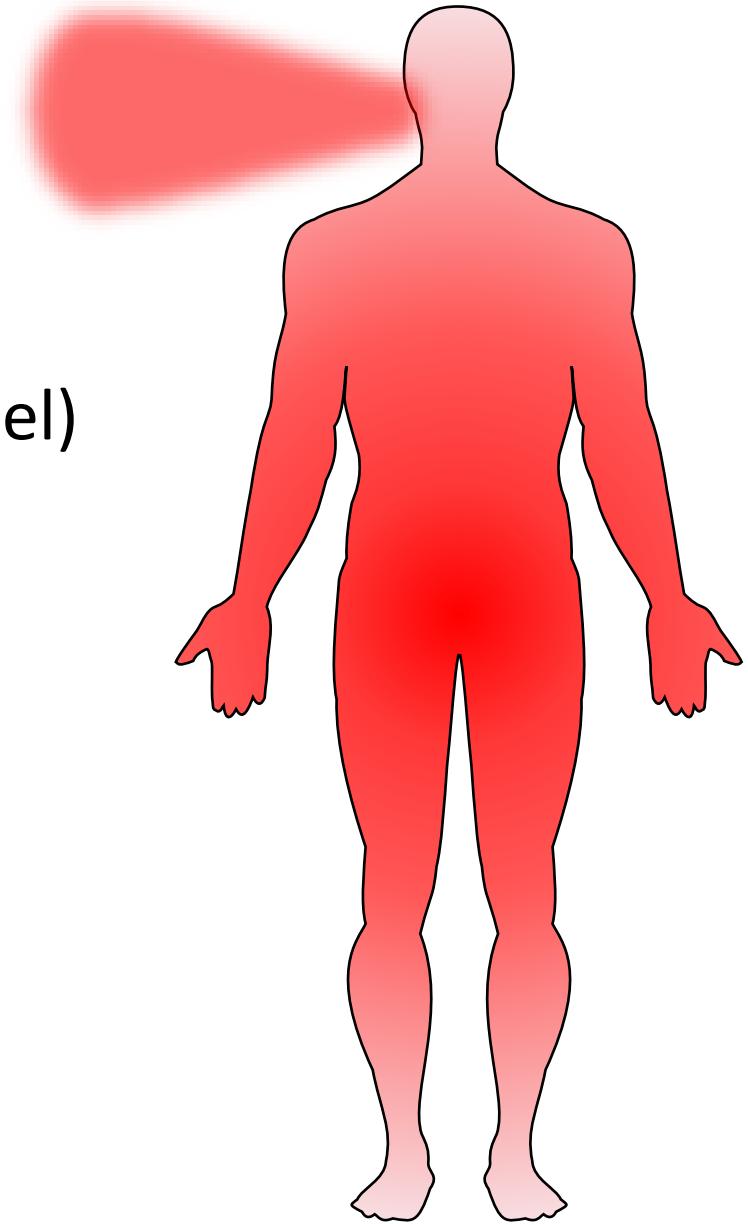
- Radiation (from skin)
- Convection (air/wind/water)
- Conduction (contact with ground/water/fuel)
- **Evaporation** (moisture from skin)

- Stay Dry!



Mechanisms of Heat Loss

- Radiation (from skin)
- Convection (air/wind/water)
- Conduction (contact with ground/water/fuel)
- Evaporation (moisture from skin)
- **Respirations** (each breath is heated)



Mechanisms of Heat Loss

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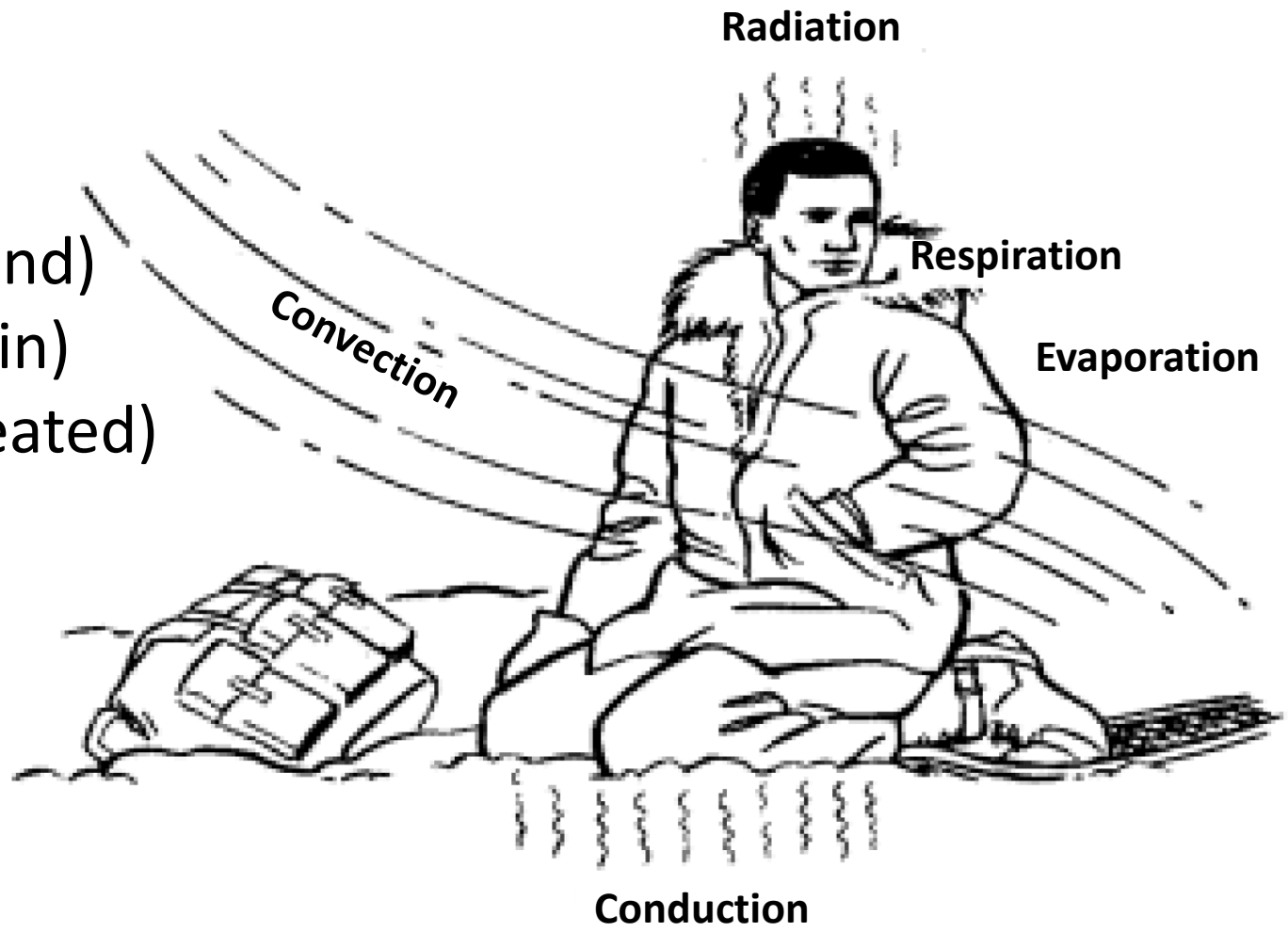


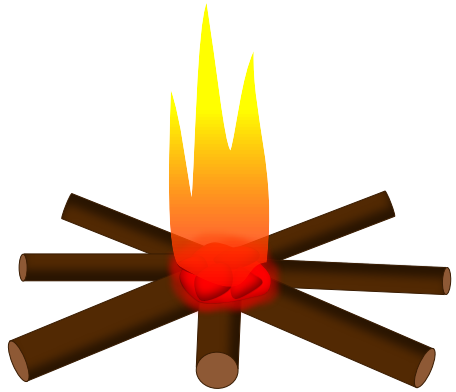
Image Source: TC 21-3 SOLDIER'S HANDBOOK FOR INDIVIDUAL OPERATIONS AND SURVIVAL IN COLD-WEATHER AREAS

Sources of Heat Gain

- **Non-exercise activity thermogenesis** (NEAT) (60-75%)
  - Basal metabolic rate (BMR)
  - Shivering
  - Non-shivering thermogenesis - brown adipose tissue (brown fat)
  - Diet-induced thermogenesis (DIT) (10%)

- **Exercise-associated thermogenesis** (EAT) (15-30%)

- **External Heat Sources** (heat pads, wood stove)



Castellani JW, Young AJ, Ducharme MB, Giesbrecht GG, Glickman E, Sallis RE; American College of Sports Medicine. American College of Sports Medicine position stand: prevention of cold injuries during exercise. Med Sci Sports Exerc. 2006 Nov;38(11):2012-29

Institute of Medicine (US) Committee on Military Nutrition Research; Marriott BM, Carlson SJ, editors. Nutritional Needs In Cold And In High-Altitude Environments: Applications for Military Personnel in Field Operations. Washington (DC): National Academies Press (US); 1996.

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Hypothermia and Frostbite

Heat Loss is Reduced via

- Peripheral blood vessel constriction
- Insulation
- Wind Barriers
- Mylar Blanket
- Reducing surface area – balling up
- Body Fat – some more protected than others

Castellani JW, Young AJ, Ducharme MB, Giesbrecht GG, Glickman E, Sallis RE; American College of Sports Medicine. American College of Sports Medicine position stand: prevention of cold injuries during exercise. Med Sci Sports Exerc. 2006 Nov;38(11):2012-29

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Metabolism

Cold Air

Conduction

Exercise

Wind

Sun

Wetness

Metabolism

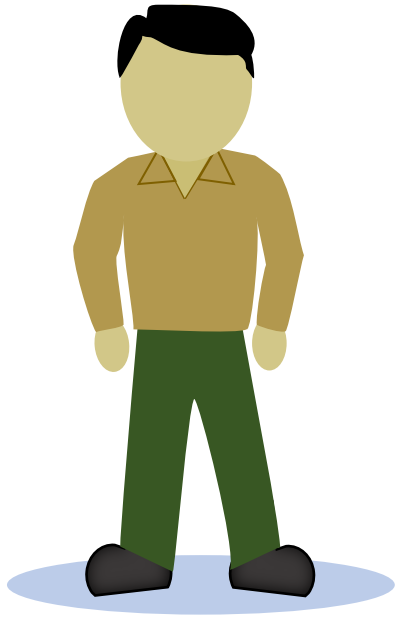
Cold Air

Conduction

Wind

Sun

Wetness



Metabolism

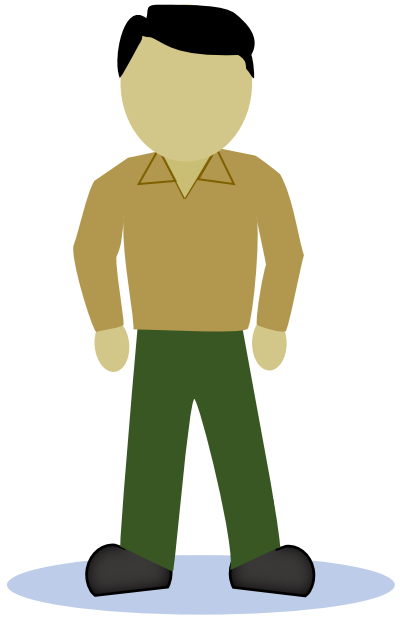
Cold Air

Conduction

Wind

Sun

Wetness



Metabolism

Cold Air

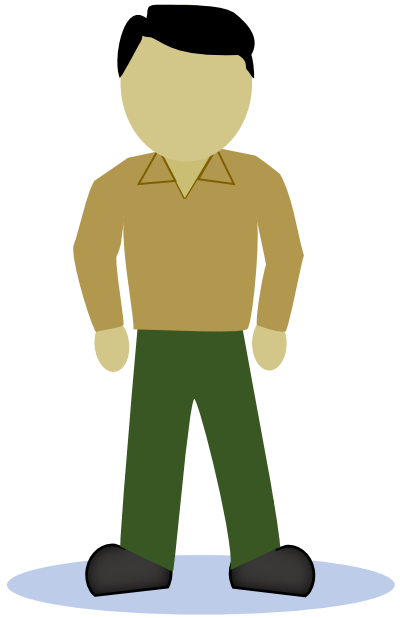
Shivering

Conduction

Wind

Sun

Wetness



Metabolism

Shivering

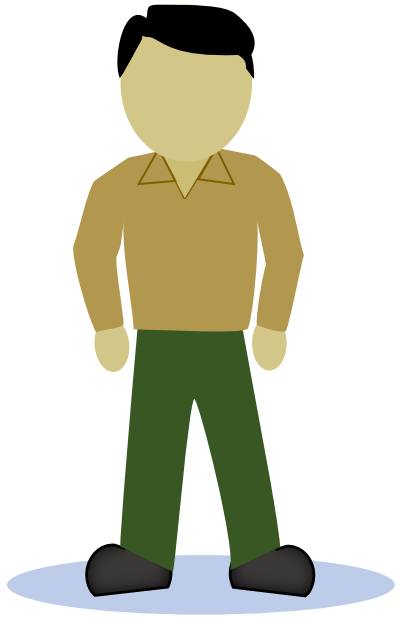
Sun

Cold Air

Conduction

Wind

Wetness



Metabolism

Cold Air

Conduction

Wind

Sun

Wetness

Metabolism

Cold Air

Conduction

Wind

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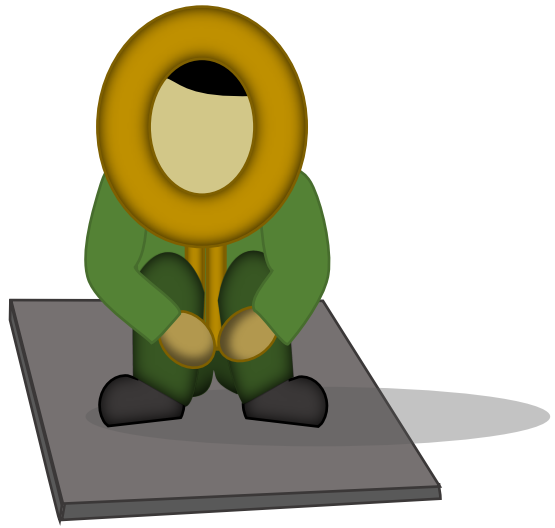


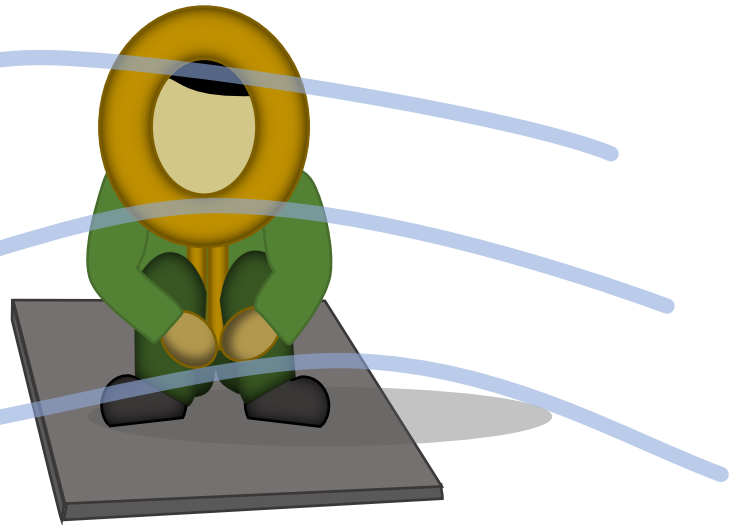
Metabolism

Shivering

Cold Air

Conduction

Wind



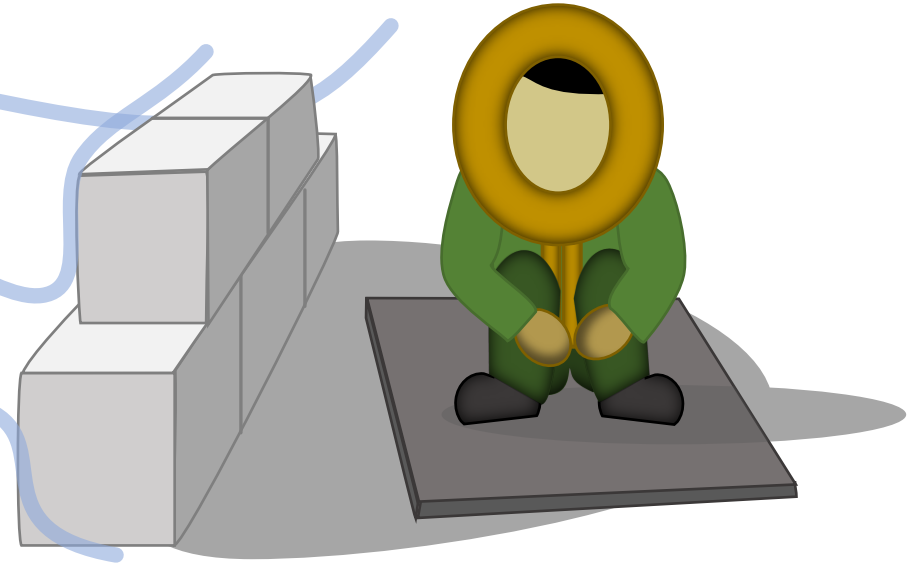
Metabolism

Shivering

Cold Air

Conduction

Wind

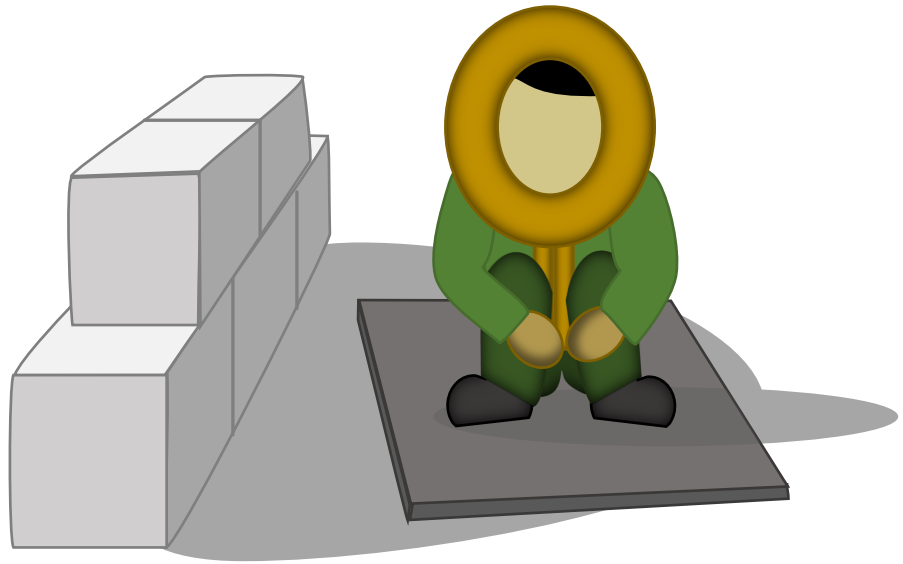


Metabolism

Cold Air

Shivering

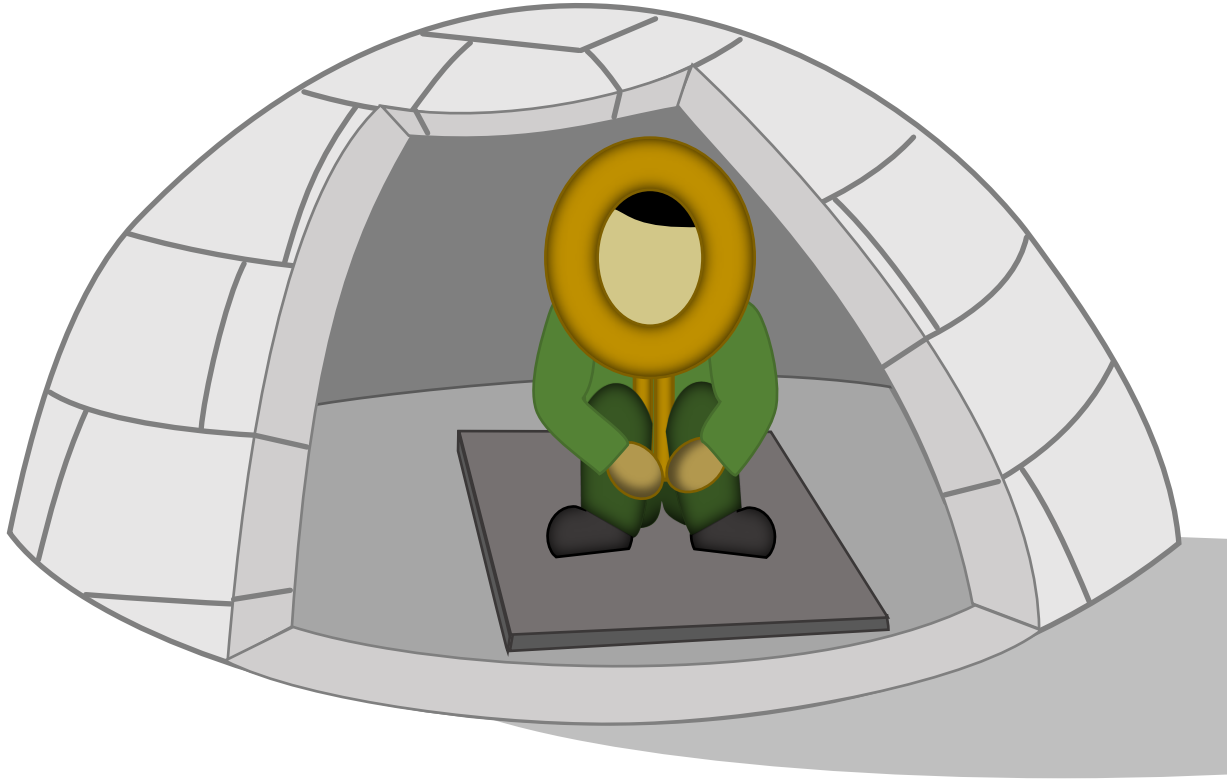
Wetness



Metabolism

Cold Air

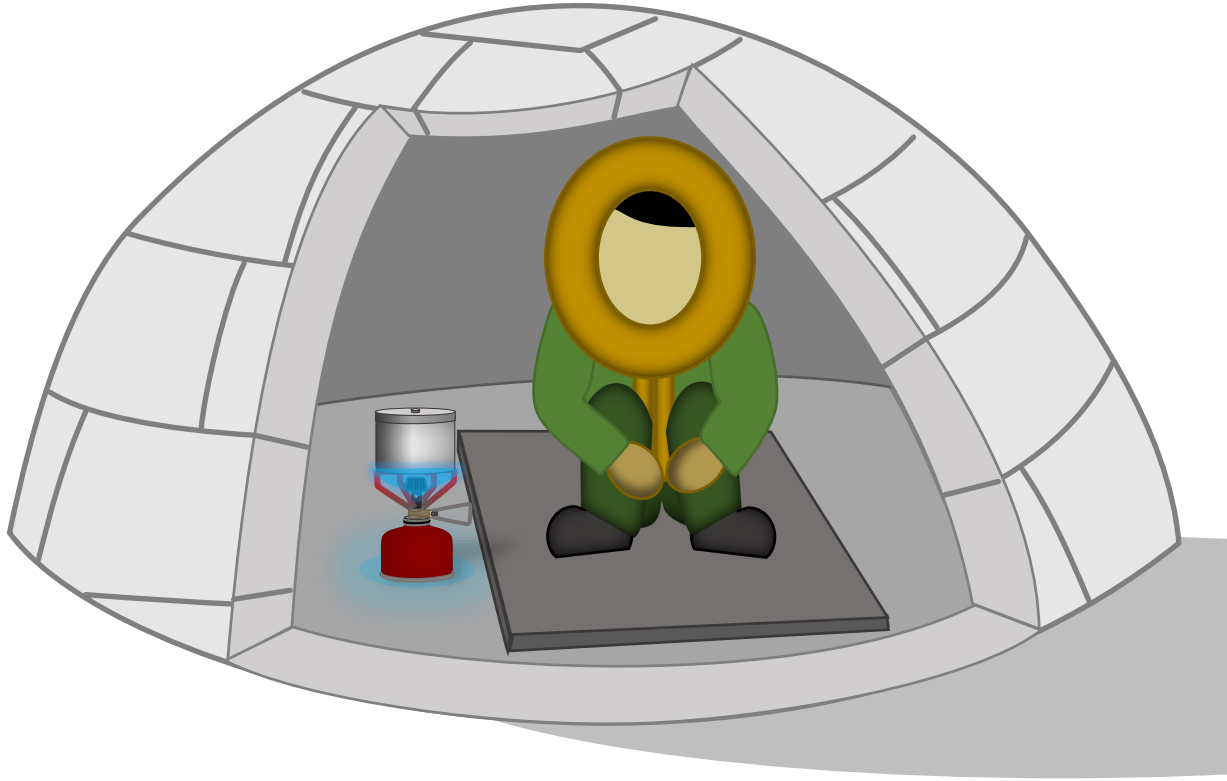
Conduction



Metabolism

Cold Air

Conduction



Heat

Flame in enclosed area = Carbon Monoxide

Metabolism

Shivering

Exercise

Sun

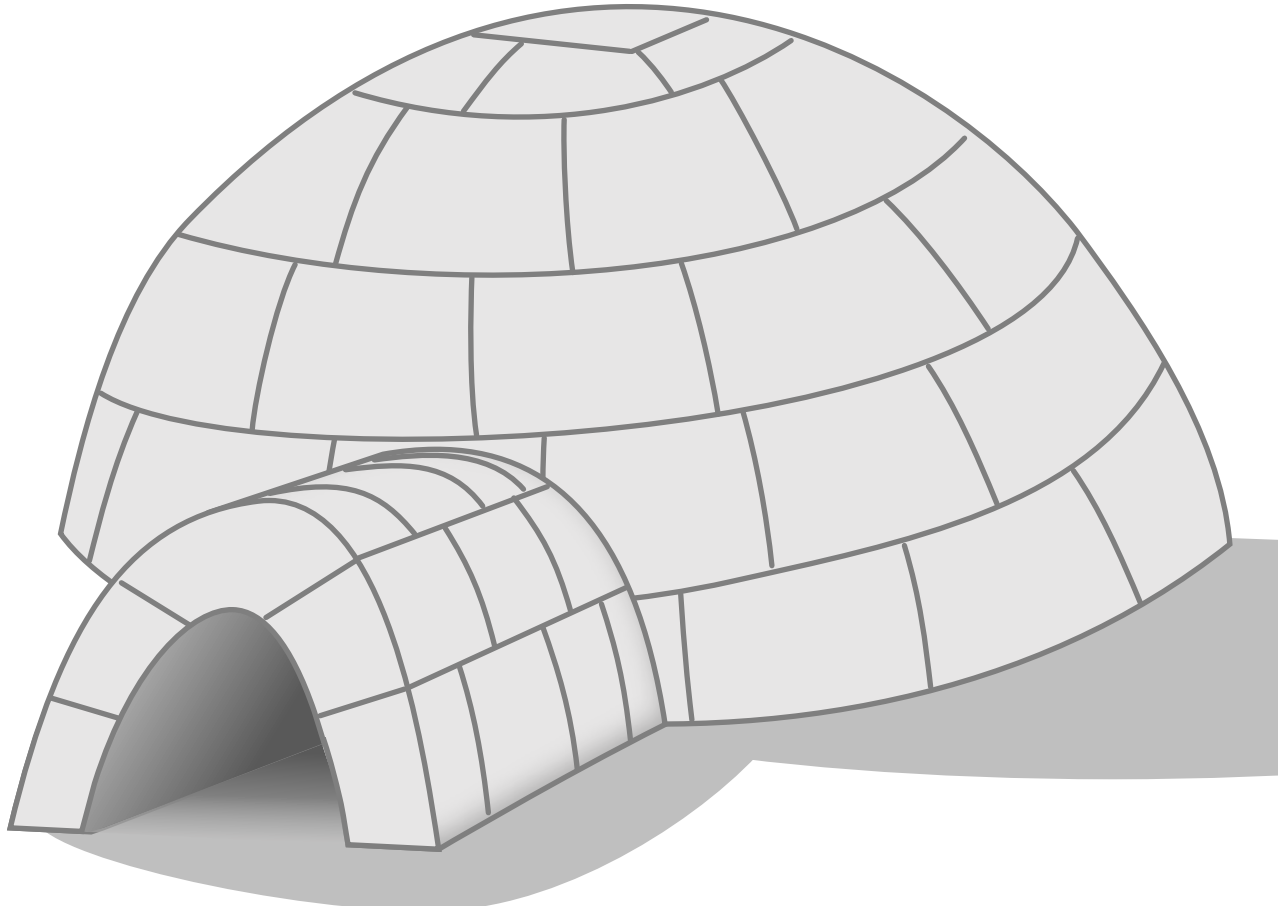
Heat

Cold Air

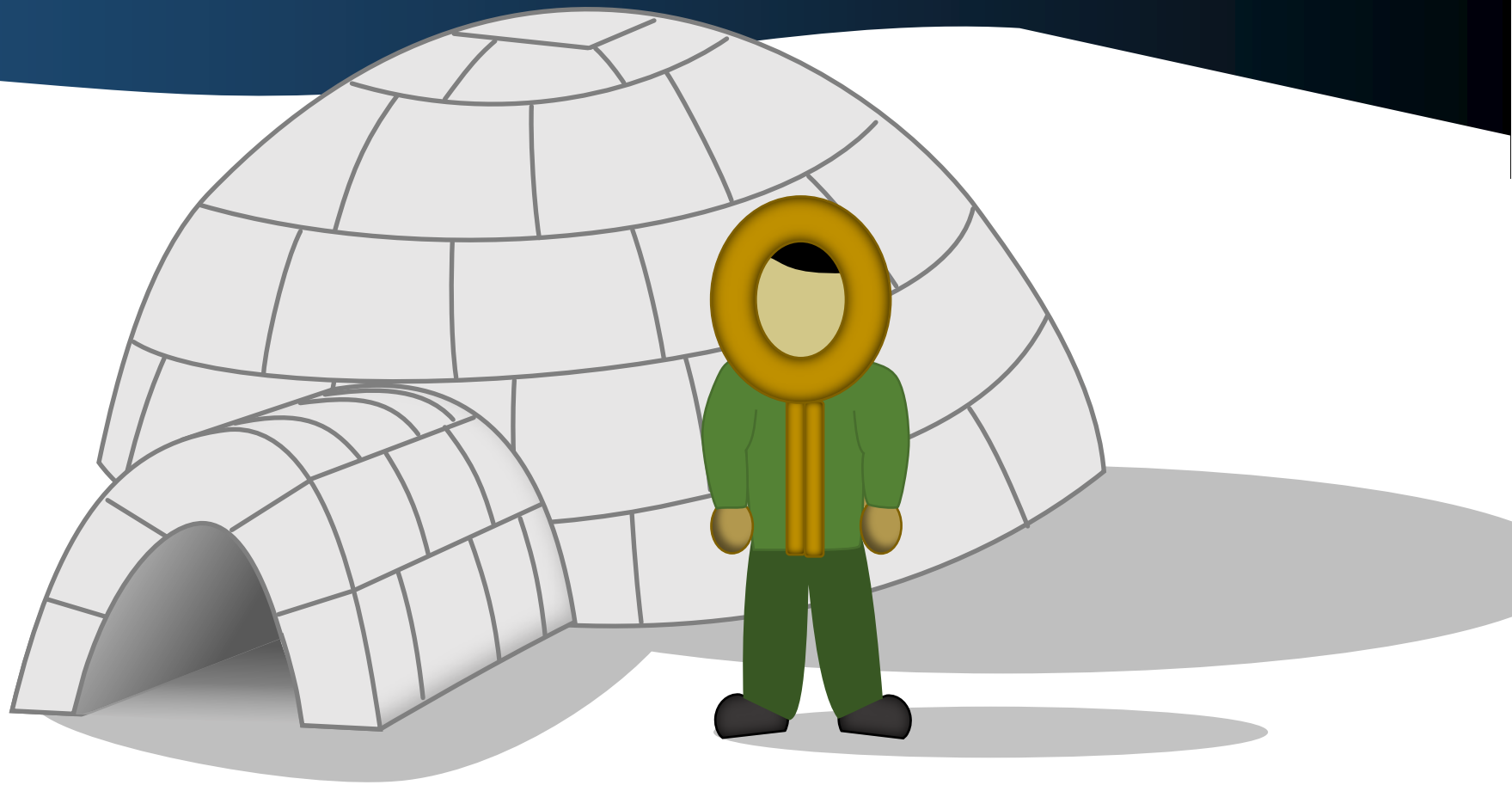
Conduction

Wind

Wetness



Cold Injuries



Hypothermia and Frostbite

Common Cold Injuries

- **Chilblains**
  Painful inflammation of small blood vessels in skin that occur in response to repeated exposure to cold but not freezing air
- **Trench/Immersion Foot**
  Potentially crippling, nonfreezing injury (32-50°F) from prolonged exposure of skin to moisture (12 or more hours - days)
- **Frostbite**
  Freezing of skin and possibly deeper tissues. Skin freezes at 28°F
- **Hypothermia**
  Life-threatening condition when your body's temperature drops below 95°F (35°C)

UpToDate frostbite

Hypothermia and Frostbite

Chilblains

- Painful inflammation of small blood vessels in your skin
- Occurs after repeated exposure to cold air
- Signs and Symptoms:
  - Red and itchy areas on hands and feet
  - Skin may have burning sensation or swell up
  - Blisters and ulcers can occur
  - Skin can turn red or dark blue and hurt
- Treatment
  - Keep hands and feet warm
  - Seek medical care if ulcers or infection

UpToDate frostbite

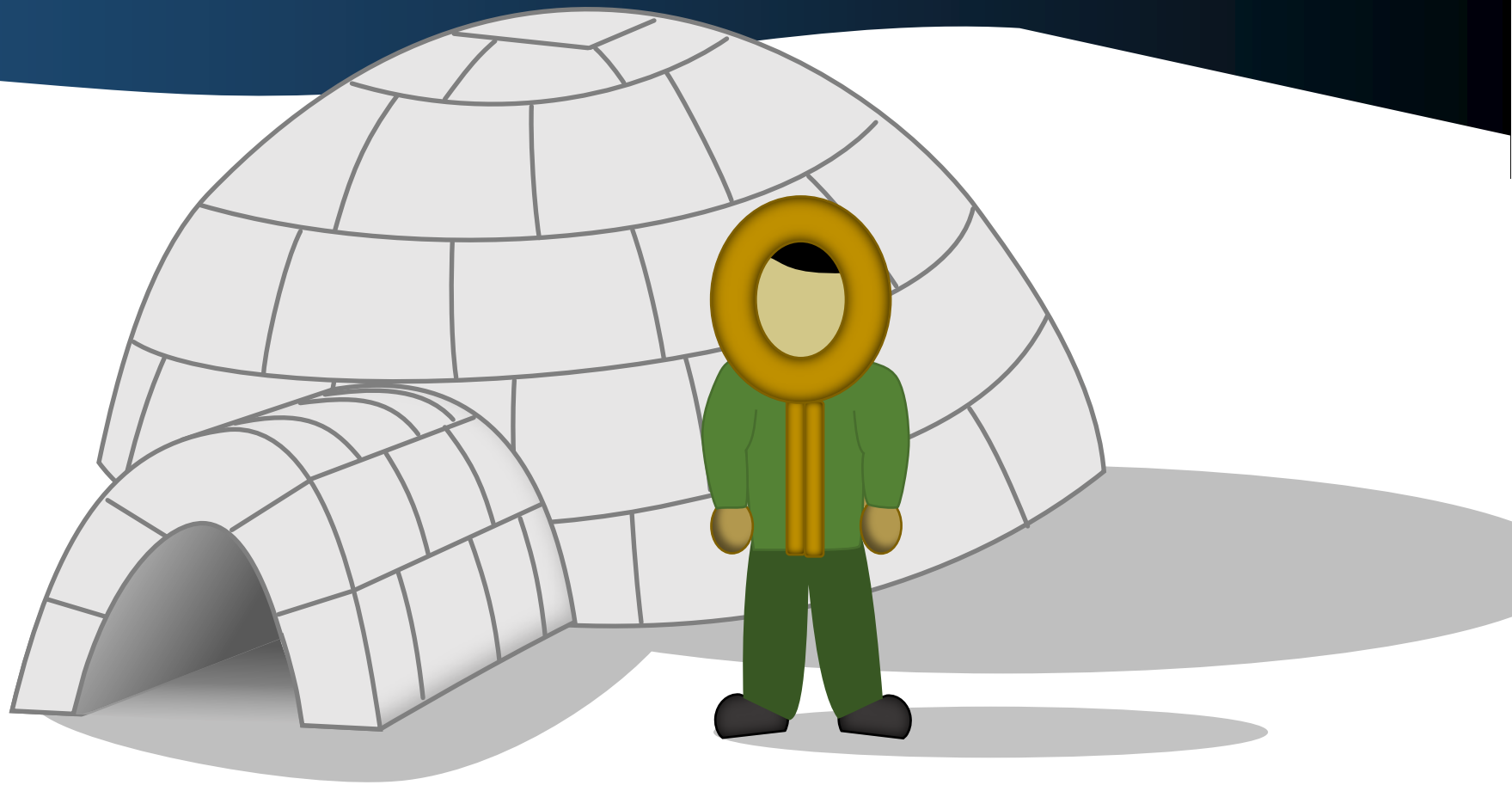
Hypothermia and Frostbite

Trench Foot AKA Immersion Foot Syndrome

- Potentially crippling, nonfreezing injury (32-50°F)
- Prolonged exposure of skin to moisture (10 or more hours)
- Worsened with Tight Boots and Immobilization
- Signs
  - Red or bluish skin
  - Swelling of feet
  - Rotten smell (late sign)
  - Blisters and sores that become infected with fugus
- Prevention
  - Changing socks twice a day
  - Allow feet and boots to dry out
- Treatment – may need antibiotics, surgery or event amputation

UpToDate frostbite

Frostbite



Frostbite

Information for this section is based on:

Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update

McIntosh, Scott E. et al. Wilderness & Environmental Medicine, Volume 30, Issue 4, S19 - S32

Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update

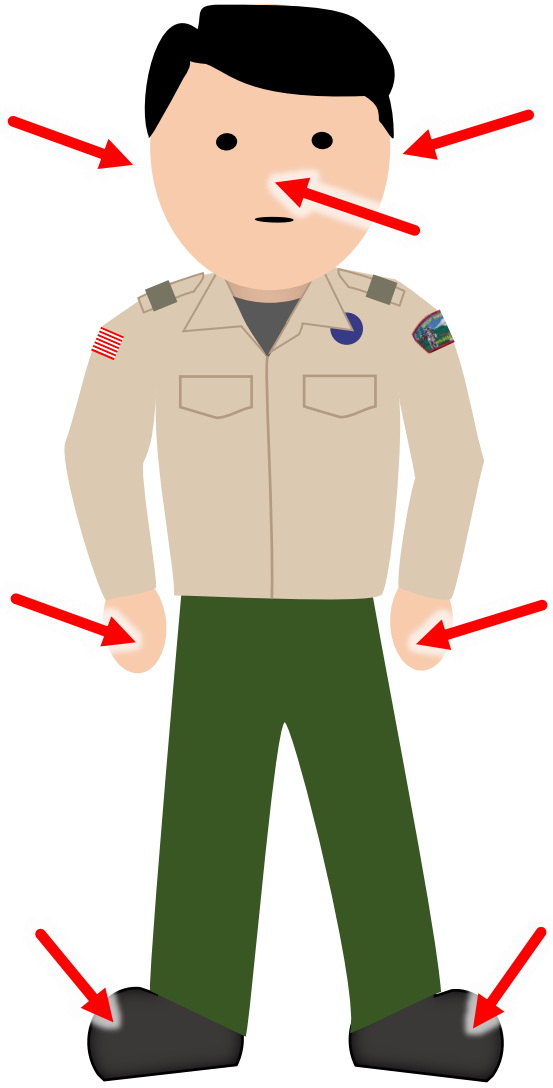
Dow, Jennifer et al. Wilderness & Environmental Medicine, Volume 30, Issue 4, S47 - S69

We encourage anyone traveling to an area where hypothermia or frostbite is a concern to review these articles prior to their trip.

Frostbite

- Skin freezes at 28°F

- Exposed skin:
  - Feet & hands at greatest risk
  - Nose and ears also at risk



UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Frostbite - Signs and Symptoms

Healthy Skin

1st Degree
Superficial Frostbite
Red

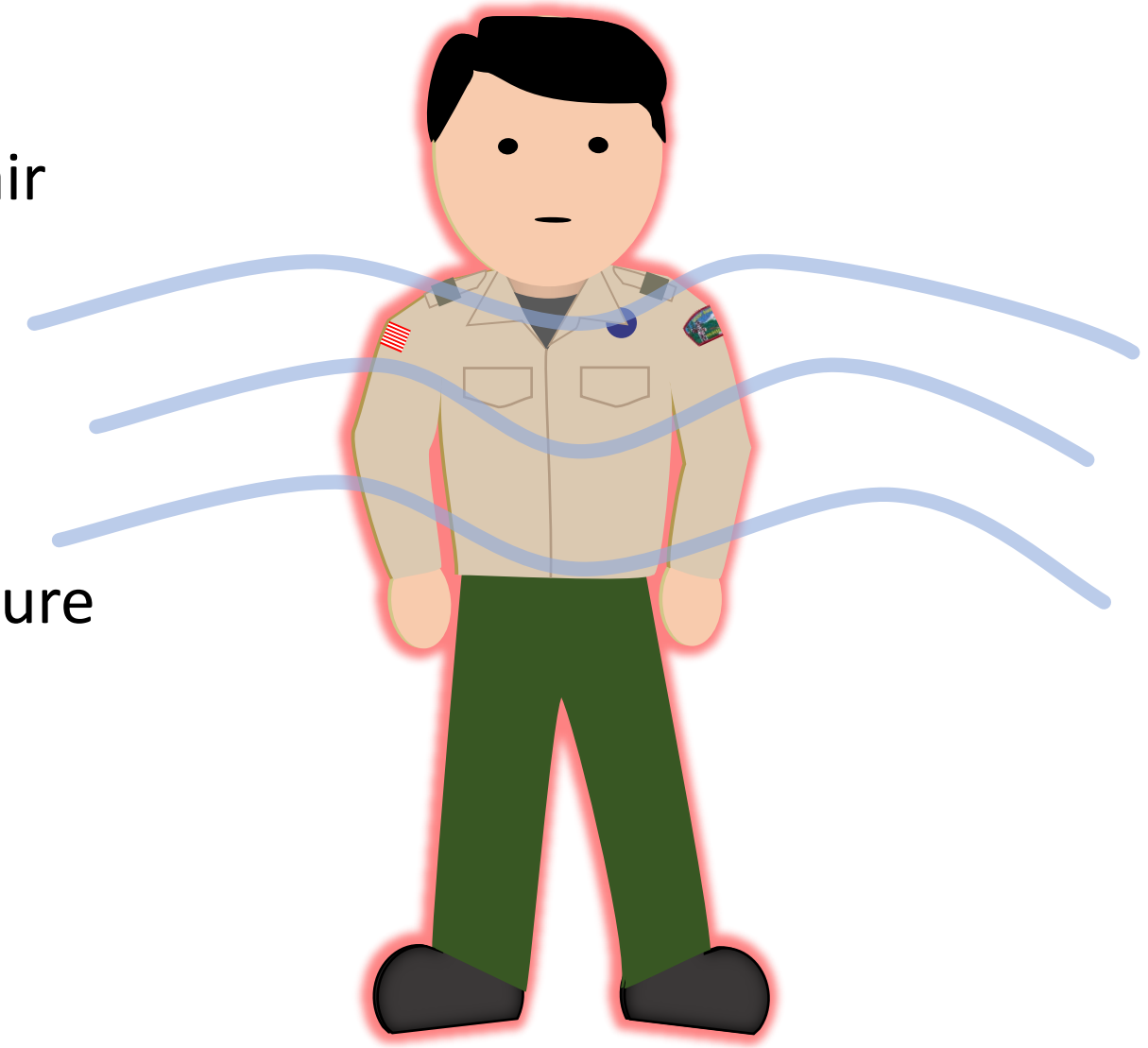
2nd & 3rd Degree
Deeper Frostbite
White/Waxy
Blisters

4th Degree
Deep Frostbite
Black

e frostbite
McIntosh SE, Freer L, Gri S, Rodway GW, Cochran A, evitt M, Imray CH, Johnson L Hackett PH. Medical Society Clinical Practi e Prevention and Treatment Update. Wilderness Environ M S):S19-S32.

Frostbite – Wind Chill

- Body is surrounded by warmed air
- Wind blows away this warm air



- Wind doesn’t lower air temperature
- Hastens cooling

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

NOAA Wind Chill Chart

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45

Frostbite Times: 30 minutes | 10 minutes | 5 minutes

Chart Source: weather.gov/safety/cold-wind-chill-chart

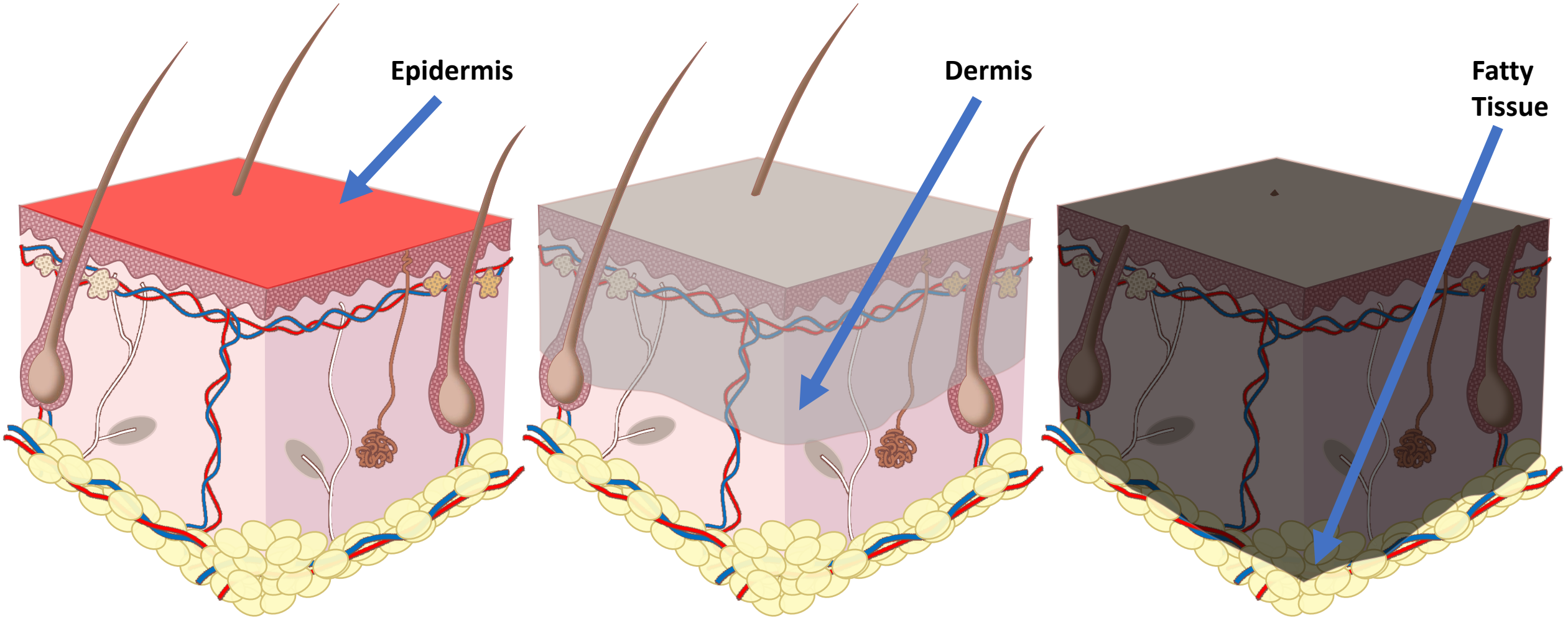
Hypothermia and Frostbite

Frostbite – Classification of Frostbite

- **Frostnip** – NOT Frostbite
  - Superficial nonfreezing cold injury
  - Associated with intense vasoconstriction on exposed skin
  - Frost may appear on skin
  - Numbness and pallor resolve quickly after warming
  - No long-term damage occurs

ostbite
McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pan tt PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2 -S32.

Frostbite – Classification of Frostbite



1st Degree

2nd Degree

3rd Degree

Image Source: U.S. Army Medical Department Center and School Fort Sam Houston, TX 78234-6100 Wound Care Subcourse MD0576

Hypothermia and Frostbite

Frostbite – Classification of Frostbite

- **First-Degree Frostbite**
  - Numbness and erythema (redness)
  - A white or yellow, firm, slightly raised plaque
  - No gross tissue infarction occurs
  - There may be slight epidermal sloughing
  - Mild edema is common

ostbite
McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pan tt PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2 -S32.

Hypothermia and Frostbite

Frostbite – Classification of Frostbite

- **Second-Degree Frostbite**
  - Blisters with clear or milky fluid
  - Surrounded by erythema (redness) and edema

ostbite
McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pan tt PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2 -S32.

Hypothermia and Frostbite

Frostbite – Classification of Frostbite

- **Third-Degree Frostbite**
  - Deeper bloody (hemorrhagic) blisters
  - Injury has extended into the reticular dermis and beneath the dermal vascular plexus

ostbite
McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pan tt PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2 -S32.

Hypothermia and Frostbite

Frostbite – Classification of Frostbite

- **Fourth-Degree Frostbite**
  - Injury extends completely through the dermis
  - Involves the comparatively avascular subcutaneous tissues
  - Necrosis extending into muscle and to the level of bone
  - Initially mottled, deep red or cyanotic
  - Eventually dry, black and mummified

ostbite
McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pan tt PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2 -S32.

Hypothermia and Frostbite

Frostbite – Classification of Frostbite – Simplified System

- **Superficial**
  - No or minimal anticipated tissue loss
  - Corresponding to 1st- and 2nd-degree injury

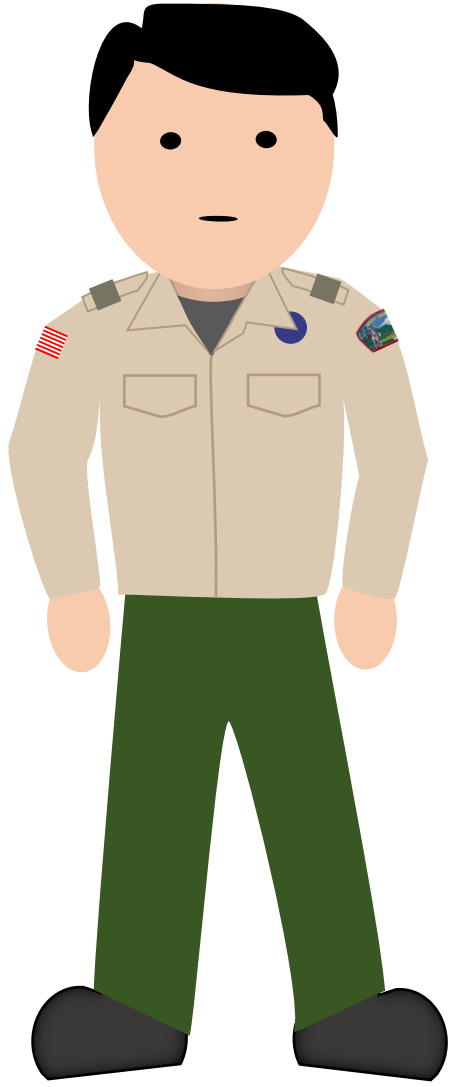
- **Deep**
  - Deeper injury and anticipated tissue loss
  - Corresponding to 3rd- and 4th-degree injury

ostbite
McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pan tt PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2 -S32.

Hypothermia and Frostbite

Frostbite – Prevention

- Prevention is far better than Treatment!
- Typically preventable
- Often not improved by treatment



UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

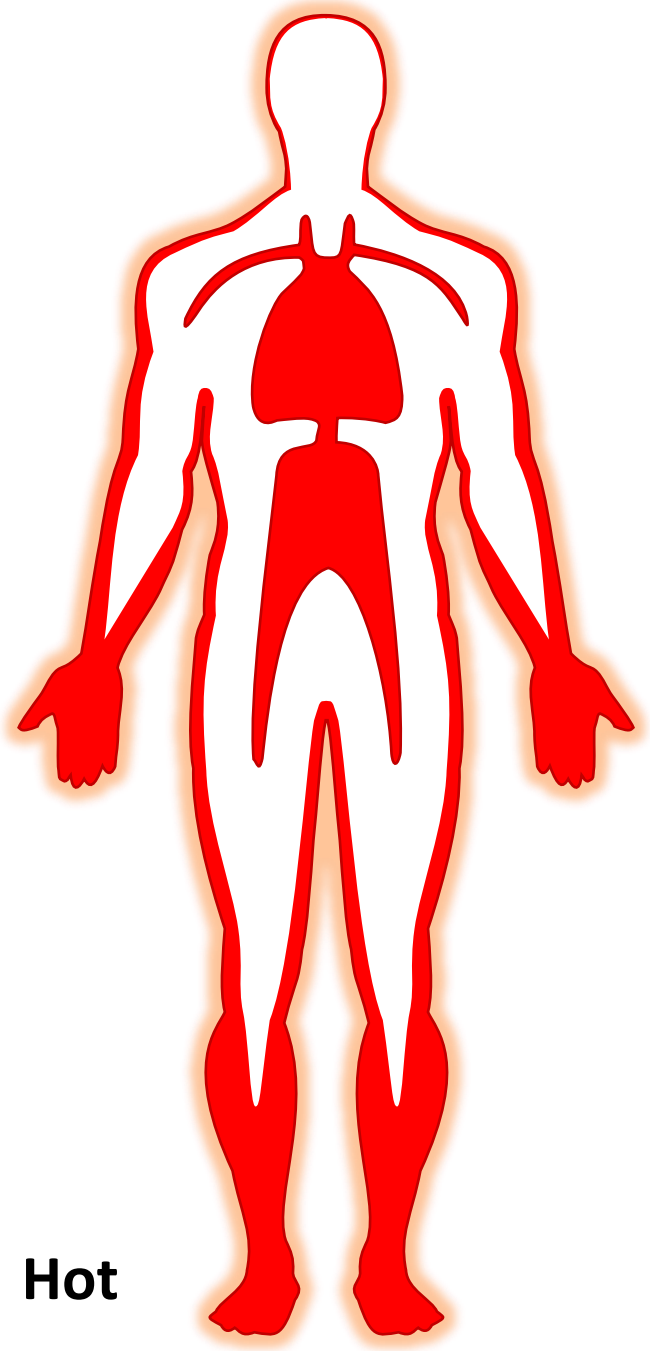
Hypothermia and Frostbite

Frostbite – Prevention

- Cover Exposed Skin
- Keep Core Temperature Up

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Heat Regulation

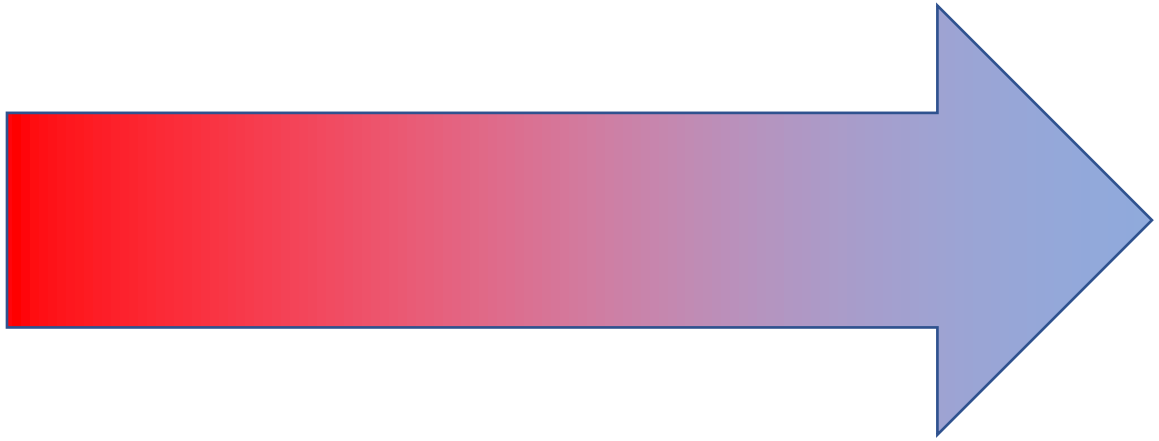


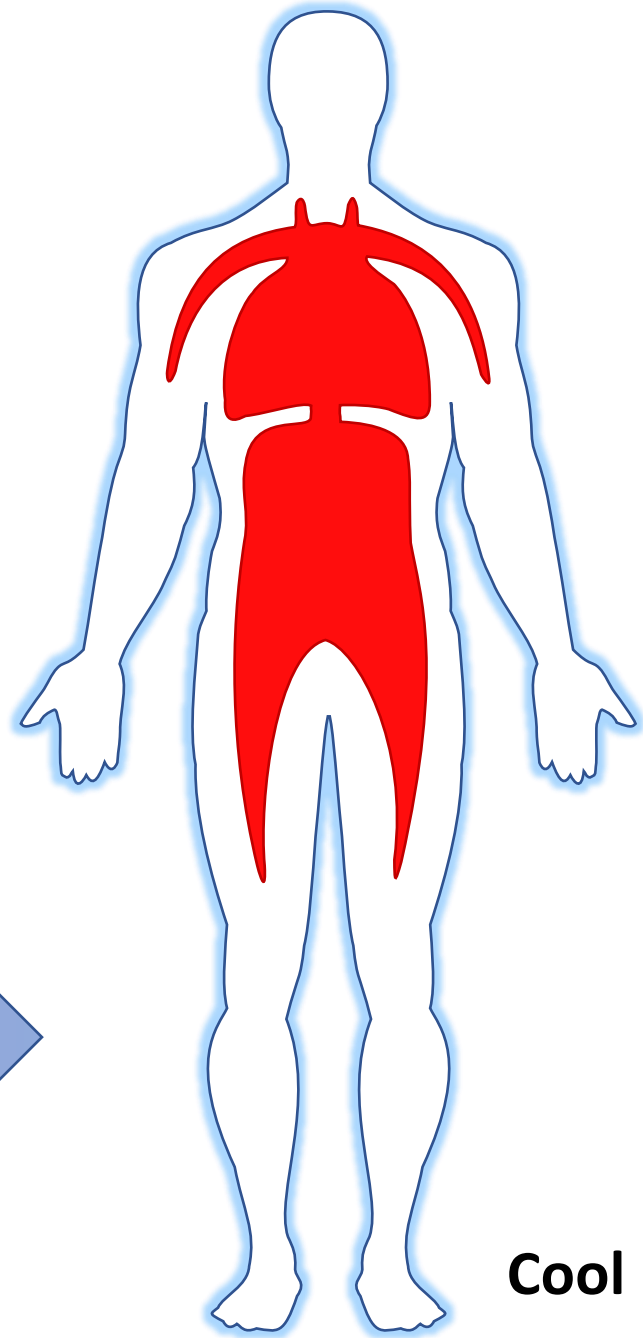
Hot

As your body cools

Blood is redirected

from Skin to Core

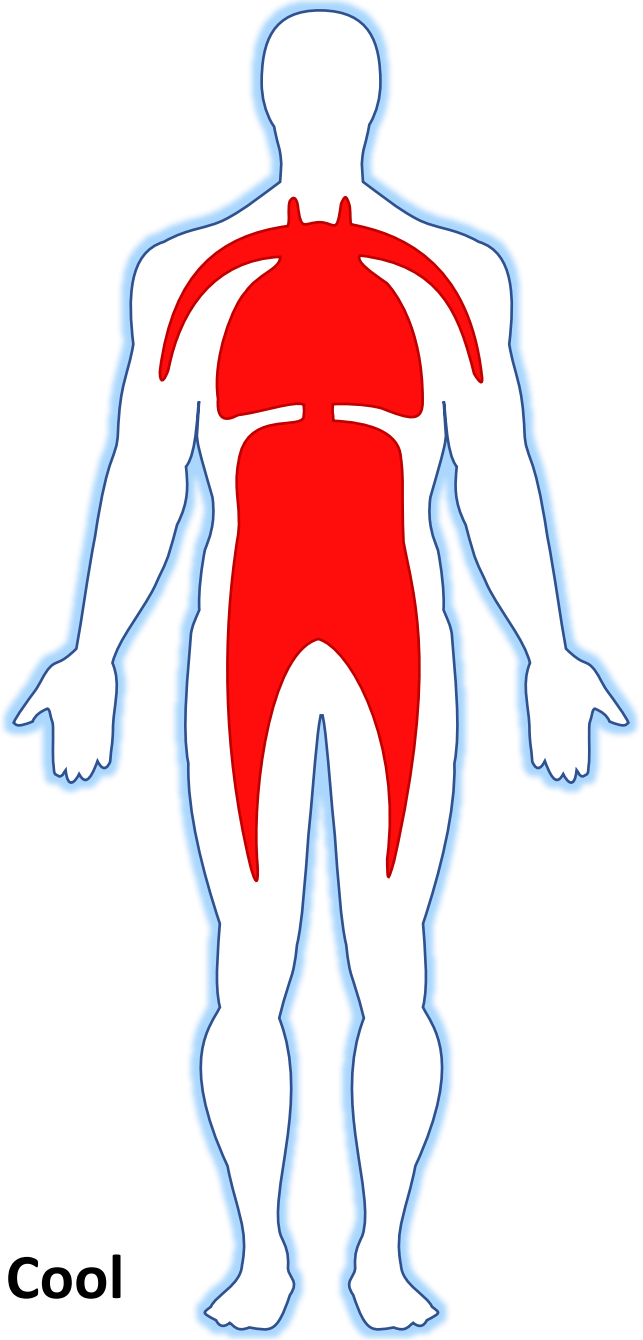




Cool

Images based on Rowell LB. Human experimentation: No accurate, quantitative data? Journal of Applied Physiology Published 1 March 2007 Vol. 102 no. 3, 837-840.

Blood Equals Heat



Cool

Dehydration = Less Blood

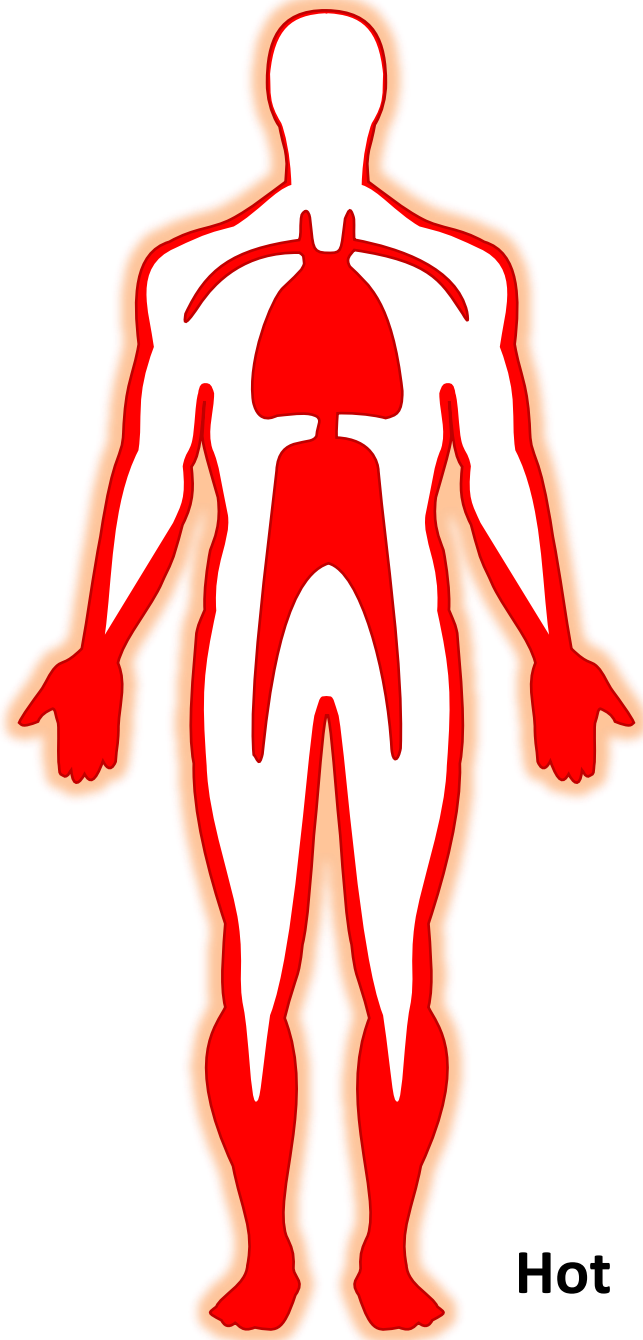
Tight Boots = Less Blood

Less Blood = Risk Frostbite

Hydration = Increased Blood Flow

Exercise = Increased Blood Flow

Windmilling = Increased Blood Flow



Hot

Images based on Rowell LB. Human experimentation: No accurate, quantitative data? Journal of Applied Physiology Published 1 March 2007 Vol. 102 no. 3, 837-840.

Hypothermia and Frostbite

Frostbite – Prevention – Peripheral Perfusion

- Maintain adequate core temperature and body hydration
- Minimize effects of known diseases or medications and drugs that may decrease perfusion
- Cover all skin and the scalp to avoid vasoconstriction
- Minimize restriction in blood flow, such as constrictive clothing, footwear, or immobility
- Ensuring adequate nutrition
- Use supplemental oxygen in severely hypoxic conditions (e.g., >7500m)

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Prevention – Exercise

- Enhances cold-induced peripheral vasodilation (CIVD)
- Increased thermal response in the hands and toes during exercise
- Exercise elevates the core and peripheral temperatures
  - Protective in preventing frostbite
  - Protective in preventing hypothermia
  - Assuming you have reserve energy for exercise
  - If you exercise to collapse – expect profound systemic heat loss

UpToDate frostbite

Dobnikar, U., Kounalakis, S.N., and Mekjavic, I.B. The effect of exercise-induced elevation in core temperature on cold-induced vasodilatation response in toes. Eur J Appl Physiol. 2009; 106: 457–464

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Prevention – Protection from Cold

- Temperature below 0°F with minimal wind are dangerous – Avoid this
- Protect skin from moisture, wind, and cold
- Stay dry – avoid sweating or getting wet
- Layer up and increase insulation
- Don’t be stupid in the cold - Avoid drugs, alcohol and hypoxemia
- Chemical heat warmer can increase vasodilation in feet and hands
  - Don’t place directly against skin and avoid constricting flow in boots
- “Cold checks” if extremity numbness or pain or other concern
- Recognize frostnip or superficial frostbite before it becomes worse
- Emollients are dangerous, avoid these

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Frostbite - Treatment

- Remove jewelry
- Remove wet clothing
- Place dry dressings between digits otherwise tissue will get wet and icky (tissue maceration during demarcation)
- Elevate (to reduce swelling)

oToDate frostbite
McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, I ow J, Hackett PH.
Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. V 30(4S):S19-S32.

Frostbite - Treatment

Evacuate to a Hospital

oToDate frostbite
McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, I ow J, Hackett PH.
Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. V 30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Treatment – Evac

- Frostbite victims need to be seen by a medical care provider
- Evac is needed for both urgent and long-term management
  - Hospitalization
  - Hydrotherapy
  - Sympathectomy
  - Thrombolytic Therapy or Heparin
  - Vasodilator Therapy
  - Hyperbaric Oxygen Therapy
  - Fasciotomy
  - Imaging
  - Surgical Treatment or Amputation

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Treatment – Evacuation is Delayed

- If evacuation is delayed greater than two hours, rewarm
  - Keep victim warm
  - Dry heat is difficult to regulate and is not recommended
  - Buddy system – skin to skin
  - Soak in warm water (37-39°C / 98.6-102.2°F) for 15-30 minutes

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Rescuer Five-Finger Thermometer

Hypothermia and Frostbite

Frostbite – Treatment – Thawing

- Dry heat is difficult to regulate
  - Danger of burning tissue if too hot or too close
- Rapid rewarming in water bath is better than a slow thaw
  - Water should be heated to 37°C to 39°C (98.6° to 102.2°F)
  - Water should feel nice and warm to caregiver (check for 30 seconds)
  - Recheck water often to make sure it doesn't get too cold
  - Avoid contact between side of pot and frozen parts
- Rewarming is complete when
  - Red or purple appearance and soft and pliable to the touch
  - Takes about 30 minutes

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Treatment – When NOT to Rewarm

Do NOT Rewarm If:

Evacuation by Walking and Extensive Frostbite (entire foot)
or
If Refreezing is Expected

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Treatment – Thaw or Not?

- Prostaglandin and thromboxane is released when tissue thaws
  - Causes vasoconstriction, platelet aggregation and thrombosis
  - This results in dermal ischemia, and further tissue damage
- Refreezing thawed tissue makes this even worse
- Must avoid refreeze at all cost!
- If likely that tissue will refreeze, keep frozen until able to safely thaw

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Treatment – Thawing – Afterwards

- Remove jewelry if not done so already
- Allow thawed extremity to dry
- Place gauze between toes
- Place dry bulky dressing on extremity
  - Keep loose enough to allow for swelling
- Keep elevated is possible
- DO NOT RUB
- Do NOT walk on extremity
- Prevent refreezing
- Keep body hydrated

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Treatment – Ibuprofen

- Decreases production of prostaglandin and thromboxane
  - In setting of thawing frostbite – this is a good thing
- Aspirin may also help – but ibuprofen is thought to be better

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Treatment – Walking on Frostbite?

- Most agree that you should NOT use frostbitten hands or feet to climb or walk
- This could cause more damage to an already damaged extremity

- That said, there are stories about people with frostbite walking for days on frozen extremities with minimal or no amputation
- If you must evac on a frozen extremity, protect it as much as possible
  - Pad, splint and immobilize
  - Avoid rethawing extremity until safe to do so

UpToDate frostbite

Mills WJ Jr. Frostbite. A method of management including rapid thawing. Northwest Med. 1966 Feb;65(2):119-25.

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Risk Factors - Behavioral

- Inadequate clothing and shelter
- Alcohol and other drug use
- Psychiatric illness
- Smoking

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

Frostbite – Risk Factors - Physiological

- Genetic susceptibility
- Dehydration and hypovolaemia
- High altitude, hypoxia and hypothermia
- Diabetes, atherosclerosis, vasculitis
- Arthritis
- Raynaud's phenomenon
- Vasoconstrictive drugs
- Cryoglobulinopathies
- Sweating or hyperhydrosis (↑ heat loss)
- Previous frostbite

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia and Frostbite

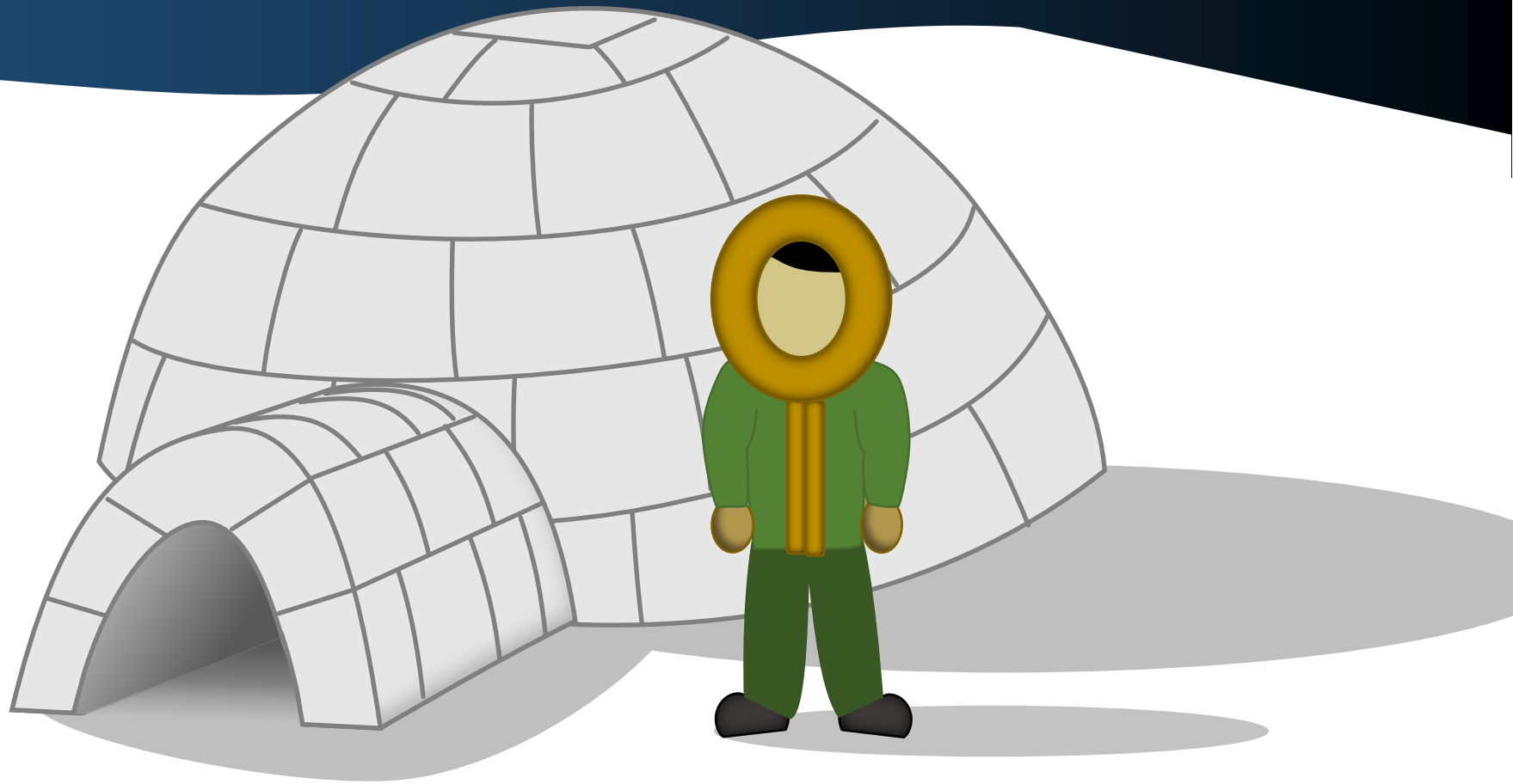
Frostbite – Risk Factors - Mechanical

- Tightly constrictive clothing (too many socks)
- Contact with heat conductive materials
- Rings on fingers
- Immobility (military situations)

UpToDate frostbite

McIntosh SE, Freer L, Grissom CK, Auerbach PS, Rodway GW, Cochran A, Giesbrecht GG, McDevitt M, Imray CH, Johnson EL, Pandey P, Dow J, Hackett PH. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S19-S32.

Hypothermia



Hypothermia and Frostbite

Hypothermia

A good deal of the information for this section is based on:

Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update

Dow, Jennifer et al. Wilderness & Environmental Medicine, Volume 30, Issue 4, S47 - S69

We encourage anyone traveling to an area where hypothermia is a concern to review this article prior to their trip.

Cold Air

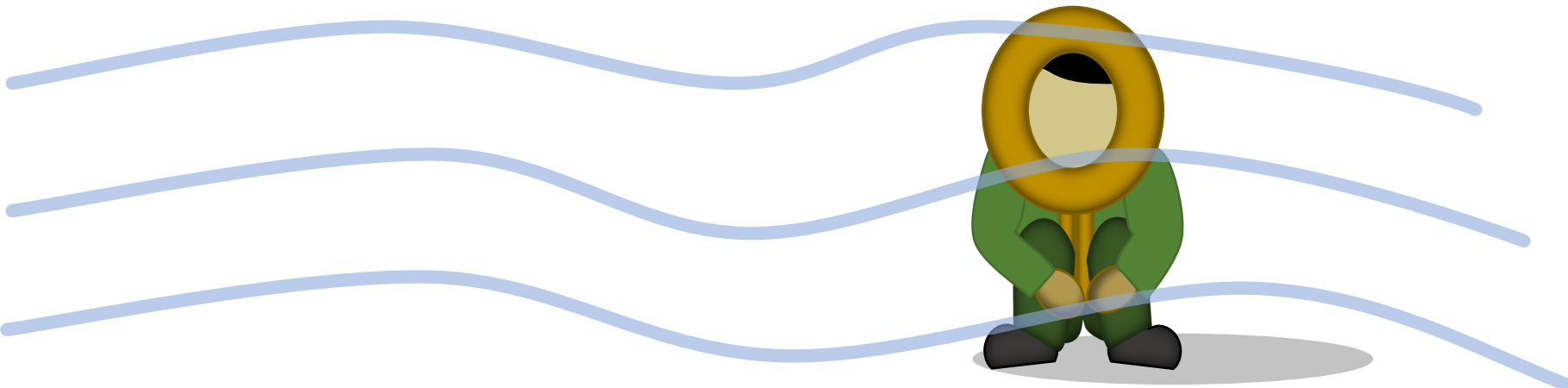
Conduction

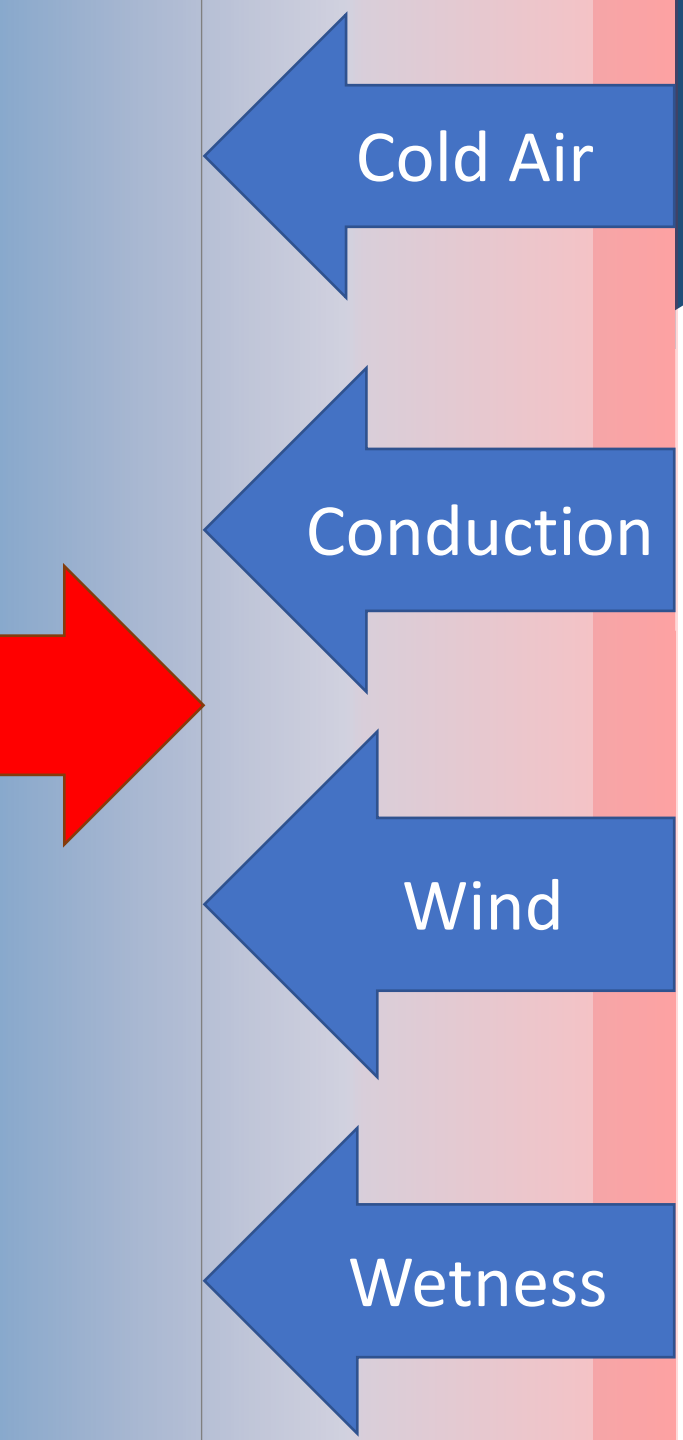
Wind

Wetness

Hypothermia

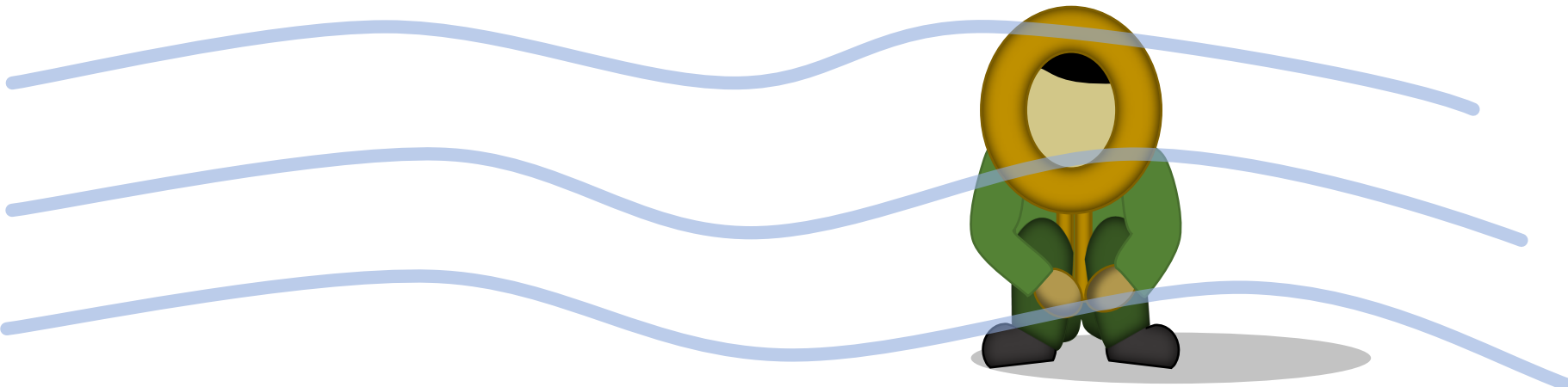
- A condition when body's temperature is below normal





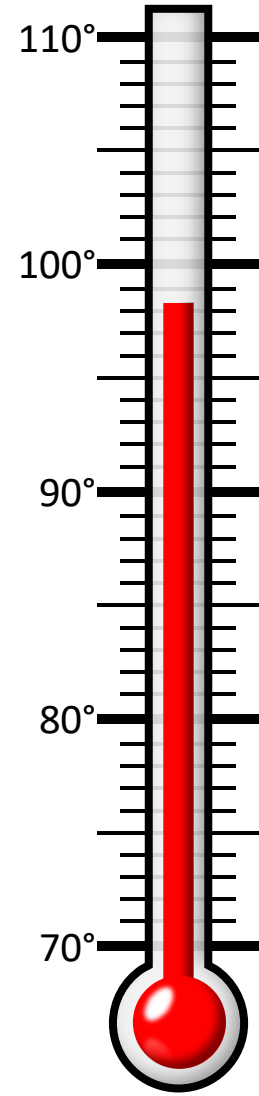
Hypothermia

- Heat Loss is Greater than Heat Generation
- Generally occurs in temperatures ~ 30-50°F
- Can occur at up to 70°F
  - Especially when wet or in water



Hypothermia "the Swiss System"

Mild (HT I)	90-95°F (32-35°C)	Awake and shivering
Moderate (HT II)	82-90°F (28-32°C)	Drowsy and not shivering
Severe (HT III)	75-82°F (24-28°C)	Unconscious, not shivering
Profound (HT IV)	57-75°F (13.7-24°C)	No vital signs, Dead?
Death (HT V)	<48-57°F (9-13.7°C)	Death

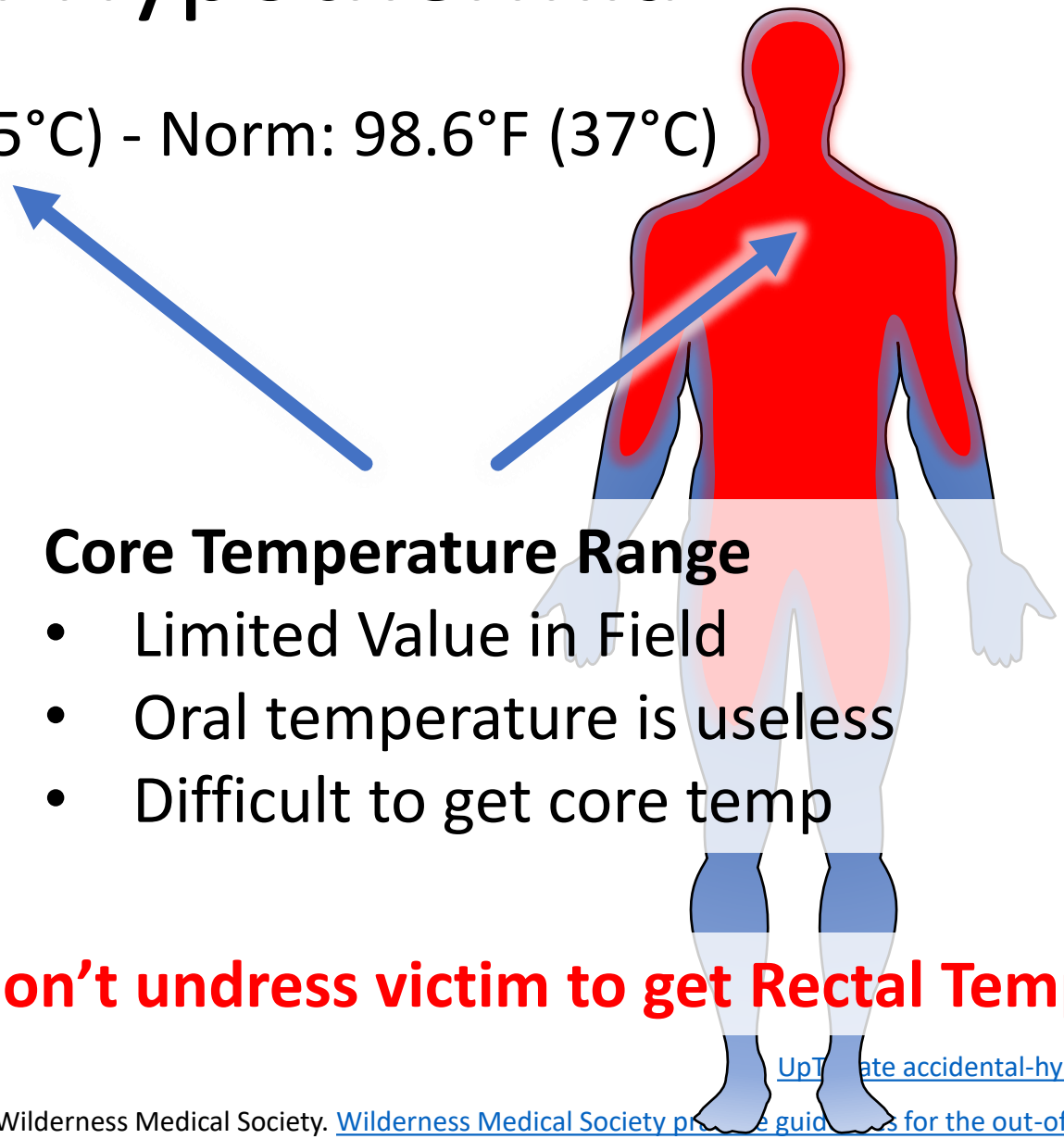


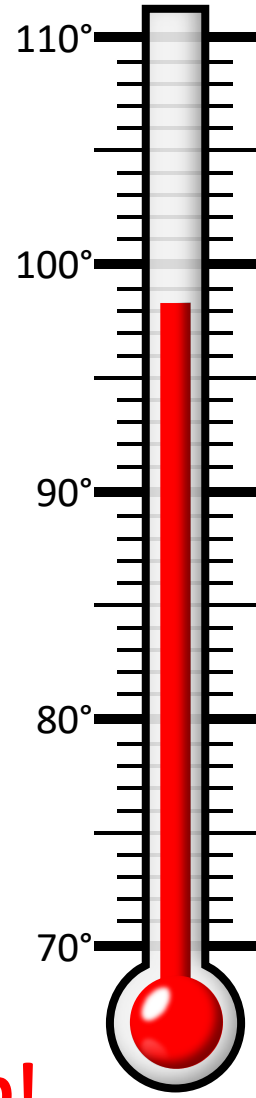
UpToDate accidental-hypothermia-in-adults

Stages of Hypothermia

Not Hypothermic > 95°F (35°C) - Norm: 98.6°F (37°C)

Shivering	No
Functioning Normally	Yes
Normal Mental Status	Yes
Conscious	Yes
Signs of Life	Yes





Core Temperature Range

- Limited Value in Field
- Oral temperature is useless
- Difficult to get core temp

Don’t undress victim to get Rectal Temp!

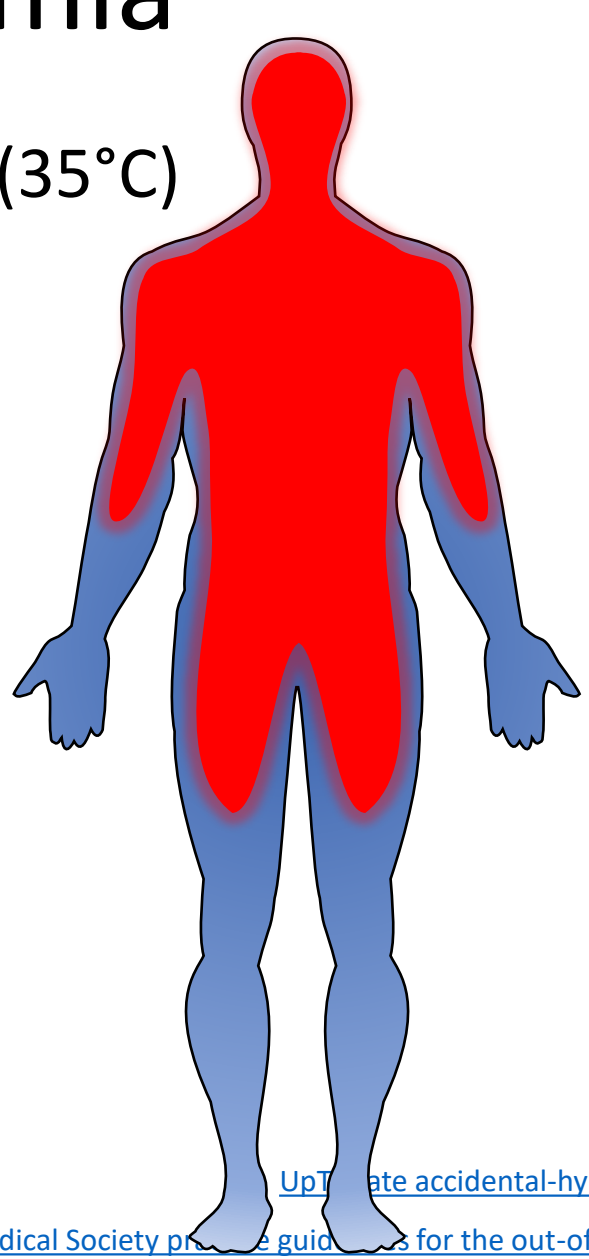
UpT[illegible]ate accidental-hypothermia-in-adults

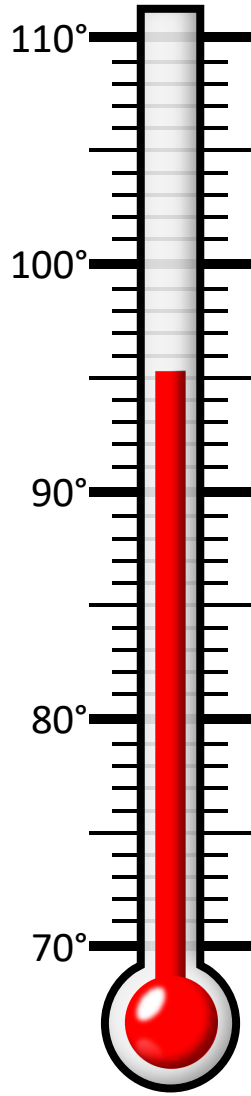
Zafren K, et al. Wilderness Medical Society. Wilderness Medical Society pr[illegible]e guid[illegible]s for the out-of-hospital evaluation and treatment of accidental hypothermia: 2014 update. Wilderness Environ Med. 2014. Dec;25(4 Suppl):S66-85.

Stages of Hypothermia

Cold Stressed – Not Hypothermic > 95°F (35°C)

Shivering	**Yes**
Functioning Normally	Yes
Normal Mental Status	Yes
Conscious	Yes
Signs of Life	Yes





UpT ate accidental-hypothermia-in-adults

Zafren K, et al. Wilderness Medical Society. Wilderness Medical Society pr e guid s for the out-of-hospital evaluation and treatment of accidental hypothermia: 2014 update. Wilderness Environ Med. 2014. Dec;25(4 Suppl):S66-85.

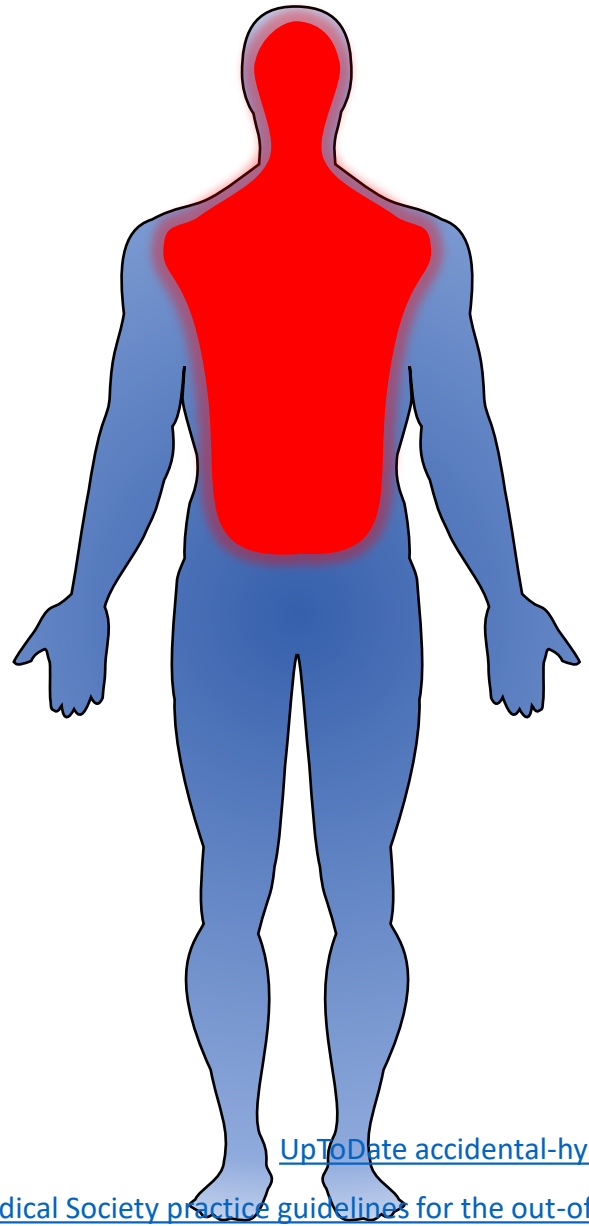
Stages of Hypothermia

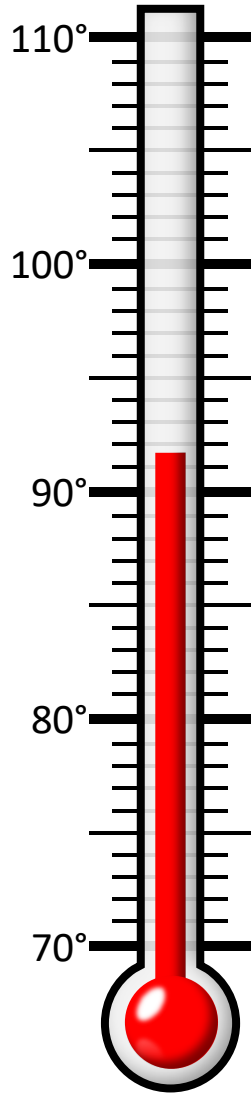
Mild Hypothermia (HTI) 90-95°F (32-35°C)

Shivering	**Yes**
Functioning Normally	**NO**
Normal Mental Status	Yes
Conscious	Yes
Signs of Life	Yes

Umbles

- F*umble*
- Gr*umble*
- M*umble*
- St*umble*
- T*umble*





UpToDate accidental-hypothermia-in-adults

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Stages of Hypothermia

Mild Hypothermia - Signs and Symptoms

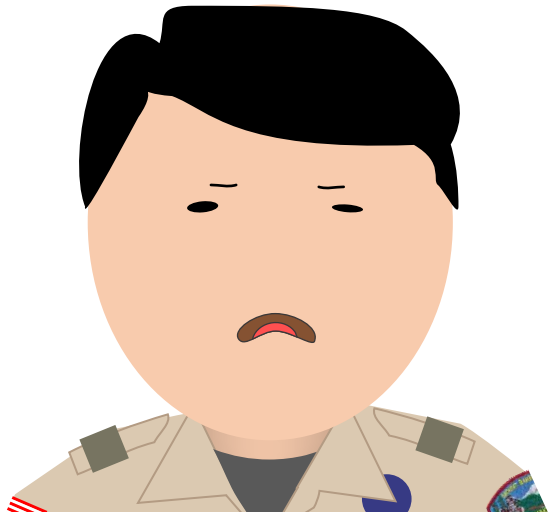
- **Shivering**
- High blood pressure
- Fast heart rate
- Fast respiratory rate
- Contraction of blood vessels
- Increased urine production due to cold
- Liver dysfunction may be present
- Mental confusion may be present

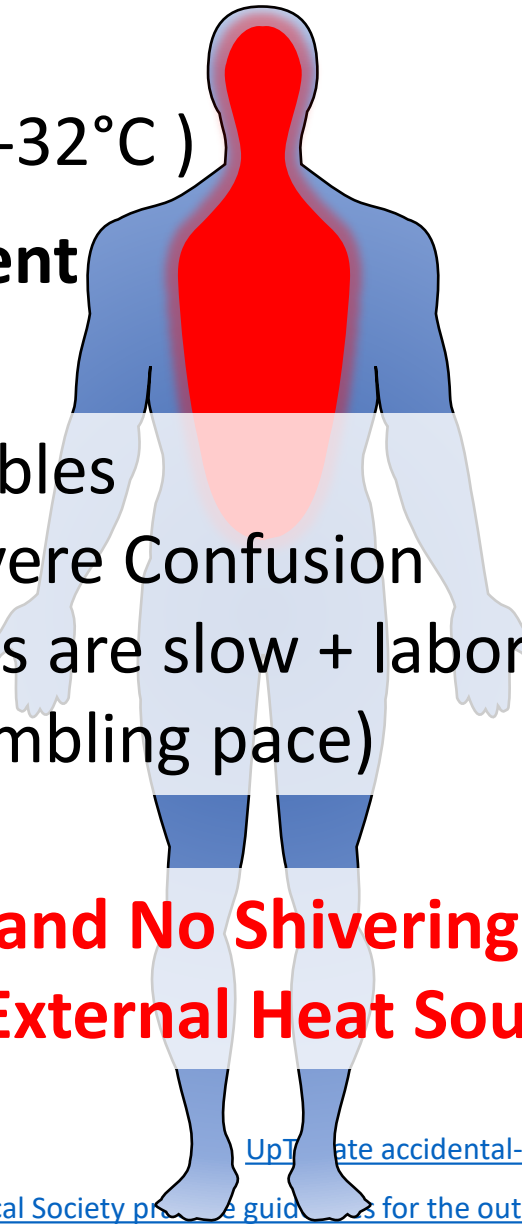
UpToDate accidental-hypothermia-in-adults

Stages of Hypothermia

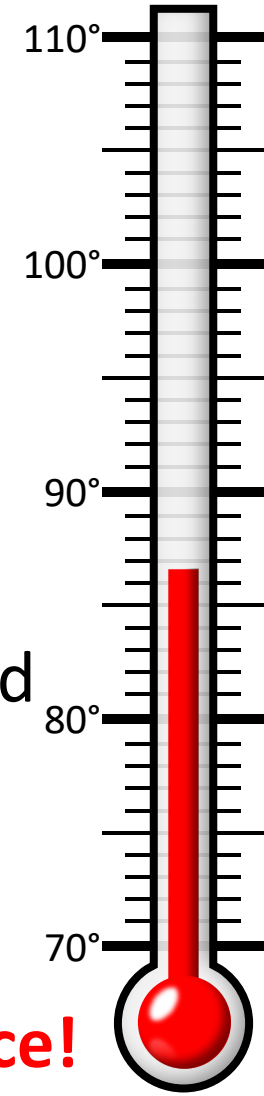
Moderate Hypothermia (HTII) 82-90°F (28-32°C)

Shivering	**Becomes Violent then Absent**
Functioning Normally	**NO**
Normal Mental Status	**NO**
Conscious	Yes
Signs of Life	Yes





- Severe Umbles
- Mild to Severe Confusion
- Movements are slow + labored
- Ataxia (stumbling pace)



Hypothermia and No Shivering?
Victim Needs an External Heat Source!

UpT ate accidental-hypothermia-in-adults

Zafren K, et al. Wilderness Medical Society. Wilderness Medical Society pr e guid s for the out-of-hospital evaluation and treatment of accidental hypothermia: 2014 update. Wilderness Environ Med. 2014. Dec;25(4 Suppl):S66-85.

Stages of Hypothermia

Moderate Hypothermia - Signs and Symptoms

- **Shivering** becoming more **violent or absent**
- Muscle miscoordination becomes apparent
- Movements are slow and labored
- Ataxia (stumbling pace)
- Mild to severe confusion, although the person may appear alert
- Surface blood vessels contract
- Pale skin
- Lips, ears, fingers, and toes may become blue

UpToDate accidental-hypothermia-in-adults

Stages of Hypothermia

Moderate-Severe Hypothermia - Signs and Symptoms

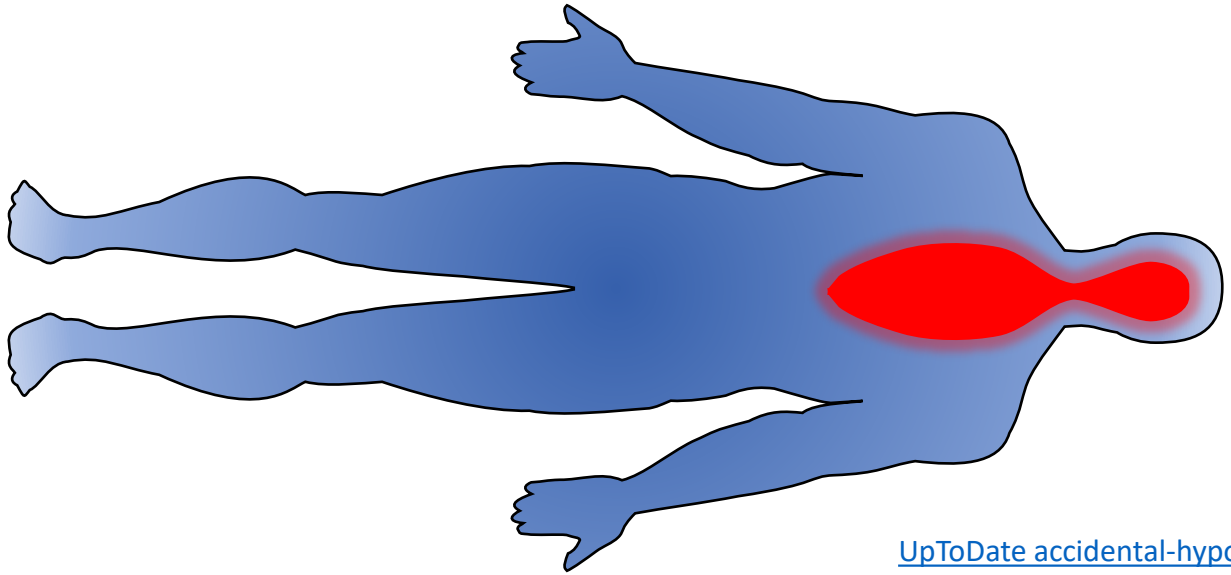
- No Shivering
- Heart rate, respiratory rate, and blood pressure all decrease.
  - Expected heart rate in the 30s at a temperature of 82°F (28°C)
  - Fast heart rates (ventricular tachycardia, atrial fibrillation) possible
- Difficulty speaking, sluggish thinking, and amnesia start to appear
- Inability to use hands and stumbling are also usually present
- Exposed skin becomes blue and puffy
- Muscle coordination very poor, and walking almost impossible
- Incoherent/irrational behavior or even stupor

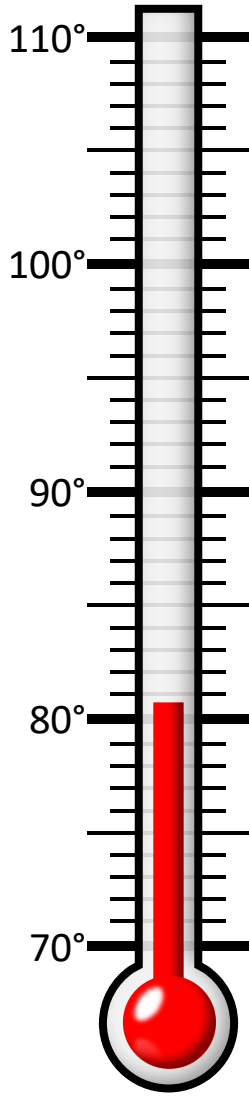
Stages of Hypothermia

Severe Hypothermia (HTIII) < 82°F (28°C)

Shivering	**NO**
Functioning Normally	**NO**
Normal Mental Status	**NO**
Conscious	**NO**
Signs of Life	Yes

- Will die without heat source
- Handle with Care
- Keep Supine (lying on back)





UpToDate accidental-hypothermia-in-adults

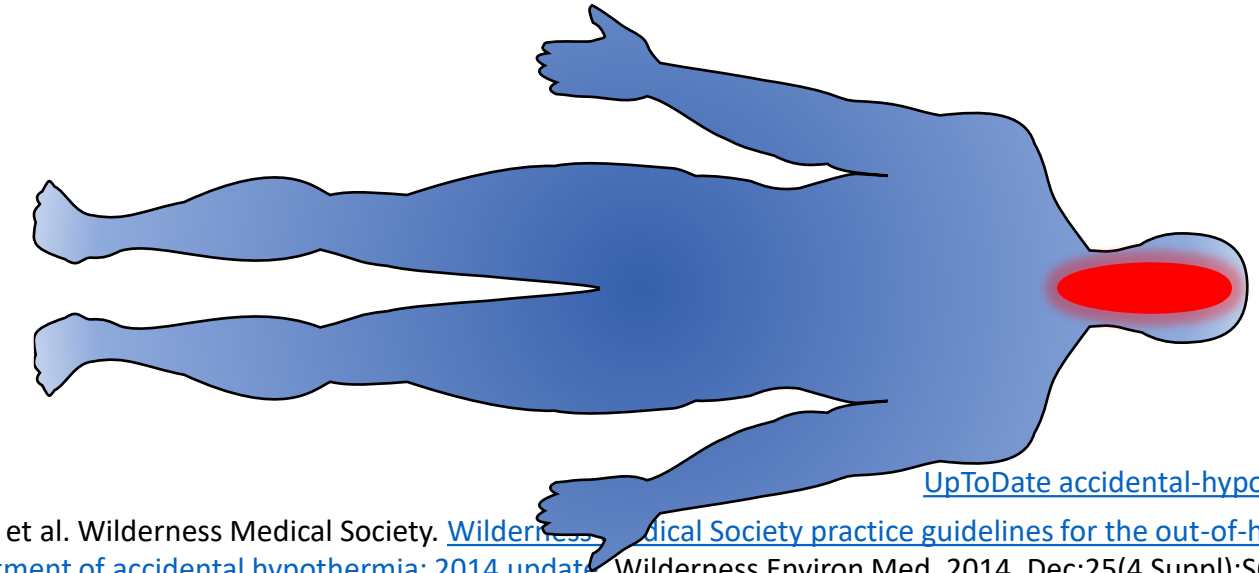
Zafren K, et al. Wilderness Medical Society. Wilderness Medical Society practice guidelines for the out-of-hospital evaluation and treatment of accidental hypothermia: 2014 update. Wilderness Environ Med. 2014. Dec;25(4 Suppl):S66-85.

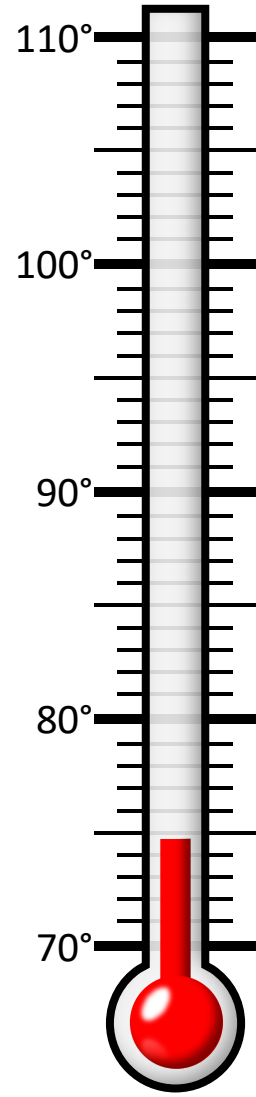
Stages of Hypothermia

Profound Hypothermia (HTIV) < 75°F (24°C)

Shivering	**NO**
Functioning Normally	**NO**
Normal Mental Status	**NO**
Conscious	**NO**
Signs of Life	**NO**

- Appears dead
- Extended CPR required
- Maintain temp in transit
- Rewarm at Hospital





"a Victim is NOT Dead until Warm and Dead"

UpToDate accidental-hypothermia-in-adults

Zafren K, et al. Wilderness Medical Society. Wilderness Medical Society practice guidelines for the out-of-hospital evaluation and treatment of accidental hypothermia: 2014 update. Wilderness Environ Med. 2014. Dec;25(4 Suppl):S66-85.

Paal P, Gordon L, et al. Accidental hypothermia-an update : The content of this review is endorsed by the International Commission for Mountain Emergency Medicine (ICAR MEDCOM). Scand J Trauma Resusc Emerg Med. 2016 Sep 15;24(1):111.

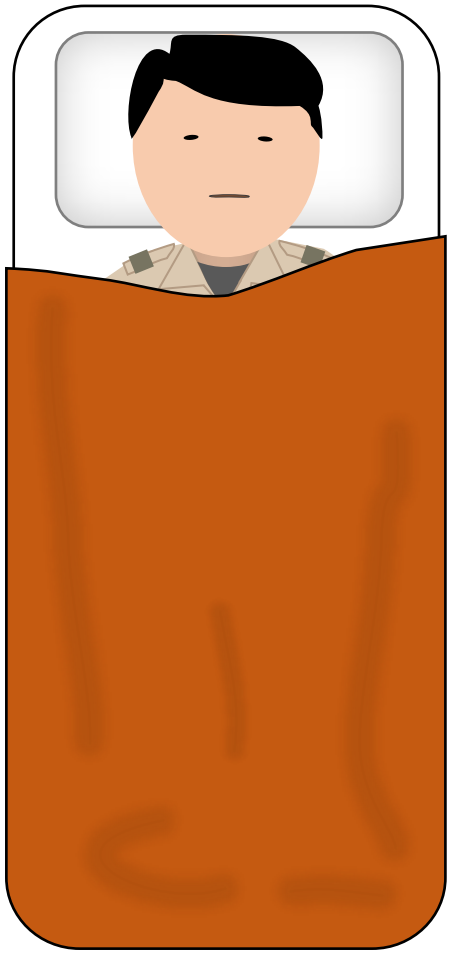
Hypothermia Treatment - Rewarming

Mild Hypothermia	Passive external rewarming
Moderate Hypothermia	Active external rewarming
Severe Hypothermia	Active internal rewarming

UpToDate accidental-hypothermia-in-adults

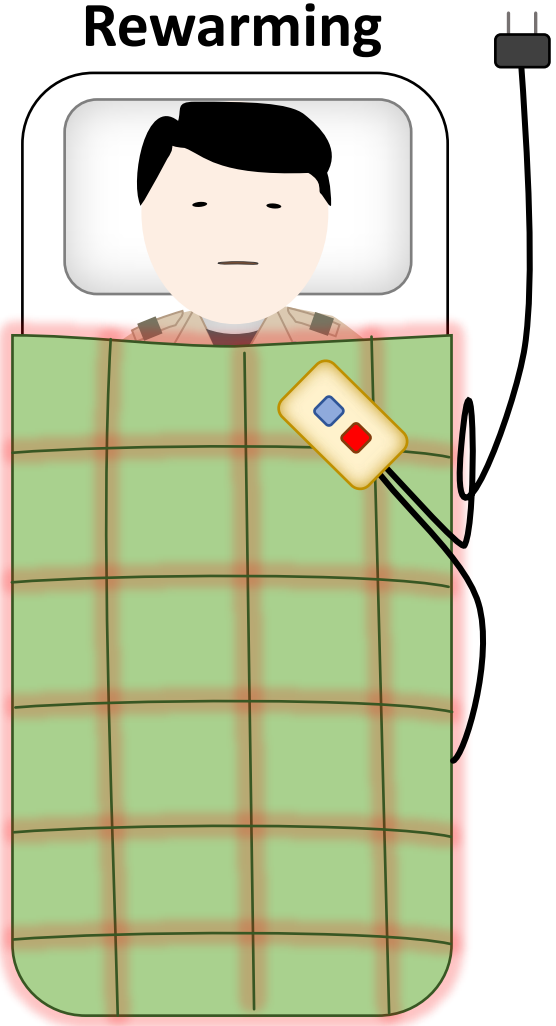
Hypothermia Treatment - Rewarming

Passive External Rewarming



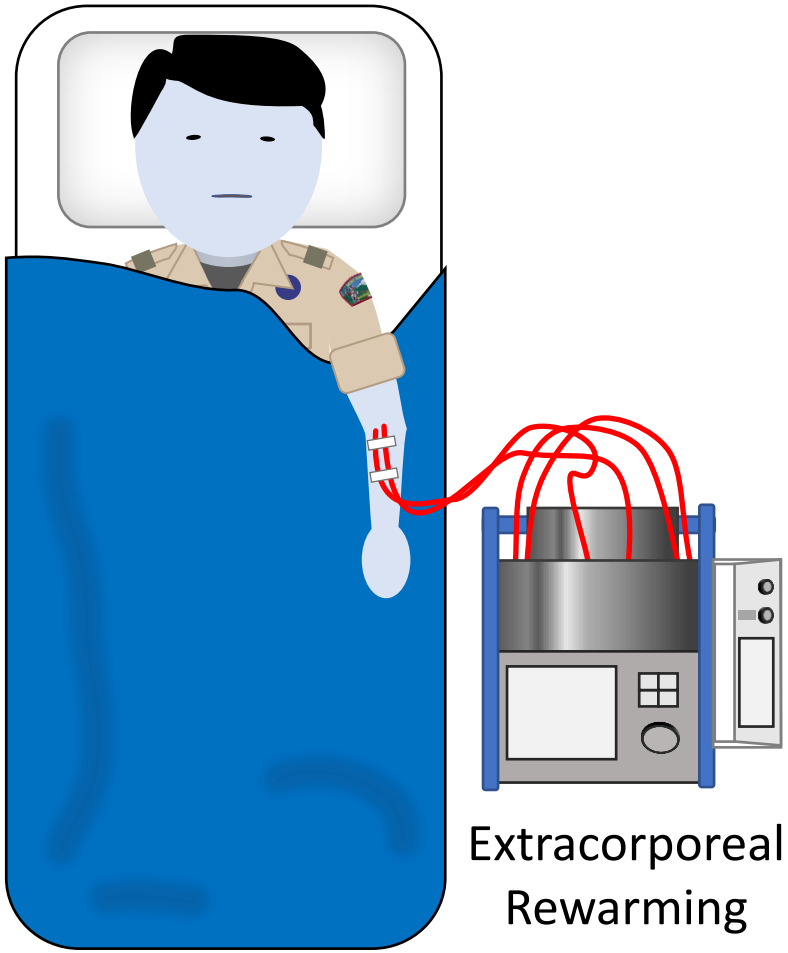
Mild Hypothermia

Active External Rewarming



Moderate Hypothermia

Active Internal Rewarming



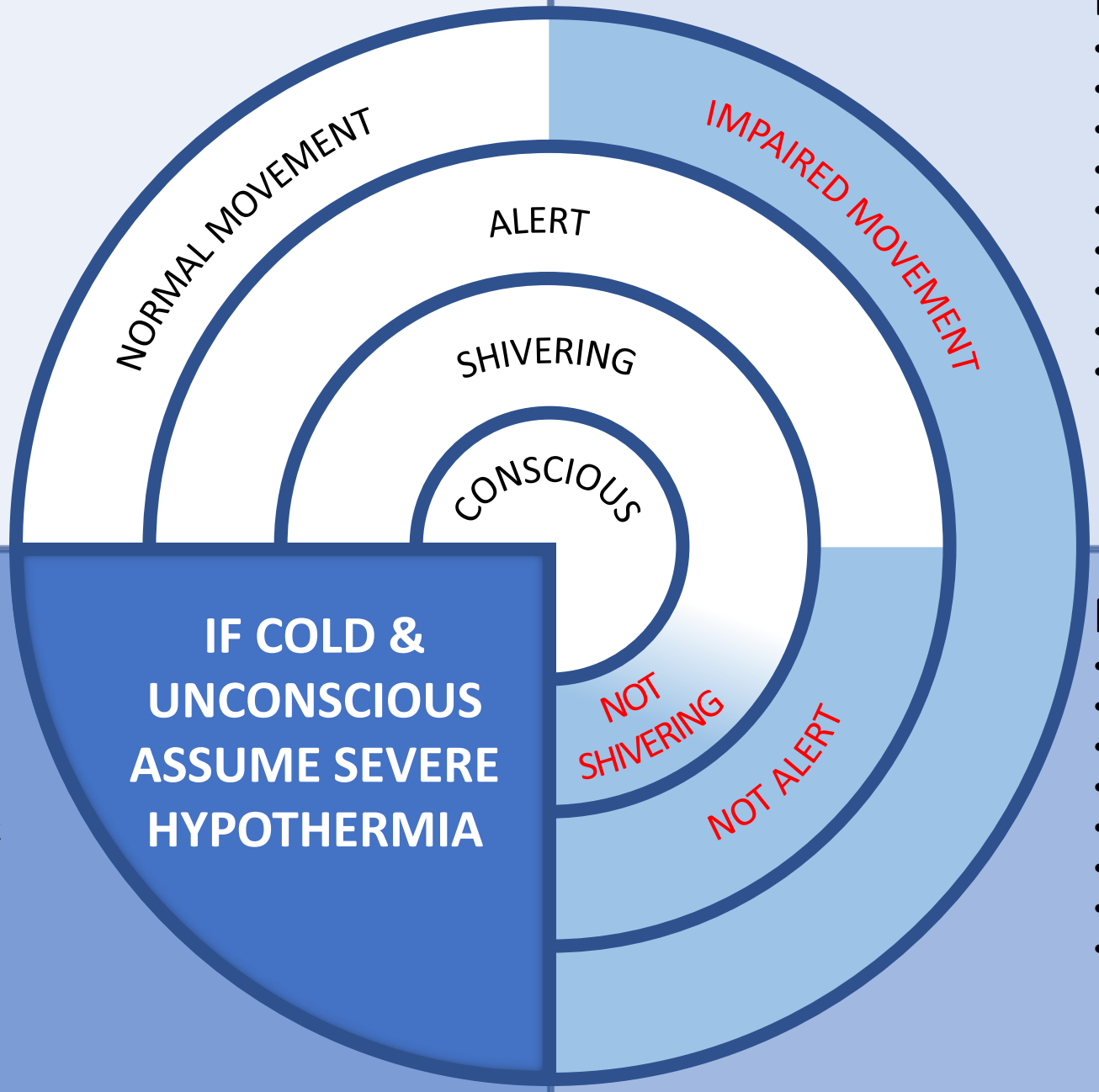
Severe Hypothermia

Cold Stressed

- **Reduce Heat Loss**
  Get dry
  Put on more clothes
- **Increase Heat Production**
  Exercise
- **Consume Calories**
  High calorie food
  High calorie drink

Mild Hypothermia

- Handle Gently
- Keep Horizontal
- No standing/walking 30 min
- Remove wet clothing if sheltered
- Insulate/vapor barrier as needed
- Heat applied to chest and armpits
- High-calorie food/drink
- Monitor until better
- Evac if no improvement



Severe Hypothermia

- Treat as Moderate Hypothermia
- Evac

- IF NO obvious vital signs-
  60-second breathing/pulse check

- IF NO breathing/pulse-
  Start CPR

Moderate Hypothermia

- Handle gently
- Keep horizontal
- No standing/walking
- No drink or food
- Remove wet clothing if sheltered
- Insulate/vapor barrier
- Heat applied to chest and armpits
- Evac

Information and image idea: Baby It's Cold Outside Program BICO_Hypothermia_Card_En_Web.pdf
Giesbrecht GG. "Cold Card" to Guide Responders in the Assessment and Care of Cold-Exposed Patients. Wilderness Environ Med. 2018 Dec;29(4):499-503.

RECOOMMEDARIONS FOR OUT-OF-HOSPITAL EVALUATION AND TREAMTMENT OF ACCIDENTAL HYPOTHERMIA

Ensure Scene Safety. Handle gently. Keep horizontal

Stabilize injuries. Consider cause of altered mental status other than hypothermia.

SUSPECT HYPOTHERMIA
Normal mental status?

NO

YES

Shivering?

NO

YES

Functioning normally/able to care for self?

NO

YES

NOT HYPOTHERMIC

COLD STRESSED – NOT HYPOTHERMIC > 35°C
Reduce heat loss, increase heat production

MILD HYPOTHERMIA 35-32°C
Protect from further cooling using insulation and vapor barrier.
Seek shelter. Remove (cut off) wet clothing only with shelter.
Measure temperature if possible.
Passive warming: Support shivering with calorie replacement.
After protected from heat loss: **No standing or walking for 30 min.**
Active warming is beneficial. (See moderate hypothermia, below.)

Uninjured, alert and shivering: may not need hospital.
Trauma patients: active rewarming, trauma center.
Asphyxiated patients: closest hospital for observation.

Shivering? YES

NO

Conscious? YES

NO

MODERATE HYPOTHERMIA 32-28°C
Treat as Above
Active warming: apply heat to upper torso: chest, axilla and back.
Use large heat pads, HPMK, Norwegian Heat Pac, forced-air.
Monitor. Circulatory access: peripheral IV or IO or femoral line.
Volume replacement: 40-42°C saline boluses. IV or IO glucose.
No standing or walking.

Hemodynamically stable: closest hospital.
Otherwise: hospital with ICU. Hospital with ICU and ECC capabilities if possible.

Signs of life or **organized rhythm on ECG?**
Respiration/pulse. Check for up to 1 minute

YES

NO

Lethal injury? or
Chest too stiff for CPR? Or
Avalanche burial > 35 min and
airway obstructed by snow?

NO

YES

DEATH
Do not resuscitate

SEVERE/PROFOUND HYPOTHERMIA <28°C
Treat as Above
Intubate or use supraglottic device.
Anesthetic and paralytic drugs: Lower dosage and extend dosing interval below 30°C.
- **Ventilation:** With advanced airway, ventilate at half standard (normothermic) rate.
- Without advanced airway, ventilate at standard rate or use $ETCO_2$ to guide ventilation.
- Use supplemental O_2, especially above 2500m.
- Naso/orogastric tube if advance airway in place.

CPR if no signs of life. (Can use cardiac monitor, $ETCO_2$, US to confirm)
- Chest compressions at standard normothermic rate.
- If <30°C VT or VF or AED advises shock: one shock at max power.
- Warm 1-2°C or > 30°C prior to additional shocks.
- No vasoactive drugs until 30°C or above. From 30-35°C, increase dosing interval to twice as long as normal.
- CPR may be delayed or given intermittently if necessary to accomplish evacuation.
- No temperature cut-off for CPR

No CPR if signs of life or perfusing rhythm (unless no cardiac activity on US)
Consider transcutaneous pacing if bradycardic with hypotension.
Terminate CPR if potassium >12.

Hospital with ICU and ECC capabilities if possible.

DURING TRANSPORT
Handle gently.
Keep horizontal.
Continue rewarming.
Warm ambulance or helicopter to 24°C if possible.

Dow J. Summary of Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update. *Wilderness Medicine Magazine*. Volume 37, Issue 2. Published April 22, 2020

FIRST-AID VERSION FOR EVALUATION AND TREAMTMENT OF ACCIDENTAL HYPOTHERMIA

Ensure Scene Safety. Handle gently. Keep horizontal

Stabilize injuries. Consider cause of altered mental status other than hypothermia.

SUSPECT HYPOTHERMIA
Normal mental status?

YES → **Shivering?**

YES → **Functioning normally/able to care for self?**

NO → **NOT HYPOTHERMIC**

NO → **COLD STRESSED – NOT HYPOTHERMIC > 35°C**
Reduce heat loss, increase heat production

YES → **MILD HYPOTHERMIA 35-32°C**
Protect from further cooling using insulation and vapor barrier.
Seek shelter. Remove (cut off) wet clothing only with shelter.
Measure temperature if possible.
Passive warming: Support shivering with calorie replacement.
After protected from heat loss: **No standing or walking for 30 min.**
Active warming is beneficial. (See moderate hypothermia, below.)

NO → **Shivering?**

YES → **MODERATE HYPOTHERMIA 32-28°C**
Treat as Above
Active warming: apply heat to upper torso: chest, axilla and back.
Use large heat pads, HPMK, Norwegian Heat Pac, forced-air.
No standing or walking.

NO → **Conscious?**

YES → **MODERATE HYPOTHERMIA 32-28°C** (see above)

NO → **Signs of life**
Respiration/pulse.
Check for up to 1 minute

YES → **SEVERE/PROFOUND HYPOTHERMIA <28°C**
Treat as Above
CPR if no signs of life.
- Chest compressions at standard normothermic rate.
- If AED advises shock: one shock at max power.
- Warm 1-2°C or > 30°C prior to additional shocks.
- CPR may be delayed or given intermittently if necessary to accomplish evacuation.
- No temperature cut-off for CPR

No CPR if signs of life

NO → **Lethal injury?** or
Chest too stiff for CPR? Or
Avalanche burial > 35 min and
airway obstructed by snow?

YES → **DEATH**
Do not resuscitate

Uninjured, alert and shivering: may not need hospital.
Trauma patients: active rewarming, trauma center.
Asphyxiated patients: closest hospital for observation.

Hemodynamically stable: closest hospital.
Otherwise: hospital with ICU. Hospital with ICU and ECC capabilities if possible.

Hospital with ICU and ECC capabilities if possible.

DURING TRANSPORT

Handle gently.
Keep horizontal.
Continue rewarming.
Warm ambulance or helicopter to 24°C if possible.

NOTE:
These guidelines were modified with removal of treatment beyond First-Aid

Original Guidelines:
Dow J. Summary of Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update. *Wilderness Medicine Magazine*. Volume 37, Issue 2. Published April 22, 2020

Hypothermia and Frostbite

Hypothermia and CPR

A frozen victim is not dead until they are warm and dead.

Under usual circumstances, resuscitative efforts should be continued until the victim's core temperature reaches 90-95°F (32-35°C). This may take several hours.

CPR should be withheld if the body is frozen so completely that chest compressions are impossible or if the nose and mouth are blocked with ice.

UpToDate accidental-hypothermia-in-adults

Hypothermia and Frostbite

Hypothermia, CPR and survival

Longest manual CPR
6 hrs and 30 min CPR. Full recovery.

Longest total resuscitation
Total resuscitation time was 8 hrs 40 min.

Lowest survived body core temperature
At hospital admission 13.7 °C. Full recovery

Longest intermittent CPR
Transport distance to EMS vehicle of 1.1 km, 122 m difference in height; 1 min CPR alternating with 1 min walking for 25 min, 5 hrs CPR. Full recovery.

Longest submersion
Submersion in icy water for at least 83 min, CPR for 64 min. Full recovery.

Longest survival in an avalanche
43 hrs and 45 min.

Paal P, Gordon L, et al. Accidental hypothermia-an update : The content of this review is endorsed by the International Commission for Mountain Emergency Medicine (ICAR MEDCOM). Scand J Trauma Resusc Emerg Med. 2016 Sep 15;24(1):111.

Hypothermia and Frostbite

Hypothermia - Weirdness

Paradoxical Undressing

20-50% hypothermia deaths are associated with paradoxical undressing. This typically occurs during moderate to severe hypothermia, as the person becomes disoriented, confused, and combative. They may begin discarding their clothing, which, in turn, increases the rate of heat loss.

Adventure Time “Memory of a Memory”

UpToDate accidental-hypothermia-in-adults

Hypothermia and Frostbite

Hypothermia - Weirdness

Terminal Burrowing (Hide-and-Die Syndrome)
Occurs in the final stages of hypothermia. The afflicted will enter small, enclosed spaces, such as underneath beds or behind wardrobes.

Adventure Time “Memory of a Memory”
UpToDate accidental-hypothermia-in-adults

Hypothermia Treatment

- Prevent further cold exposure
- Remove wet clothing
- Insulate from the cold ground
- Evacuate immediately if moderate to severe hypothermia
- Send for help
- CPR if needed
- Rewarm the victim

UpToDate accidental-hypothermia-in-adults

Hypothermia Treatment - Passive Rewarming

- Do NOT leave a hypothermic victim alone
- Passive rewarming requires physiologic reserve sufficient to generate heat by shivering or by increasing the metabolic rate
- Cover with blankets or stuff victim in sleepingbag(s)
- Shelter - room temperature should be maintained at approximately 28°C (82°F), if possible
- Provide warm, sweet fluids if victim is alert

UpToDate accidental-hypothermia-in-adults

Hypothermia Treatment – Passive Rewarming

- **Warm Brew**

- Warm sweet drink - such as diluted Jell-O
  - Heat (minimal benefit)
  - Water (you need this)
  - Calories (fuels shivering)

Strawberry is the best flavor

[Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update]

Hypothermia Treatment – Passive Rewarming

- **NOT Boiling HOT Brew!**
  - Risk of burns

- Also Not for:
  - Victim who is NO longer Alert
  - Unconscious
  - Risk of Choking (asphyxiation)

Yum

Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update

Hypothermia and Frostbite

Hypothermia Treatment – Skin to Skin Rewarming

- Getting near-naked and snuggling?
  - Scientifically doesn't work as well as you might think
  - Shivering is blunted
    - Shivering is better than Skin to Skin Rewarming
  - Heat transfer is minimal
  - Donor may become hypothermic

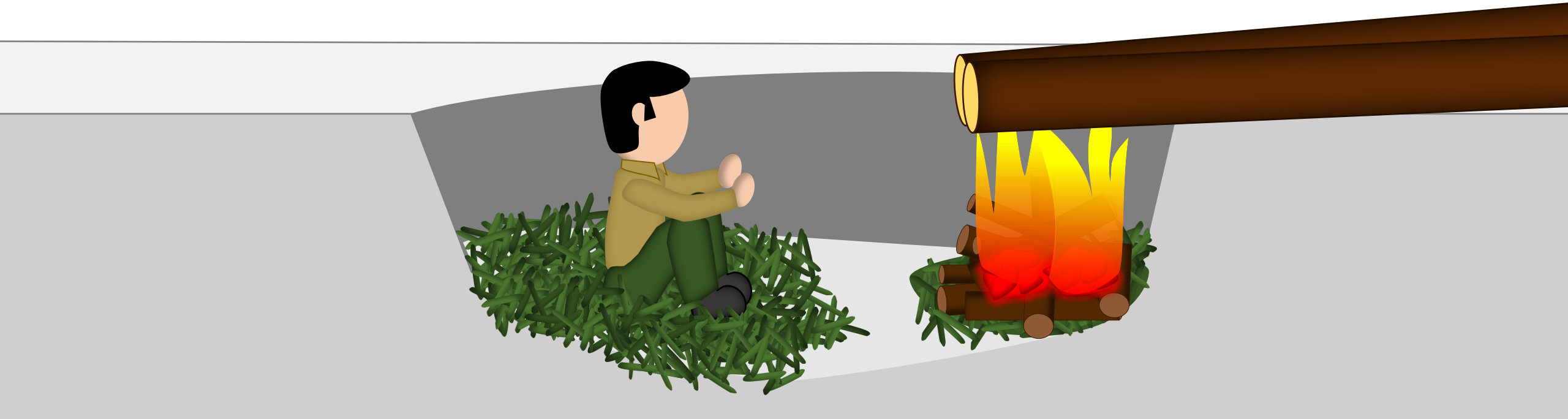
  - When to use
    - Victim is severely hypothermic and **NO LONGER** shivering
    - No other good options – such as evacuation
    - You have excess heat

Harnett RM, O'Brien EM, Sias FR, Pruitt JR. Initial treatment of profound accidental hypothermia. Aviat Space Environ Med. 1980;51:680–687.
Giesbrecht GG, Sessler DI, Mekjavic IB, Schroeder M, Bristow GK. Treatment of mild immersion hypothermia by direct body-to-body contact. J Appl Physiol. 1994;76: 2373–2379.

Hypothermia Treatment - Active Rewarming

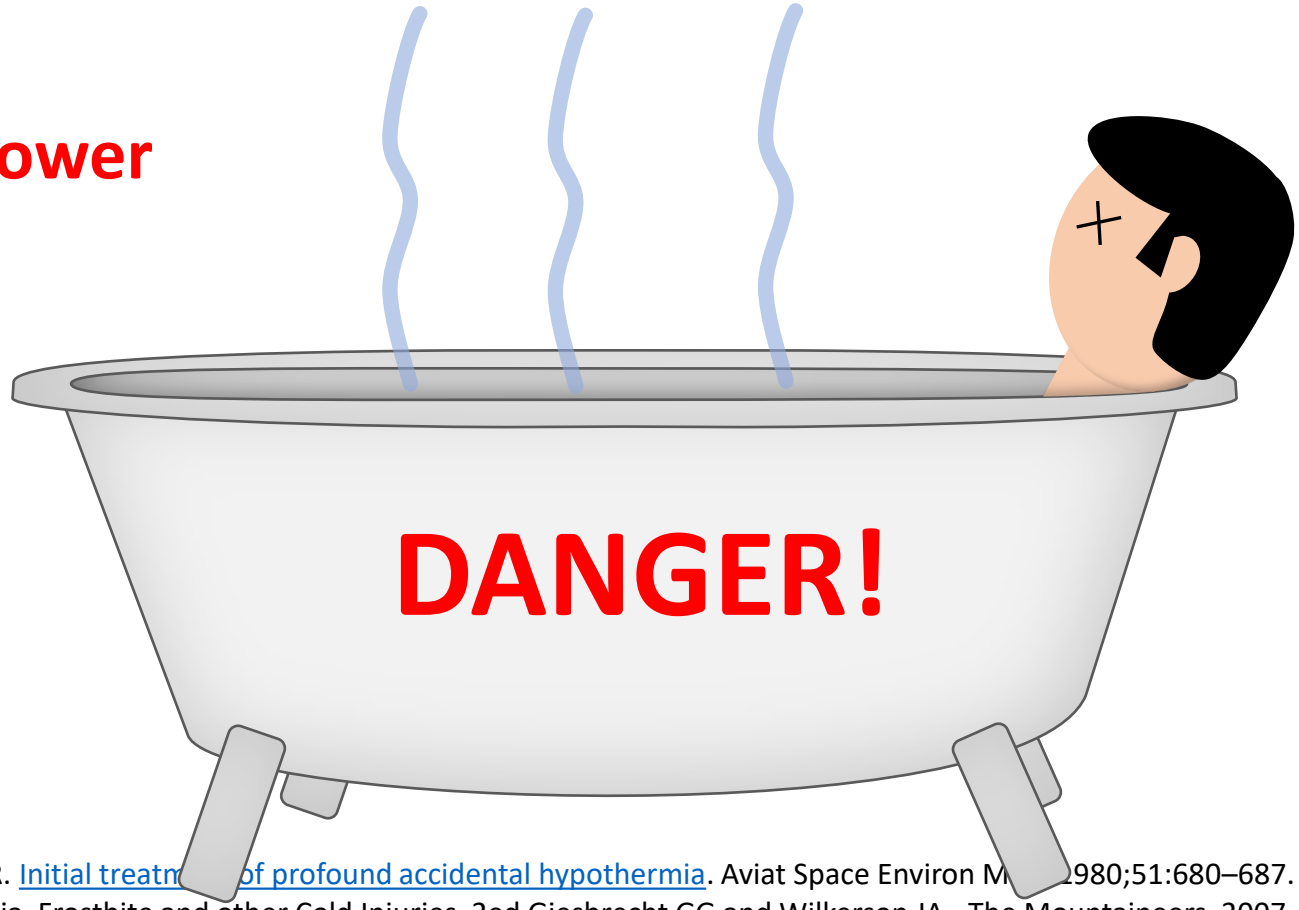
- Fire and Heaters

USE WITH CAUTION



Hypothermia Treatment - Active Rewarming

- Avoid Rapid Rewarming
  - **Do NOT use a HOT Bath or Shower**
  - Can cause circulatory collapse
  - **Potentially LEATHAL!**



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Hypothermia, Frostbite and other Cold Injuries. 2ed Giesbrecht GG and Wilkerson JA. The Mountaineers. 2007.
Dow, Jennifer et al. Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S47-S69. Review.

Hypothermia and Frostbite

Hypothermia Treatment – Hot Bath NO!

- Hot Bath or Shower?
- Causes circulatory collapse
- Can kill someone with even mild hypothermia
- This is a bad thing

Adventure Time “The Lich”

Zafren K, et al. Wilderness Medical Society. Wilderness Medical Society practice guidelines for the out-of-hospital evaluation and treatment of accidental hypothermia: 2014 update. Wilderness Environ Med. 2014 Dec;25(4 Suppl):S66-85.

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Hypothermia Treatment - Active Rewarming

- Water bottles with heated water (NOT directly on the victim's skin)
- "Hypothermia Burrito"

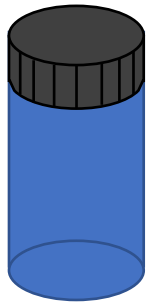


Image Idea: NOLS Case Study - Hypothermia

Harnett RM, O'Brien EM, Sias FR, Pruitt JR. Initial treatment of profound accidental hypothermia. Aviat Space Environ Med. 1980;51:680–687.
Hypothermia, Frostbite and other Cold Injuries. 2ed Giesbrecht GG and Wilkerson JA. The Mountaineers. 2007.

Hypothermia and Frostbite

Hypothermia Treatment – Wet Clothing

Dry or Damp Clothing Leave victim's clothing on and Wrap as needed

Very Wet Clothing

IF Shelter or Evac is **<30 minutes** away -

- Keep clothing on
  - Consider Vapor Barrier wrap over clothes
- Hypothermia Wrap

IF Shelter or Evac is **>30 minutes** away -

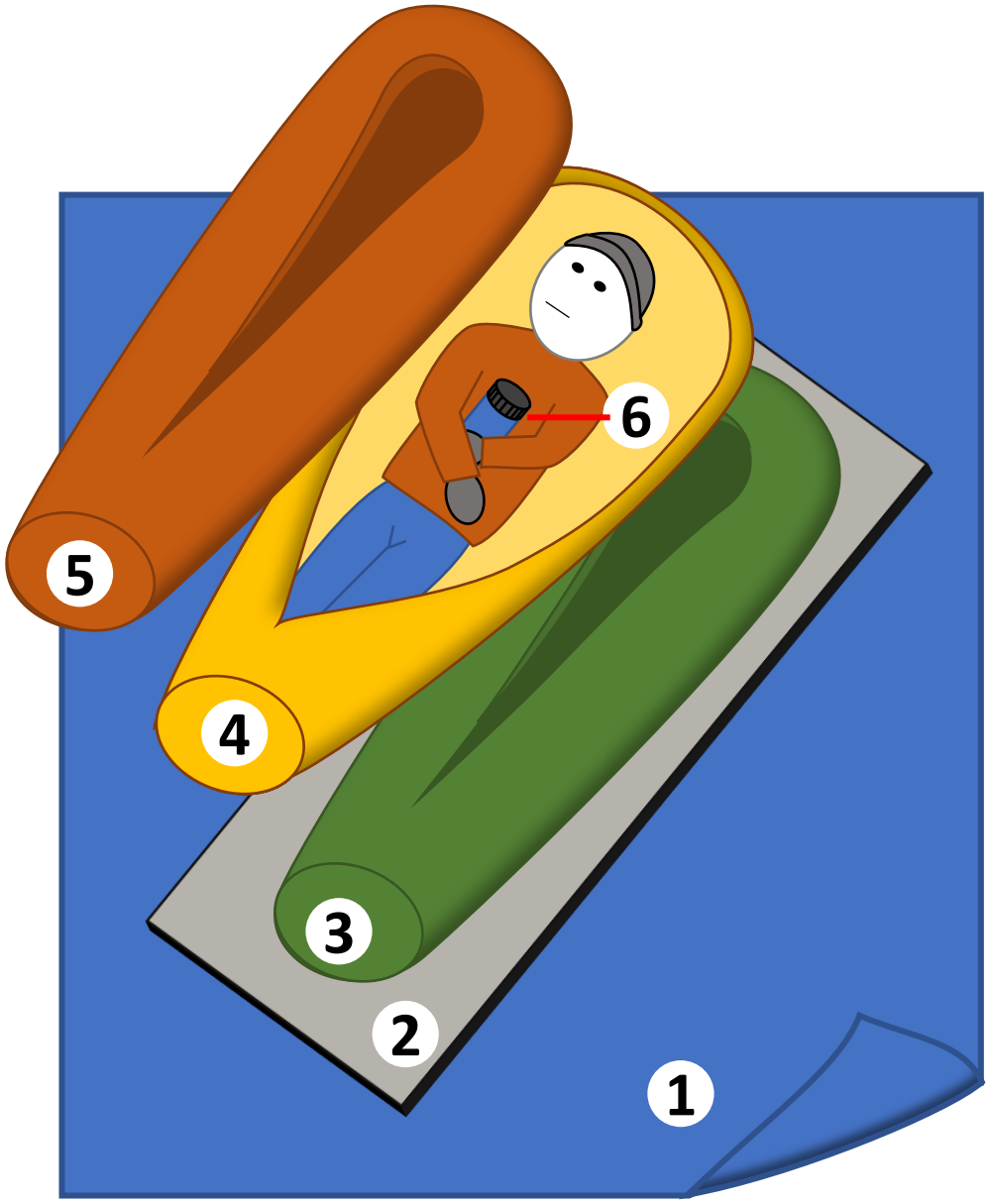
- First protect from environment if possible
- Then remove all wet clothing
  - Ideally cut away clothing
- Hypothermia Wrap

Baby It's Cold Outside bicorescue.com/images/BICO_Hypothermia_Card_En_Web.pdf

Dow, Jennifer et al. Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S47-S69.

Henriksson O, Lundgren P, Kuklane K, Holmér I, Naredi P, Bjornstig U. Protection against cold in prehospital care: evaporative heat loss reduction by wet clothing removal or the addition of a vapor barrier--a thermal manikin study. Prehosp Disaster Med. 2012 Feb;27(1):53-8.

“Hypothermia Burrito” or Hypo-Wrap



1. Lay out a tarp on the ground.
2. Place 1 or 2 pads down on top of the tarp.
   Two pads are always better than one.
3. Place a sleeping bags on top of the pads.
4. Place the victim in a second sleeping bag over the first.
5. Wrap a third sleeping bag over the second.
6. Place heat in axillae, chest and back (ideally in that order).
   Additional heat can be applied to the neck if possible.
7. Wrap the victim in the tarp and Daisy Chain rope around tarp.

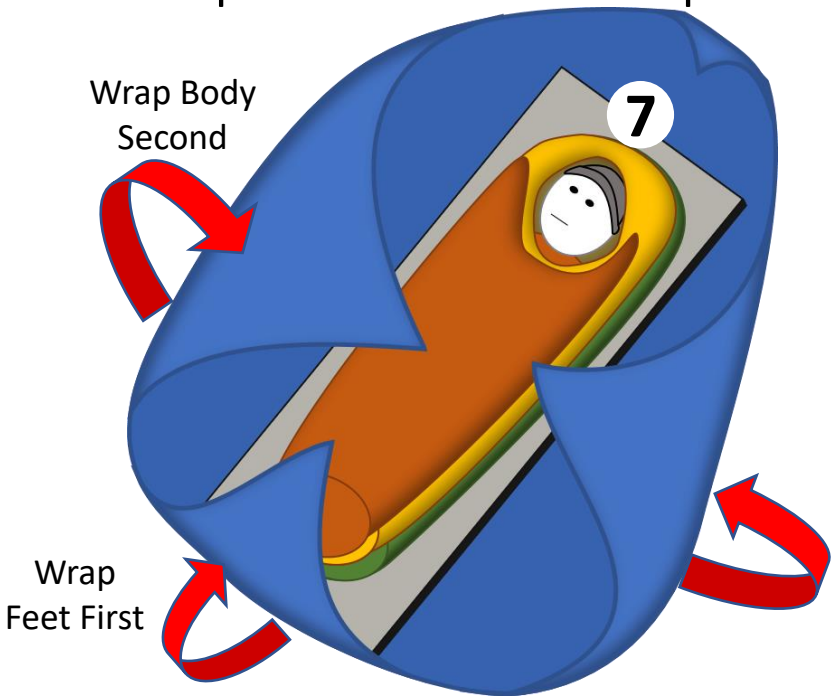


Image Idea: [NOLS Case Study - Hypothermia]

Hypothermia and Frostbite

Hypothermia Treatment – Active Rewarming

- Use with Hypothermia Burrito
- Warm water bottles (wrapped in cloth)
- Large heat pads
    - Large electric heat pads
    - Large electric heat blankets
    - Large chemical heat pads
    - Norwegian charcoal-burning HeatPac (outdoors only!)
    - Hypothermia Prevention Management Kit (HPMK)
- **Do not** use small chemical heat packs for Hypothermia

Dow, Jennifer et al. Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S47-S69. Review.

Hypothermia and Frostbite

Hypothermia Treatment – Active Rewarming and BURNS

- Burns have been caused by bottles of lukewarm water
- Hypothermic skin easily burns!
  - Avoid direct contact between heat source and skin
  - Avoid applying pressure over your heat source
- Place thin insulating material between the skin and heat source
- Avoid heat pads on back
  - Weight of victim + heat may result in burn
- Skin should be reassessed every 20-30 minutes for signs of burns
  - Done segmentally to minimize exposure to cold

Dow, Jennifer et al. Wilderness Medical Society Clinical Practice Guidelines for the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update. Wilderness Environ Med. 2019 Dec;30(4S):S47-S69. Review.
Giesbrecht GG, Walpoth BH. Risk of Burns During Active External Rewarming for Accidental Hypothermia. Wilderness Environ Med. 2019 Dec;30(4):431-436.

Hypothermia and Frostbite

Hypothermia Treatment – Active Rewarming and BURNS

- Small Chemical Pads
  - Maybe you have a box of these?
  - Can be used to prevent local cold injury
    - To hands and feet during treatment and transport
  - **Do not use** to rewarm core in hypothermic patient
    - Does NOT produce enough heat to rewarm victim
    - Risk of producing localized burns

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Giesbrecht GG, Walpoth BH. Risk of Burns During Active External Rewarming for Accidental Hypothermia. Wilderness Environ Med. 2019 Dec;30(4):431-436.

Hypothermia and Frostbite

Cold Weather Clothing

Hypothermia and Frostbite

Cold Weather Clothing

C Keep clothing **C**lean

O Avoid **O**verheating

L Wear clothing **L**oose and in Layers

D Keep clothing **D**ry

Hypothermia and Frostbite

Cold Weather Clothing – Clean

- Keep clothing clean
- Soiling of clothing
  - Makes insulation ineffective
  - Causes wear of clothing
  - May cause holes in fabric
- Washing clothing may be impractical in field
- Easier to keep clean than to wash
  - Don’t wipe dirt off on clothing
  - Don’t walk on your knees

Hypothermia and Frostbite

Cold Weather Clothing – Overheating

- Wear clothing in layers
  - Wear wicking material against skin
  - Layering allows for removal of layers and ventilation
- Avoid overheating and perspiring
  - Perspiration leads to wet clothes
  - Wetness decreases insulation of clothing
  - Wetness leads to evaporative heat loss
- If you are getting too hot, such as when digging
  - Remove layers
  - Vent clothing

Hypothermia and Frostbite

Cold Weather Clothing – Loose

- Tight clothing reduces blood circulation
- Decreased blood circulation increases risk of frostbite

Hypothermia and Frostbite

Cold Weather Clothing – Dry

- Small amount of wetness increases heat loss significantly
- Drying clothing may be impractical
  - Easier to stay dry than to dry out
- Fires can be used to dry clothing
  - Avoid overheating and damaging clothing
  - “Bare Hand” test
    - Place hand over fire where you would like to place clothing
    - Count to 3 slowly
    - If no excessive heat is noted – that’s a safe place to dry clothing
  - Take great care with drying of boots, mittens and gloves
    - Overheating causes permanent shrinkage, stiffness and cracking

Hypothermia and Frostbite

Cold Weather Clothing – Dry

- Sun and wind will sublimate water over time
  - Secure clothing outside and wait
  - Keep an eye on weather
- Freeze drying works better than you would think
  - Allow water to freeze on/in clothing
  - Shake, beat or bend frozen clothing to remove crystals

Hypothermia and Frostbite

Cold Weather Clothing – Dry

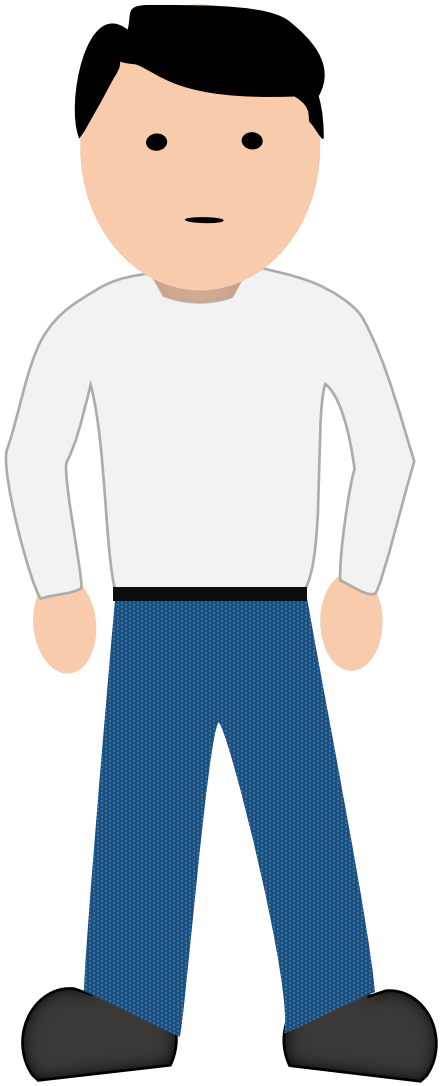
More on clothing and equipment is covered in our

Surviving the Cold Section

Hypothermia and Frostbite

Cold Weather Clothing - Fabric

- **Cotton**
  - Holds **2700%** its weight in water
  - Keeps water next to skin
  - Quickly absorbs water
  - Loses ability to insulate when wet



Hypothermia and Frostbite

Cold Weather Clothing - Fabric

- **Rayon, Viscose, Tencel, Lyocell, Bamboo** and **Silk**
  - Holds 30% its weight in water
  - Loses ability to insulate when wet

Hypothermia and Frostbite

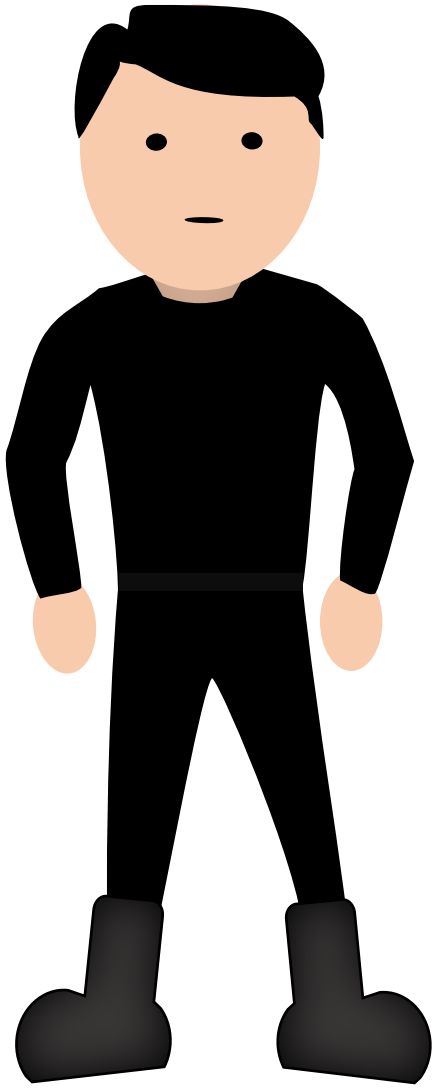
Cold Weather Clothing - Fabric

- **Wool**
  - Holds 37% its weight in water
  - Repels some rain and allows vapor to pass
  - Maintains some insulating potential when wet

Hypothermia and Frostbite

Cold Weather Clothing - Fabric

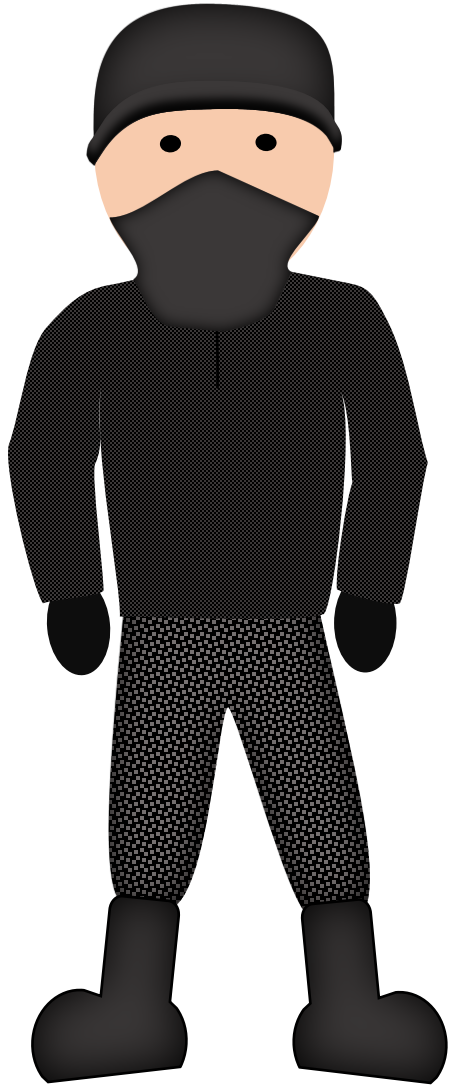
- **Polyester** (Polyethylene Terephthalate aka PET)
  - Many different structures
  - Polyester is water-repellent
  - Holds up to 0.4% its weight in water
  - Low level of wicking
  - Oleophilic – absorbs oil but not water
    - Holds body oils – “Hiker’s Stink”



Hypothermia and Frostbite

Cold Weather Clothing - Fabric

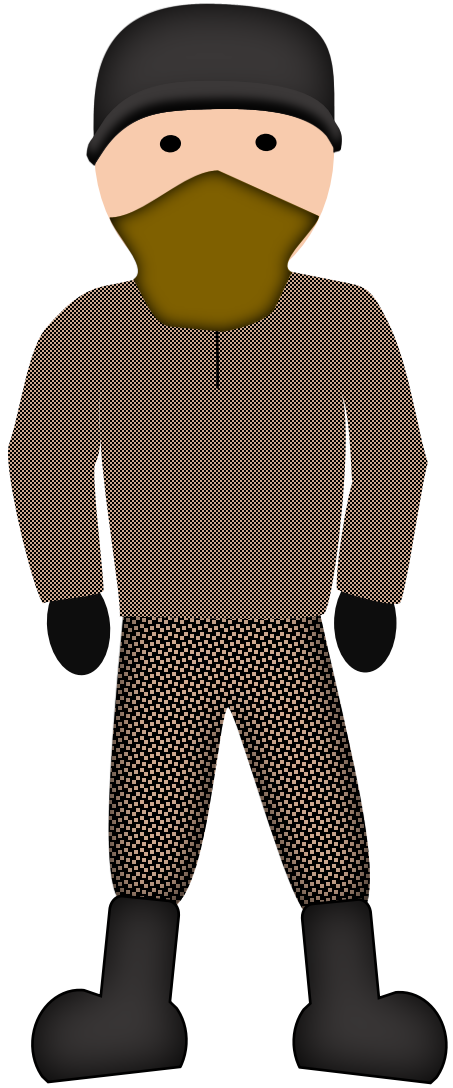
- **Nylon** (Polyamide)
  - Many different structures
  - Holds up to 10% its weight in water
  - Compared to Poly, it is colder when wet
  - Stays wet longer than poly but dries quickly



Hypothermia and Frostbite

Cold Weather Clothing - Fabric

- **Polypropylene**
  - Poor thermal transfer rates
    - This is a GOOD thing
    - Traps heat
  - Retains even less water than polyester
  - Poor UV resistance
  - Melts in high heat driers – must air dry
  - Oleophilic – absorbs oil but not water
    - Holds body oils - **Notorious Stink**!



Hypothermia and Frostbite

Cold Weather Clothing - Fabric

- **Down** - Goose or Duck Feathers
  - Excellent insulation for weight
  - Incredible compressibility
  - Excellent for DRY arctic environments
  - Breathes but does NOT repel water
  - Loses ability to insulate when wet
  - SLOW to dry

In the Pacific Northwest, you can die of hypothermia if you are depending solely on down for protection and it gets wet.

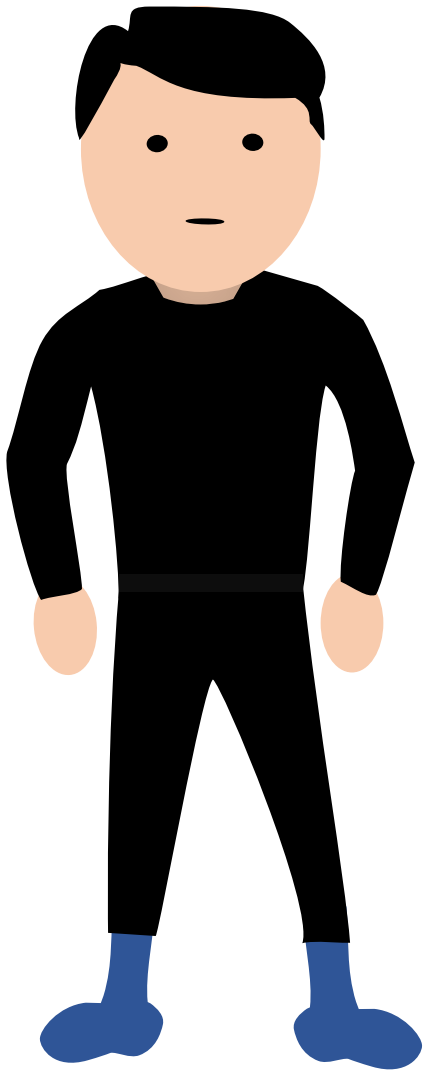
Hypothermia and Frostbite

Cold Weather Clothing - Fabric

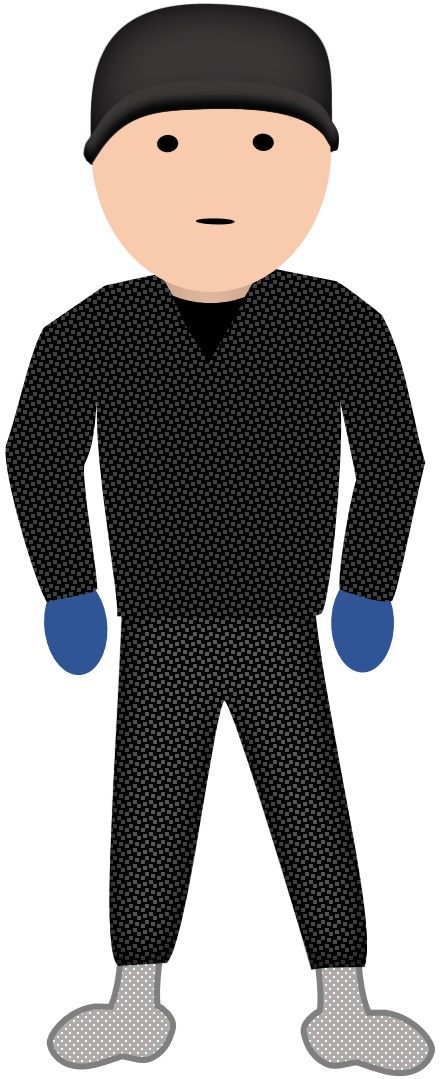
- **Waterproof Breathable Shell**
  - Fabrics such as Gore-Tex
  - Waterproof fabric
  - Seam taped – so no leakage at seams
  - Allows vapors to pass – “Breaths”
  - Windproof
  - Uses as outer shell
  - Should be large enough to fit over other layers

Dress in Layers

Synthetic or Wool



Silk Layer



Base Layer

Medium Layer

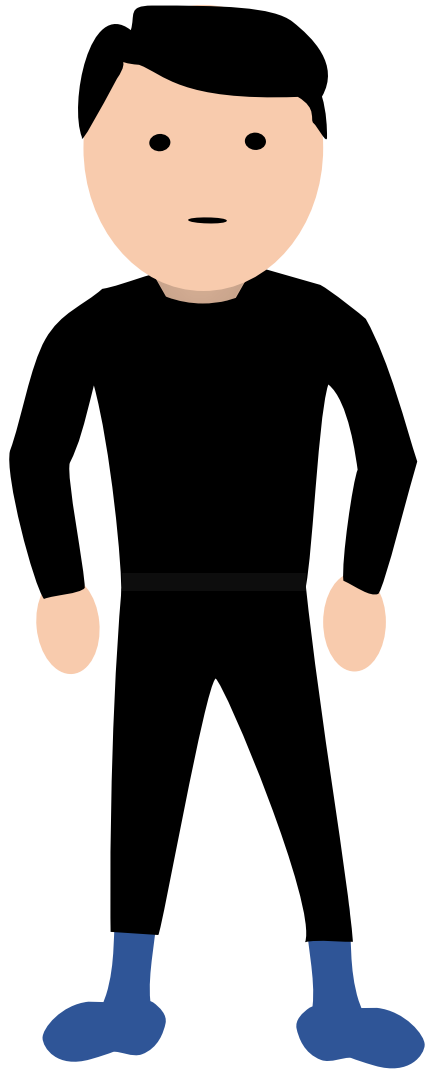
Heavy Layer

Shell

Hypothermia and Frostbite

Cold Weather Clothing - Layering

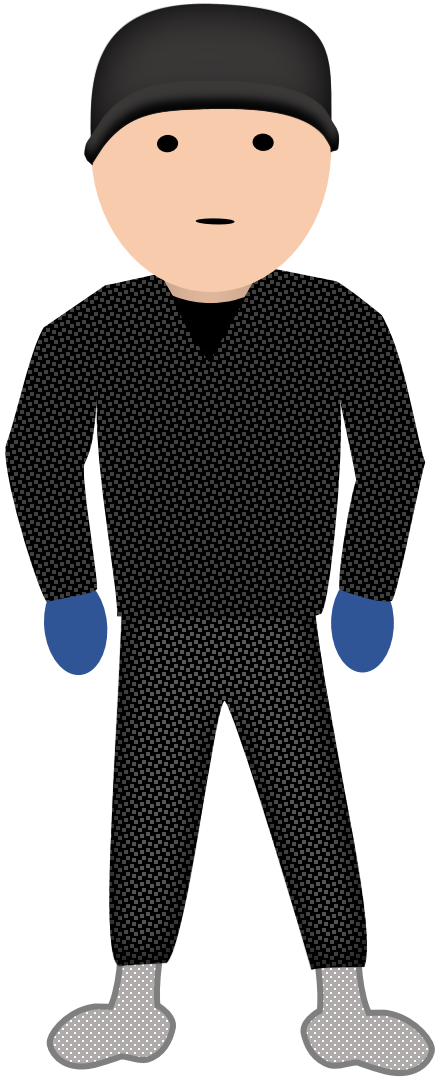
- **Layer 1 – Silk Layer**
  - Long-sleeved silk-weight underwear
  - Wicks moisture off skin
  - Polyester or other synthetic material



Hypothermia and Frostbite

Cold Weather Clothing - Layering

- **Layer 2 – Base Layer**
  - Polyester or wool material
  - Thin insulation layer



Hypothermia and Frostbite

Cold Weather Clothing - Layering

- **Layer 2 – Medium Layer**
  - Polyester or wool or a blend of the two
  - Thicker than base layer

Hypothermia and Frostbite

Cold Weather Clothing - Layering

- **Layer 3 – Heavy Layer**
  - Puffy jacket traps air = insulation
  - 300-weight fleece insulates well (more loft than 200)
  - Jackets should ideally have a hood

Polartec Fleece Scale		
GSM	**Description**	**Use**
Micro	Ultralight	Summer walking in cool weather
100	Lightweight	Aerobic activities and warmer conditions
200	Mid-weight	Versatile and easy to layer under shell
300	Heavywieght	Designed for cold and extreme cold environments

GSM = grams per square meter

Hypothermia and Frostbite

Cold Weather Clothing - Layering

- **Layer 4 – Waterproof/Breathable Outer Layer**
  - Protects you from wind and rain without trapping too much vapor
  - Quality made with fabric such as Gore-Tex
  - Taped seams

Hypothermia and Frostbite

Cold Weather Clothing - Head

- **Head and Neck**
  - Need to be covered
    - Balaclava – covers both neck and head
    - Beany hat
    - Scarf vs neck gator

Hypothermia and Frostbite

Cold Weather Clothing - Gloves

- **Gloves**
  - Appropriate level of insulation for climate
  - 2+ pairs should be carried
  - Liners help keep hands dry and warm

Hypothermia and Frostbite

Cold Weather Clothing - Boots

- **Boots** should be
  - Waterproof
  - Insulated
  - Ideally full length to keep snow out

Hypothermia and Frostbite

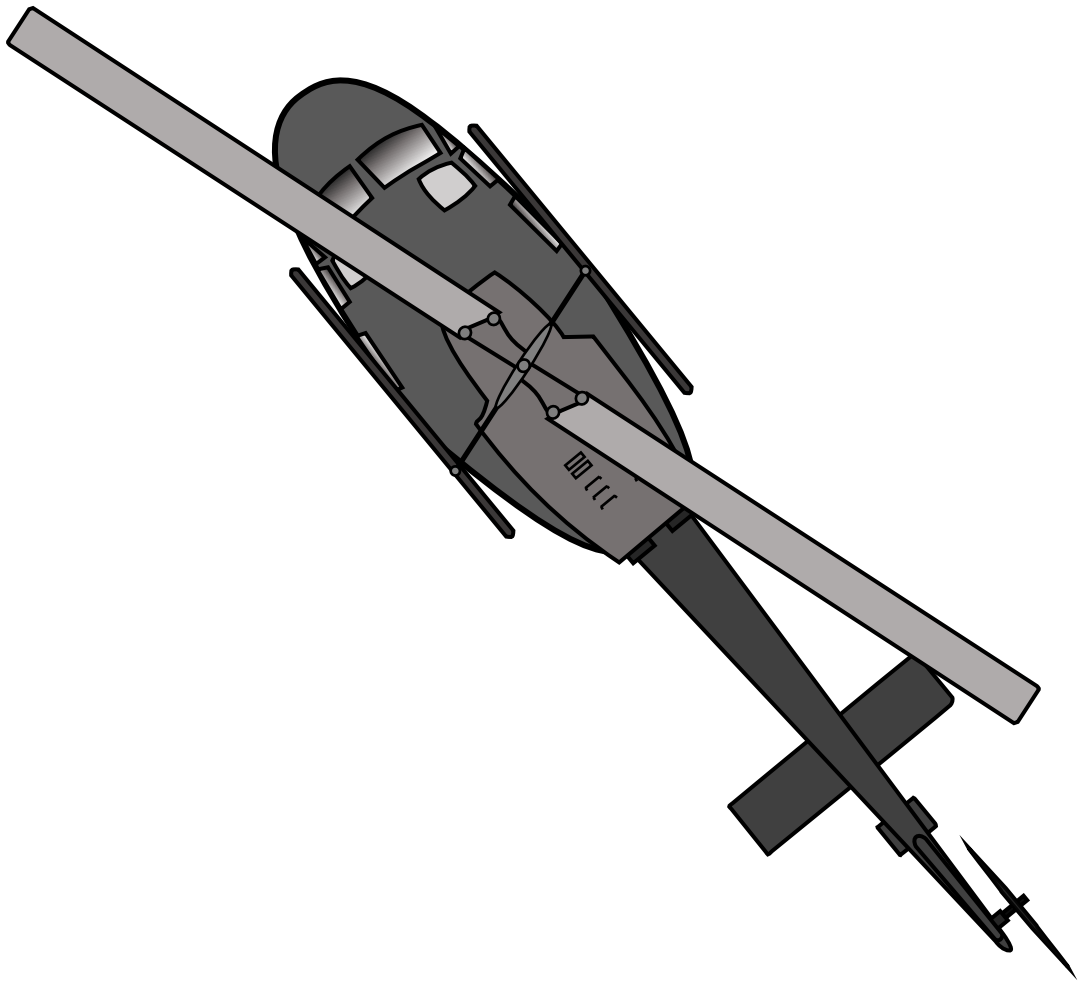
Cold Weather Clothing - Fabric

- If you didn't catch the earlier hints

Don't Wear Cotton!!!

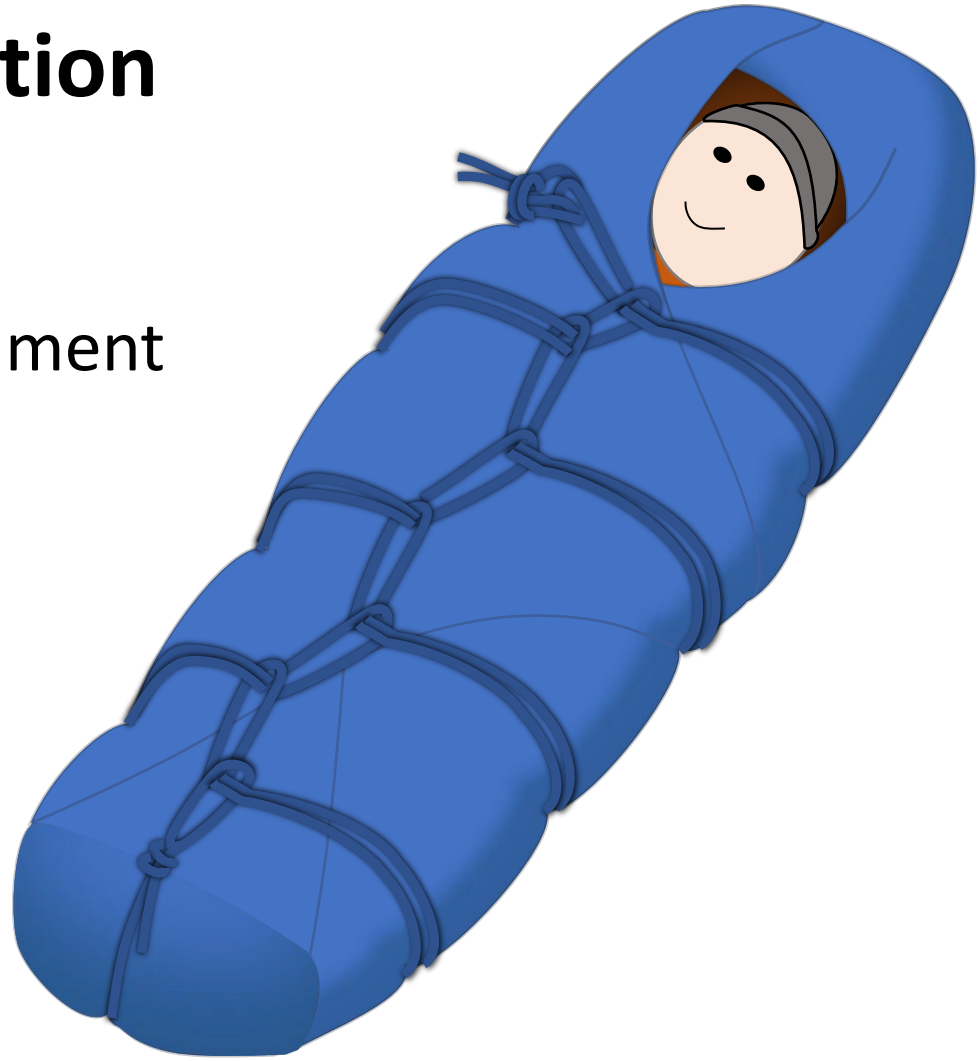
- Cotton Should be Banned as a Policy

Evacuation



Hypothermia Treatment - Evacuation

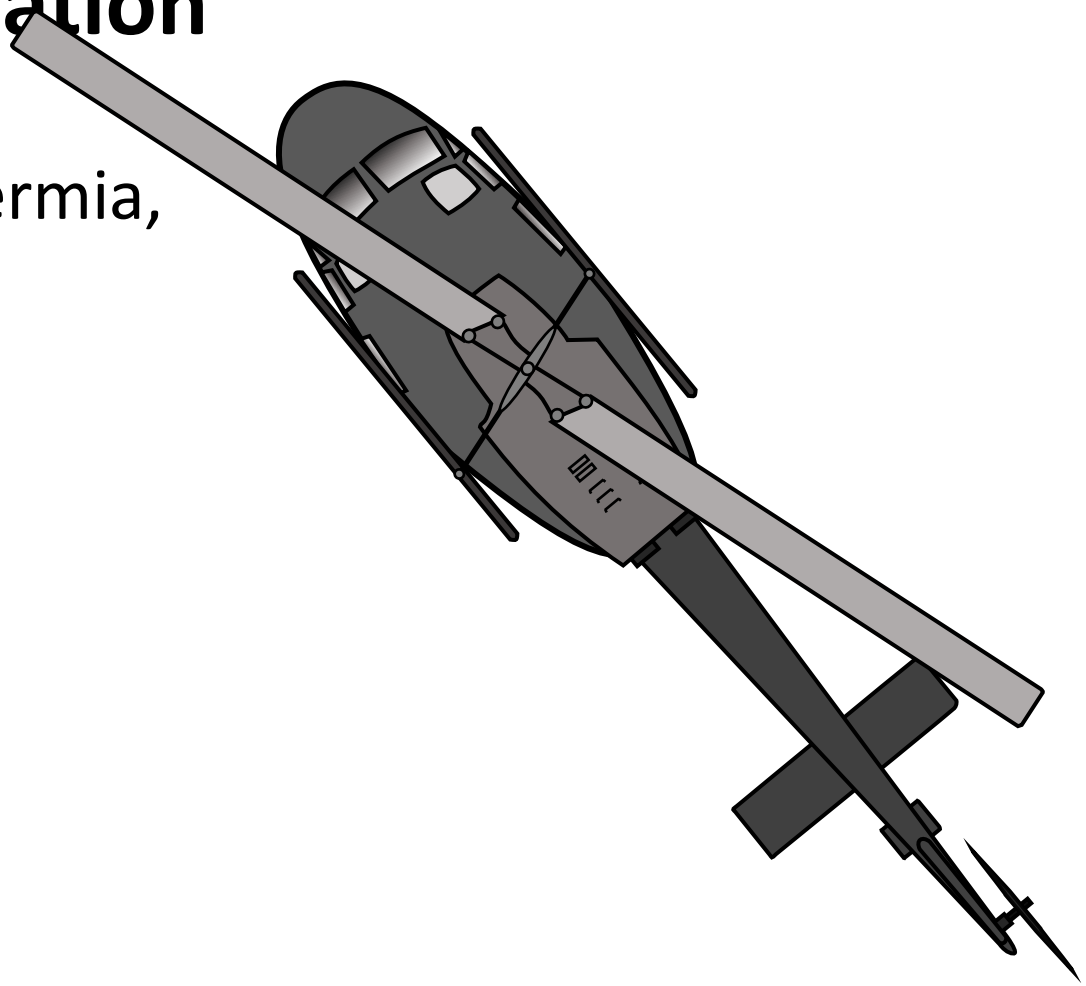
- Send/Call for help
- Insulate and protect victim from environment
- Never leave victim alone
- Choose the safest route



Zafren K, et al. Wilderness Medical Society. Wilderness Medical Society practice guidelines for the out-of-hospital evaluation and treatment of accidental hypothermia: 2014 update. Wilderness Environ Med. 2014. Dec;25(4 Suppl):S66-85.

Hypothermia Treatment - Evacuation

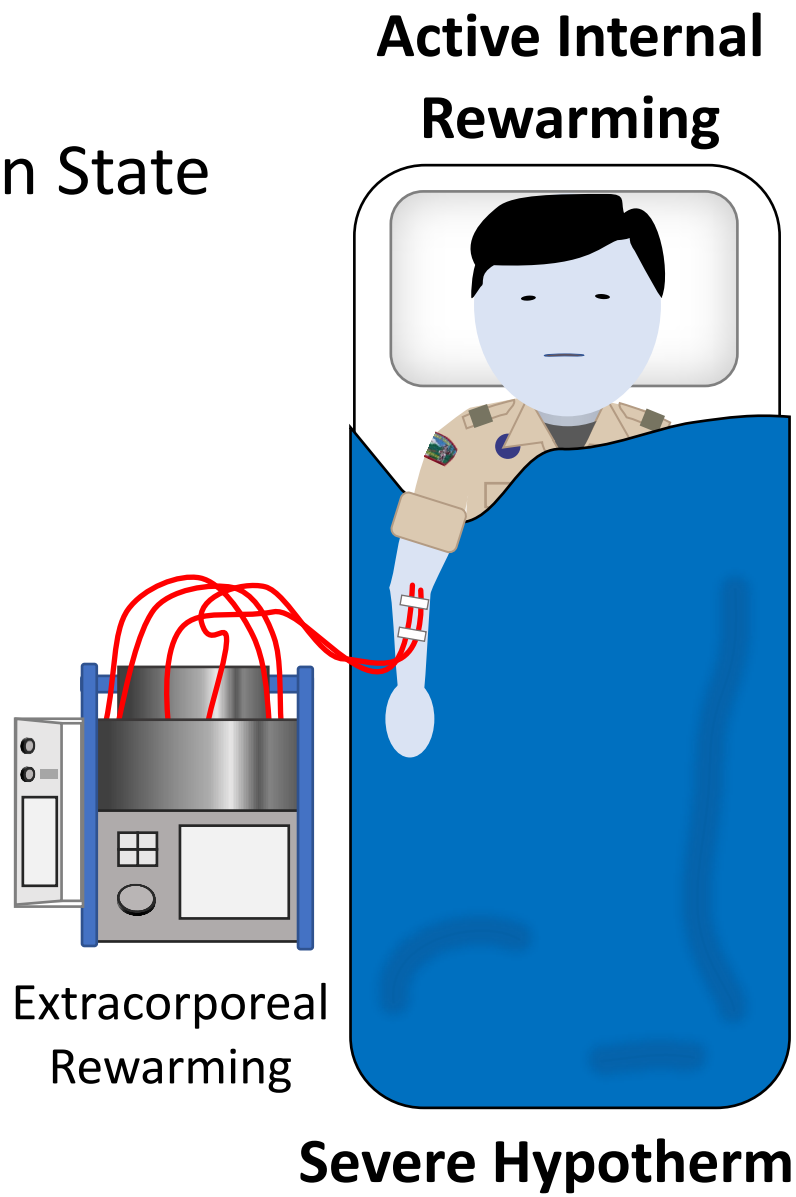
- Once you start evacuation for Hypothermia, follow through,
  even if victim looks better



Zafren K, et al. Wilderness Medical Society. Wilderness Medical Society practice guidelines for the out-of-hospital evaluation and treatment of accidental hypothermia: 2014 update. Wilderness Environ Med. 2014. Dec;25(4 Suppl):S66-85.

Hypothermia Treatment - Evacuation

- Extracorporeal Cardiac Life Support – Washington State
  - Seattle
    - Seattle Children's Hospital
    - University of Washington Medical
    - Harborview Medical Center
    - Swedish Medical Center
    - Virginia Mason Medical Center
  - Tacoma
    - Mary Bridge Children's Hospital
  - Spokane
    - Providence Sacred Heart Medical Center



Prevention

Hypothermia Treatment - Prevention

- **Adequate Clothing**
  - **Cotton Kills** – don't wear it below 77°F (25°C)
    - Doesn't insulate when wet
    - Can hold 27 times its weight in Water
    - Water + Cold is potentially deadly

Dress in Layers

Synthetic or Wool

Silk Layer

Base Layer

Medium Layer

Heavy Layer

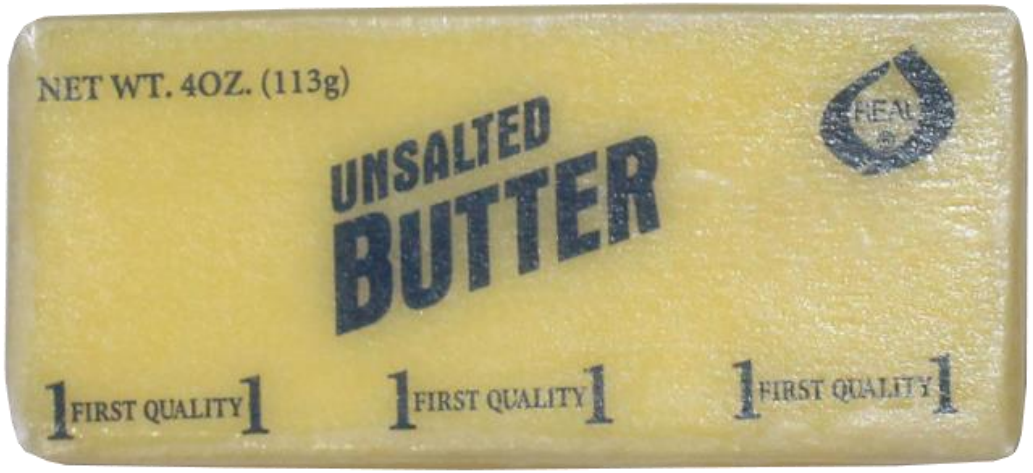
Shell

Hypothermia Treatment - Prevention

- **Stay DRY!**
  - Wear proper clothing
  - Shake off snow before entering tent or cave
  - Avoid water (ponds, lakes, mudpuddles)
  - Avoid overheating and sweating

Hypothermia Treatment - Prevention

- **Feed Your Body**
  - Stay Hydrated
  - Eat Regularly



Castellani JW, Young AJ, Ducharme MB, Giesbrecht GG, Glickman E, Sallis RE; American College of Sports Medicine. American College of Sports Medicine position stand: prevention of cold injuries during exercise. Med Sci Sports Exerc. 2006 Nov;38(11):2012-29

Hypothermia Treatment - Prevention

- **Keep an Eye on Your Team**
  - Watch for signs of cold injuries in others
  - Be ready to care for others

Hypothermia Treatment - Prevention

- **Stay Warm**

You CAN'T Care for Your Team if You Become a Victim

Hypothermia and Frostbite

Medications that increase Risk of Cold Injury

Impairs Thermoregulation

- Anxiolytics (sedative-hypnotics), antipsychotics/neuroleptics (phenothiazines), antidepressants, and opioids (meperidine)

Impairs Ability to Compensate for Low Ambient Temperature

- Antihyperglycemics, beta-blockers, alpha-adrenergic agonists (clonidine), general anesthetic agents
- Alcohol – vasodilation and leads to poor choices

Increase Risk of Frostbite

- Beta-blockers
- Nicotine

Hypothermia and Frostbite

Medical Conditions that increase Risk of Hypothermia

Decreased Heat Production

- Hypopituitarism, hypoadrenalism, hypothyroidism, severe malnutrition, hypoglycemia and neuromuscular disorders

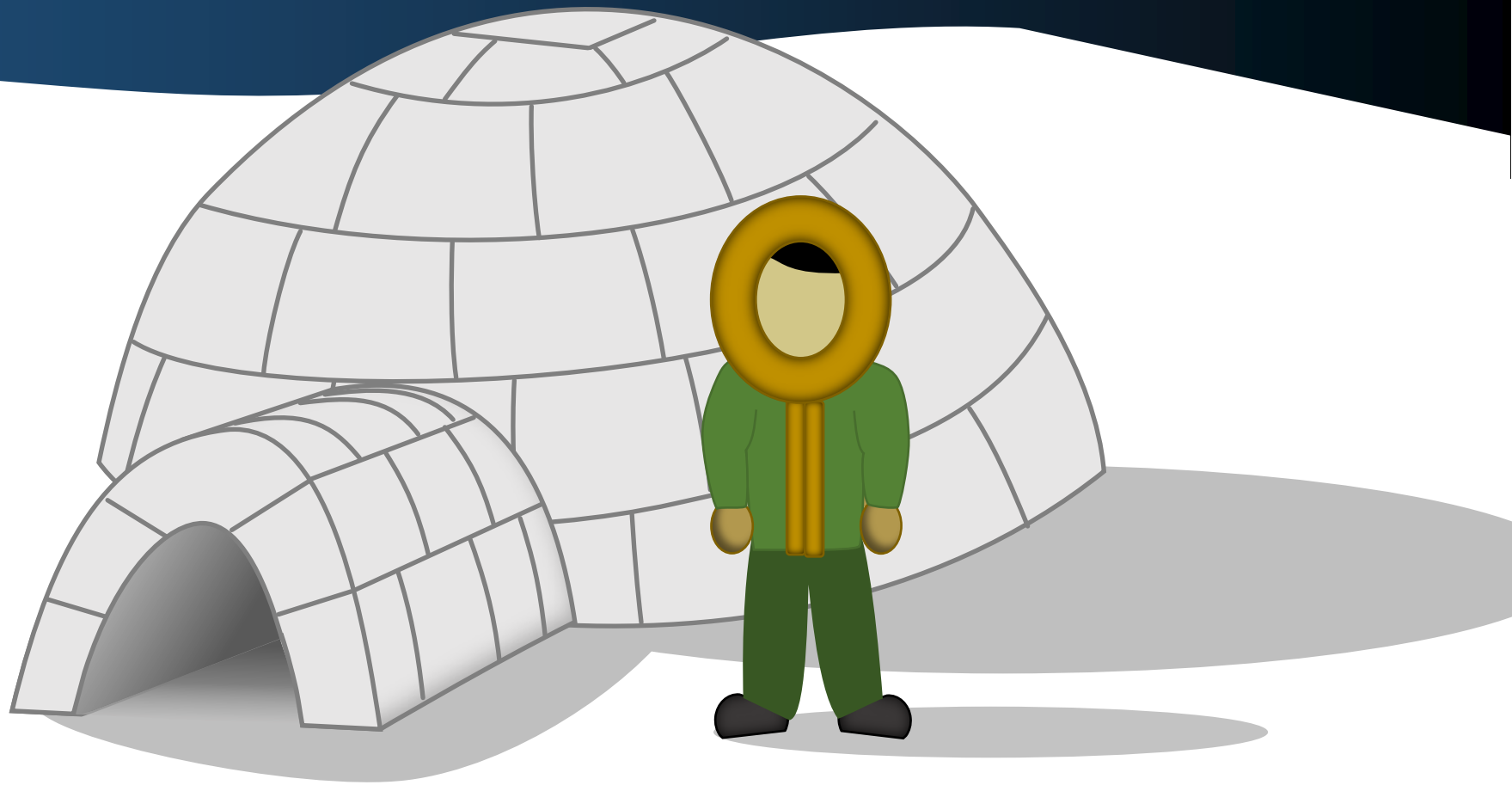
Increased Heat Loss

- Vasodilatation, erythrodermas, burns, psoriasis

Impaired Thermoregulation

- Trauma affecting the central nervous system, strokes, toxicologic and metabolic derangements, intracranial bleeding, Parkinson's disease, brain tumors, Wernicke's disease, multiple sclerosis, sepsis, multiple trauma, pancreatitis, prolonged cardiac arrest, and uremia

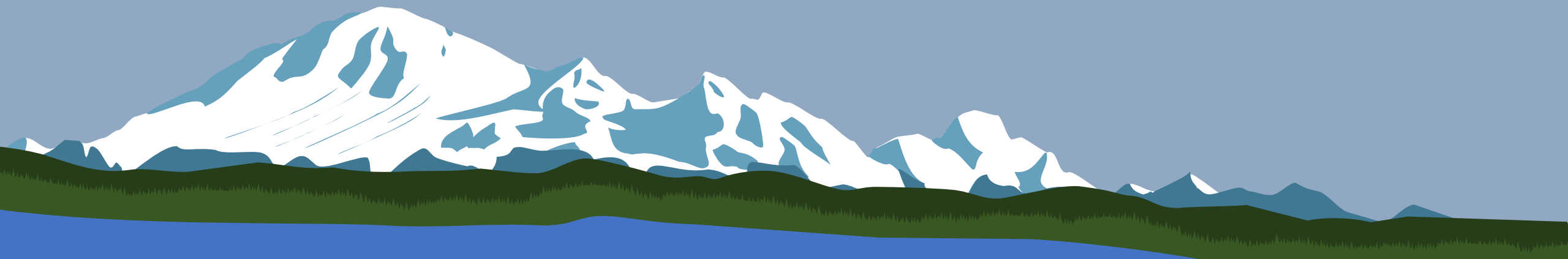
More?



Resources

- Wilderness Medical Society Clinical Practice Guidelines for
  - the Out-of-Hospital Evaluation and Treatment of Accidental Hypothermia: 2019 Update
    Dow, Jennifer et al. *Wilderness & Environmental Medicine*, Volume 30, Issue 4, S47-S69
    Summary of this article: wms.org/magazine/1260/index.html
  - the Prevention and Treatment of Frostbite: 2019 Update
    McIntosh, Scott E. et al. *Wilderness & Environmental Medicine*, Volume 30, Issue 4, S19-S32
  - Prevention and Management of Avalanche and Nonavalanche Snow Burial Accidents
    Van Tilburg, Christopher et al. *Wilderness & Environmental Medicine*, Volume 28, Issue 1, 23-42
  - the Treatment and Prevention of Drowning: 2019 Update
    Schmidt Andrew C et al. *Wilderness & Environmental Medicine*, Volume 30, Issue 4, S70-S86
  - the Prevention and Treatment of Acute Altitude Illness: 2019 Update
    Luks, Andrew M et al. *Wilderness & Environmental Medicine*, Volume 30, Issue 4, S3-S18
- Baby It's Cold Outside (BICO) Cold-Card
- Wilderness First-Aid Course

Wilderness First-Aid



Be Prepared