Chapter 7

Cold Induced Injuries and Illness

After reading this chapter, you should be able to do the following:

- Understand the mechanisms by which the body loses heat;
- Review the pathophysiology of hypothermia, frostbite, and other cold-related injuries;
- Recognize and treat hypothermia and frostbite in the wilderness with limited resources;
- Understand the evacuation criteria for frostbite and hypothermia; and
- Learn about how to prevent these conditions.
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Case 1

After spending several weeks acclimating to high altitude conditions, Scott Fisher, an experienced climber and founder of the adventure company Mountain Madness, led his team out of the Mt. Everest base camp, intent on reaching the summit. After climbing through the night, Fisher's team finally reached the peak early the afternoon of May 10, 1996. Conditions at Everest's summit were extreme, with temperatures averaging -25°C and winds blowing at nearly constant tropical storm force. From the summit, the team noticed cloud cover lower down on the mountain. Their worst fears were soon realized as they descended into 75 MPH winds and near whiteout conditions. They quickly lost their bearings and decided to huddle together in an attempt to wait out the storm. Ironically, the teams hunkered down a mere 400 meters from high camp and were eventually rescued by Anatoli Boukreev, one of the guides who had managed to make it back ahead of the storm. All members of the expedition were saved except for Fisher, who had lagged behind to assist the weaker climbers in the group. Boukreev made several attempts to reach Fisher but was unsuccessful and forced to turn back because of the severe weather conditions. Fisher had been climbing with Lopsang Sherpa, a long-time friend and climbing partner, when he collapsed an hour outside of camp. Lopsang was eventually forced to leave Fisher in an attempt to go for help, when it was clear that Fisher would not be able to continue. Unfortunately, this help would not arrive until the following day, when Fisher was found dead from hypothermia. Interestingly, his body was discovered with mittens off and down suit unzipped in an apparent attempt to undress. Fisher was one of eight people who perished on one of the deadliest days in Everest's history.

1) What are the mechanisms by which the body loses heat?
2) What are the stages of hypothermia?
3) Why have multiple victims of hypothermia been found attempting to undress despite freezing temperatures?
4) If medical care was available, what interventions could have been pursued to save Scott Fisher's life?

Case 2

After saving money for a over a year, Mike, an experienced rock and ice climber, set off with his climbing partner on a dream vacation to climb Mt. McKinley in Alaska. Being a seasoned outdoors man and knowing the extremes of temperatures that exist at McKinley's summit, Mike left California well prepared to do battle with the elements. Included in his gear was a new, top-of-the-line pair of mountaineering boots to protect his feet from cold-related injuries. Three weeks into the expedition, Mike and his climbing partner had made camp a few hours from the summit when they became victims of bad luck. A storm front moved in with blinding snow and subzero temperatures, forcing them to remain in camp for an extra two days. Somehow over the course of this period, Mike was separated from his boots but decided to continue on with a pair of standard ski boots rather than risk a
hazardous descent through avalanche terrain to retrieve his gear. On the third day, as the snow died down, Mike and his partner decided to attempt a summit push. A couple of hours into their journey, Mike began to experience pain and numbness in his feet. As they continued on, his symptoms began to grow worse with increasing stiffness in his toes. Mike was well aware that his symptoms were consistent with the early stages of frostbite and was forced to decide between returning to camp and pressing on for the summit.

1) What are the initial signs and symptoms of frostbite?
2) What is the treatment of frostbite?
3) What are complications Mike could expect if he continued his push for the summit?
4) What conditions should be distinguished from frostbite?
Hypothermia

- Although an extreme case, one can learn from the story of Scott Fisher that even the most experienced and prepared individual can succumb to hypothermia.
- Approximately 700 people die each year from this condition, most of them over age 65 years.
- Most think of hypothermia as a condition associated with prolonged cold exposure, but it can also result from immersion accidents, and it occurs more frequently in people who are intoxicated or who have co-morbidities.

Pathophysiology

- Hypothermia is defined as a core body temperature of less than 35°C.
- The primary mechanisms by which heat is lost are: radiation, conduction, convection, and evaporation. These mechanisms are all discussed in the heat illness chapter.
- Heat loss can be accelerated by poor insulation, wet clothing, or vasodilators such as coffee and alcohol.
- Perception of temperature is closely linked to skin temperature rather than core temperature.
- In order to vasoconstrict, the body must expend energy. Eventually, the body’s storage of energy is depleted, leading to a loss of temperature homeostasis and vasodilatation. When this occurs, the individual gets a rush of blood flowing back to the skin and feels warm. This may lead to the phenomenon known as paradoxical undressing, whereby hypothermic individuals take off their clothes despite being cold. This paradoxical undressing may precipitate a further drop in core temperature as blood returns to cold extremities and is subsequently circulated back to the core.

Clinical Presentation

- Hypothermia is diagnosed using a core thermometer (rectal or esophageal) as temperature measurement may be grossly inaccurate using peripheral methods.
  - It is important to note that most commercial thermometers can only register temperatures down to 34.5°C.
  - Since most people faced with hypothermia in the wilderness do not have thermometers, this is an impractical means of diagnosing this condition.
- Individuals must therefore rely on clinical symptoms to make the diagnosis. The spectrum of hypothermia can be divided into three zones: mild, moderate, and severe.

Mild Hypothermia

- Mild hypothermia is defined as a core temperature ranging from 32° - 35°C.
- At this level, the cold temperature defense mechanisms are still working and will cause one to be pale and cold, secondary to maximal peripheral and cutaneous vasoconstriction.
- Mental status may become impaired with varying degrees of confusion, ataxia, and disorientation.
- Urinary frequency is common, due to increased renal perfusion caused by elevated cardiac output and peripheral vasoconstriction increasing blood flow to the kidneys.
- The victim may have an elevation in vital signs, including tachycardia, tachypnea, and hypertension.

Moderate Hypothermia

- Moderate hypothermia is defined as a core temperature ranging from 28° - 32°C.
- Blood pressure, heart rate, and respiratory rate are all decreased.
- Individuals exhibit confusion as well as dilated pupils and muscle rigidity.
- Cardiac dysrhythmias are common and unless rewarming is possible, the victim will eventually cool to ambient temperature and die.
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Severe Hypothermia
- Severe hypothermia is defined as a core temperature below 28°C.
- At this temperature, the victim will go into a deep coma with dilated pupils and muscular rigidity.
- Blood pressure will be barely palpable and pulse may be as low as 10-20 beats per minute.
- Life-threatening dysrhythmias, such as ventricular fibrillation, are easily induced in these victims, even with the slightest of movements. Chemical or electrical conversion of such rhythms is nearly impossible without core rewarming.
- Based on this clinical picture, it is not difficult to imagine how people in severe hypothermia appear to be dead.

<table>
<thead>
<tr>
<th>TABLE 1: Hypothermia Classification</th>
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<tbody>
<tr>
<td><strong>Temperature</strong></td>
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<tr>
<td>Mild hypothermia</td>
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Treatment

General
- The most important consideration in treating hypothermia in the field is removing the victim from the situation that caused him or her to become hypothermic.
- If a victim cannot be evacuated, attempts should be made to get him or her to a shelter and out of cold, wet, and windy conditions that may precipitate further heat loss.
- Wet clothes should be removed in order to prevent conductive heat loss. Victims should be wrapped in dry blankets if possible to minimize radiant heat loss.
- Anything that can be done to help rewarm the victim will be helpful; such as sitting by a fire or drinking warm liquids. It is important however to avoid beverages such as alcohol or heavily caffeinated drinks, which may actually exacerbate hypothermia.
- In a rescue situation, it is important to remember the premise that “no one is dead until they are warm and dead.”
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- As discussed in the previous section, people suffering from severe hypothermia may be severely comatose, though alive and salvageable with proper medical care. Hypothermia decreases basal metabolic rate and lowers oxygen requirements, which may in turn allow victims to survive for a prolonged period without a detectable perfusing rhythm.
- The caveat to the above "rule" is that an individual in the wilderness may have died from a non-hypothermia related condition such as trauma or a medical illness. In this case, rewarming would obviously be of no use and would therefore not warrant risking the safety of rescuers to evacuate the individual's body.
- The following are specific recommendations for treatment of the different levels of hypothermia in the field. However, keep in mind that field treatment of hypothermia is notoriously difficult, and arrangements should begin for evacuation as soon as it is determined that the victim cannot actively rewarm himself or herself.

**Mild Hypothermia**
- As mentioned, the victim should be removed from the elements and brought to shelter to avoid further heat loss.
- The individual should be allowed to completely undress, then dressed in dry clothes and wrapped in blankets, taking special care to cover the head and neck to avoid heat loss from radiation.
- Limited exercise may generate some heat (this is not advised in moderate and severe hypothermia as it may further deplete glycogen stores). Generally speaking, those suffering from mild hypothermia will have favorable outcomes as long as the cooling process is halted.

**Moderate Hypothermia**
- In moderate hypothermia, the individual's capacity to achieve rewarming by shivering has been exhausted and therefore treatment must be more aggressive.
- These victims require active rewarming in order to get their body temperature to near a normal level.
- In addition to the treatment measures mentioned above, apply mild heat to the head, neck, chest, armpits and groin of the victim using hot water bottles, wrapped commercial heating pads, or warm, moist towels.
- If conditions prohibit the use of a fire to warm fluids, chemical heaters such as those found in military "meals ready to eat" can be used for this purpose. Warm beverages can also be used to actively rewarm victims, but care should be given to assess their level of consciousness to avoid aspiration.
- Victims with moderate hypothermia should be evacuated and transported to the nearest hospital for medical treatment and active rewarming.

**Severe Hypothermia**
- Severe hypothermia is a true medical emergency that requires aggressive treatment prompt medical management with active core rewarming and evacuation. These victims have no ability to reheat themselves at this stage.
- It is important to consider that victims suffering from this condition may exhibit altered mental status if they are still conscious. Therefore it is vital to ignore pleas of "Leave me alone, I'm okay" because these individuals are in serious trouble.
- If evacuation is not possible, place the victim in a pre-warmed sleeping bag with one to two people. Skin-to-skin contact is very important to promote transfer of warmth to the victim through conduction. It is particularly useful to initiate skin-to-skin contact in regions of the body with large surface areas and where major blood vessels are more superficial, such as in the chest and neck.
- Exhalation of warm air near the victim's nose and mouth may be minimally effective, although it is sometimes touted as a useful method of active core rewarming. Inhalation of significant volumes of warm, humidified air into the lungs can aid in rewarming key areas of the body such as the head, neck, and thorax.
- Care must be taken in handling victims suffering from this condition as extremely cold core temperatures can cause cardiac irritability.
  - Even the slightest jolt may cause these individuals to degenerate into life-threatening dysrhythmia such as ventricular fibrillation.
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- This becomes extremely important in determining when CPR needs to be initiated. As discussed earlier, victims with severe hypothermia may have faint pulses, severe bradycardia, and appear to be dead.
- If CPR is started prematurely, it may precipitate an arrhythmia due to the preexisting cardiac irritability.
- Therefore, rather than assessing the victim using the usual basic life support guidelines, each carotid should be palpated in turn for a total of two minutes each. If no pulse or respirations are present at that point, then CPR should be started.

- If available, the administration of intravenous fluids may also be helpful in the treatment of severe hypothermia. As little as 500 cc of a normal saline bolus can stabilize cardiac conduction and prevent life-threatening dysrhythmias. The infusion of warm saline will help to prevent further hypothermia. However, intravenous access may be difficult to obtain in these victims due to extreme vasoconstriction. In this situation it has been shown that saline infusion through an intraosseous line, if available, is just as effective.
- Above all else, it is crucial to closely monitor individuals suffering from this condition. Remember that severe hypothermia may mimic other medical conditions and may mimic death as well. Because the victim has lost his or her ability to thermoregulate, evacuation with active core rewarming at a medical facility must be the ultimate disposition.

Prevention

- The single most important aspect in hypothermia prevention is adequate preparation. This includes maintaining awareness of weather conditions, bringing the proper gear, and designing a contingency plan in case the worst should occur.
- The weather does not need to be sub-zero in order for hypothermia to set in, as evidenced by the fact that several cases are reported every year in states that traditionally have warmer climates, such as Florida.
- It has been said that hypothermia is the “killer of the unprepared” but even experienced and prepared outdoors people have succumbed to this ailment.
- Should the unexpected occur and you are faced with this situation, the following is a list of things that can be done to prevent hypothermia:
  - Find or create a shelter.
  - Cover exposed areas of the body.
  - Wear several loosely fitting layers of clothing.
  - Conserve, share, and create warmth.
  - Share body heat.
  - Increase heat production through voluntary muscle movement.
  - Drink and eat warmed beverages and food.
  - Build a fire.
  - Monitor for signs and symptoms of hypothermia.

Evacuation Guidelines

- All victims with moderate and severe hypothermia must be evacuated from the wilderness. They have lost the capacity to rewarm themselves and it is extremely difficult to actively rewarm these victims in the wilderness setting.
- Victims with mild hypothermia may not require evacuation as long as they are able to warm themselves and they do not develop any sequelae from the episode.
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FROSTBITE

Background
- Frostbite occurs when skin is exposed to temperatures that are below freezing.
- While the incidence of frostbite is unknown, it occurs most often in the extremities, with a slightly higher incidence in feet than in hands.
- Frostbite can occur in any area of the body.
- It more commonly affects exposed areas, but in severe conditions can arise on parts of the body that are covered.

Pathophysiology
- The pathophysiology of frostbite can be divided into four phases (Table #2): prefreeze, freeze-thaw, vascular stasis, and ischemic.
- In general, it involves the cooling and eventual freezing of body parts by heat loss through the mechanisms discussed earlier in this chapter.
- The end result is the formation of ice crystals in the extra cellular space, intracellularly, or both. However, this is only the beginning of the problem. The body’s response is an intense inflammatory response, which leads to a great deal of secondary damage.
- Extracellular ice formation leads to cell death by cellular dehydration even if there is no formation of ice crystals inside the cell.
  - The extracellular ice crystals bind up free extracellular water, which leads to higher osmolarity outside of the cell than intracellularly. This leads to a movement of water from intracellular to extracellular to equilibrate the osmotic difference.
  - This loss of intracellular water eventually leads to cell death.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Changes</th>
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<tbody>
<tr>
<td>Prefreeze</td>
<td>Vasospasticity</td>
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<td>Cell membrane instability</td>
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<td>Endothelial plasma leakage</td>
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<td>Vasoconstriction with diminished tissue temperature</td>
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<tr>
<td>Freeze – thaw</td>
<td>Tissue temperature drops below freezing</td>
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<td></td>
<td>Formation of ice crystals extracellular and intracellular</td>
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<td></td>
<td>Fluid shift across cell membrane</td>
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<td></td>
<td>Cellular shrinkage/dehydration</td>
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<td>Vascular stasis</td>
<td>Vasospasm and dilation</td>
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<td>Vascular shunting</td>
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<td>Plasma leakage</td>
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<td>Small vessel thrombosis</td>
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<td>Ischemic</td>
<td>Thrombosis</td>
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<td>AV shunting</td>
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<td>Ischemia</td>
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<td></td>
<td>Autonomic dysfunction</td>
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<td>Gangrene</td>
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</table>

Clinical Presentation
- Frostbite is the freezing of the skin, which may involve deeper tissues.
- Frostbite is divided into degrees, first through fourth and superficial through deep.
- First and second degrees are considered to be superficial and typically heal well with minor sequelae.
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- Third and fourth degrees are deeper and associated with very significant permanent damage and tissue loss.
- On initial evaluation one may be unable to differentiate the exact degree of frostbite because it is based on findings after thawing. However, the treatment for all degrees of frostbite is the same, so defining an exact degree early on is unimportant.

First Degree (Superficial)
- Involves the superficial layers of skin.
- The skin appears pale and yellowish white while frozen and is numb to the touch.
- With rewarming there will be pain and redness of the involved area.
- After rewarming, the area will be swollen and continue to be red for a period of hours.

Second Degree (Superficial)
- Involves deeper layers of the skin.
- The skin appears pale and white while frozen and is numb to the touch.
- With rewarming there will be pain and redness of the involved area.
- After rewarming, the area will be swollen and continue to be red for a period of hours.
- In addition to the redness, the skin will develop blisters over the area of involvement. These blisters will be filled with clear-to-white fluid.

Third Degree (Deep)
- Complete freezing of the skin and tissue layers under the skin.
- The skin appears pale and white while frozen.
- Numb to the touch, it has a "chunk of wood" type of consistency.
- With rewarming there will be significant pain, redness and swelling of the involved area.
- After rewarming, the area will be swollen and continue to be red for a period of hours to days.
- In addition to the redness, the skin will develop blisters over the area of involvement. These blisters will be filled with hemorrhagic fluid.

Fourth Degree (Deep)
- Involves the skin and much deeper to include the muscle, tendon, and bone.
- The area of involvement appears pale and white while frozen.
- Numb to the touch, it has a "chunk of wood" type of consistency.
- With rewarming there will be significant pain, redness and swelling of the involved area.
- After rewarming, the area will be swollen and continue to be red for a period of hours to days.
- In addition to the redness, the skin will develop blisters over the area of involvement. These blisters will be filled with hemorrhagic fluid.
- Mottled skin with bluish discoloration forms a deep, dry, black-crusted lesion.

Treatment
- Thawing of a frozen body part is a very painful process that usually requires opiate analgesics and other medications such as antibiotics and antiinflammatory agents.
- An inappropriate or poorly done thawing process will cause the victim more harm than good. If the frozen part is thawed too slowly it will increase the production of prostaglandins and thromboxane, which cause the secondary damage after the freezing injury. If the temperature is too high, the victim will sustain a burn, which will also worsen the injury.

Rapid Rewarming
- The primary treatment is rapid rewarming in a controlled manner.
  - This should only occur when there is no chance of the person refreezing the area of involvement.
    - Refreezing of a recently thawed frostbitten body part will result in a very significant increase in the inflammatory mediators such as prostaglandins and thromboxane. These and several other mediators cause a secondary injury that is worse than the initial freezing of the cells.
    - A failure to rewarmed in a rapid manner will also increase tissue damage by increasing the inflammatory mediators.
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- The optimal method of rewarming is to place the affected body part into gently circulated water that has been warmed to $40^\circ$ – $42^\circ$C ($104^\circ$ – $108^\circ$F).
  - This should be done for at least 15 – 30 minutes or until skin regains pliability and returns to its normal color.
  - The temperature must be closely monitored with a thermometer. If it is too hot, it will burn the skin. If it is too cool, it will delay thawing.
  - In the wilderness most people do not carry thermometers, which can make monitoring the water temperature more difficult. A good rule of thumb is to heat the water until it approximates the temperature of a hot tub. If the water is hot enough that you are not able to keep your hand in it for an extended period of time, then it is probably too hot.
- Refreezing is associated with significantly greater morbidity than initial freezing, even for extended periods of time. In general, if there is a chance that a body part may be subjected to a 2nd case of frostbite soon after rewarming, then it should not be thawed initially. For example, if a victim has a frostbitten foot and you must walk out of the area. If there is a chance that the foot may become frostbitten again, it is better to have him or her walk on the frostbitten foot than to thaw it.

Other Measures
- Remove all wet clothing and replace with dry clothing.
- Remove any tight or constrictive clothing and rings.
- Wrap the affected area with gauze or some other clean, absorbent material. If the hands or feet are involved, separate the fingers with gauze while wrapping.
- Splint the extremity to minimize motion, padding all joints with extra padding.
- Before thawing, administer ibuprofen or a similar NSAID to all victims who do not have a contraindication to this treatment. NSAIDs have been shown to inhibit the development of the inflammatory cascade that leads to vasoconstriction, shunting, and sludging, all of which lead to worsening ischemia and necrosis. One protocol recommends ibuprofen 400 mg every 12 hours.
- Treat the pain with medicines such as acetaminophen and opiates.
- While prophylactic antibiotics have not been proven to prevent infection and further tissue disruption, their administration is recommended in treating frostbite. Specifically, an anti-streptococcal antibiotic such as penicillin is recommended.
- Ensure that the frostbite victim is up-to-date on his or her tetanus immunization. Frostbite is a tetanus prone wound.

“DO NOTS” OF FROSTBITE TREATMENT
- Do not attempt thawing by heating with dry heat such as a fire. The fact that the temperature is not controlled may lead to delay in thawing, but may also burn the tissues because the area is numb and pain is not appreciated.
- Do not thaw the area if there is any chance that the area will refreeze. If a body part undergoes freezing again soon after being rewarmed the extent of the injury is a multitude more than if there was just a delay in the thawing. An example is the person with a frostbitten foot in the wilderness. It is better to have that person walk out on the frozen foot than to risk a refreezing injury, if such an event is possible.
- Do not rub or massage the area when it is frozen or thawing as that will worsen the injury. The victim may move that area while undergoing thawing, but that should be the extent of the motion.
- Do not rub the area with snow. This is an old recommendation that is actually harmful.

Prevention
- As with hypothermia, the most important aspect of frostbite prevention is adequate preparation.
- Covering susceptible areas of skin with properly fitting dry clothing and footgear is essential during prolonged exposure to cold weather.
- A waterproof bag containing an extra pair of socks and undergarments may come in handy.
- Maintain a good diet and stay well hydrated.
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- Consumption of alcohol and cigarettes may also contribute to frostbite and should be avoided.
- In extreme situations, putting one’s hand or feet in his or his partner’s armpits may provide some added warmth.
- Continuous movement, including frequent contraction and relaxation of extremities, may also be helpful in creating transient vasodilation and increased blood flow.

FROSTNIP

- Frostnip is a cold injury to the skin but there is no actual tissue freezing, which occurs in frostbite.
- It is the result of prolonged skin exposure to cold temperatures.
- Frostnip can be a precursor to frostbite and should therefore be taken seriously.
- Signs of frostnip include:
  - The affected area will be red and swollen, but the skin will stay soft and pliable.
  - Numbness and tingling are possible but should resolve after rewarming.
  - Frostnip only has mild pain when rewarming.
  - Pain and skin cracking are possible in areas that are repeatedly frostonipped, potentially leading to infection.
  - Areas that are most commonly affected include fingers, toes, ears, and cheeks.

Treatment

- Rewarm the injured area using warm water or another heat source.
- Take care not to rub frost nipped areas as this may promote tissue damage.
- Unlike frostbite, these injuries should always be rewarmed even if still exposed to a cold environment since the tissue has not yet been damaged and will only become damaged if the process is allowed to continue.

CHILBLAINS

- Chilblains occur at temperatures from 0-15°C (32-59°F) and result from an abnormal reaction of the body to the cold.
- Several different conditions have been linked to the formation of chilblains including the following:
  - Poor circulation
  - Rapid rewarming
  - Damp living conditions
  - Sudden exposure to cold water
- Signs of chilblains include:
  - Itchy, red or purple bumps on the skin that emerge over the course of several hours and can become very painful.
  - Common places where chilblains occur include the backs and sides of fingers and toes, lower extremities, heels, nose, and ears.
  - Blistering, ulceration, and infection are possible but they generally resolve spontaneously over the course of one to two weeks.

Treatment

- Treatment generally consists of elevation, gentle rewarming, and covering the area with a dry bandage.
- Diphenhydramine (Benadryl) may be helpful to relieve the itching.

Prevention

- Certain groups of people predisposed to chilblains include children, the elderly, and people
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with poor blood flow to the arms, hands, legs and feet.

- Keep leg and feet warm with leg warmers or wool socks
- Avoid smoking, as this causes constriction of the blood vessels
- Wear warm, waterproof gloves if working in wet environments
- Exercise and acclimatize before prolonged exposure to a cold environment
- Soak hands in warm water and then dry to promote dilation of blood vessels

**IMMERSION FOOT**

- Immersion foot, also known as trench foot, occurs as the result of several days of exposure to water at non-freezing temperatures. Ambient temperatures generally consistent with immersion foot range from 0-10°C (32-50°F).
- Signs and symptoms of immersion foot include:
  - Redness followed by bluish discoloration and mottling
  - Swelling
  - Numbness, tingling and pain (can be described as feeling “wooden” in severe cases)
  - Shiny appearance
  - Blisters, ulcers, and even gangrene are possible (although uncommon)

**Treatment**

- Most cases of immersion foot resolve spontaneously over the course of several weeks, provided they are removed from the offending conditions.
- Acutely, the affected area should be kept warm and dry.

**Prevention**

- Keep feet warm and dry by changing wet socks and boot / shoes as often as possible.
- Allow feet to air dry whenever possible.
- Frequently inspect feet for signs and symptoms of this condition.

**TABLE 3: Comparison of Local Non-Freezing Injuries**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Ambient Temperature</th>
<th>Pathophysiology</th>
<th>Signs and Symptoms</th>
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<tbody>
<tr>
<td>Frostnip</td>
<td>&lt; 15°C (59°F)</td>
<td>Local vasoconstriction</td>
<td>Erythema</td>
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<td>Freezing of moisture on skin</td>
<td>Edema</td>
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<td>Numbness</td>
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<td>Paresthesia</td>
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<td>Skin remains soft</td>
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<tr>
<td>Chilblains</td>
<td>0-15°C (0-59°F)</td>
<td>Local vasoconstriction</td>
<td>Red/purple bumps</td>
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<td></td>
<td>Followed by vasodilatation</td>
<td>Itchy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leakage blood into tissue</td>
<td>Painful</td>
</tr>
<tr>
<td>Immersion Foot</td>
<td>0-10°C (32-50°F)</td>
<td>Prolonged exposure to water</td>
<td>Hyperemia</td>
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<tr>
<td></td>
<td></td>
<td>Local vasoconstriction</td>
<td>Cyanosis</td>
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<tr>
<td></td>
<td></td>
<td>Neurovascular damage</td>
<td>Mottling</td>
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<td>Delayed cap refill</td>
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<td>Erythema</td>
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<td>Edema</td>
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<td>Numbness</td>
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<td>Paresthesia</td>
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</tbody>
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Chapter 7: Cold Induced Injuries and Illnesses

Evacuation Guidelines

- All victims with frostbite must be evacuated from the field for definitive rewarming and management of their frostbite. The treatment regimen has just begun with the rapid rewarming.
- Frostnip, chilblains, and immersion foot do not require evacuation.
Chapter 7: Cold Induced Injuries and Illnesses

Questions

1) In which degree of hypothermia is uncontrollable shivering a feature?
   a) Mild hypothermia
   b) Moderate hypothermia
   c) Severe hypothermia

2) Which one of the following is not a step that should be taken to prevent further hypothermia in the victim who is cold?
   a) Getting the victim to shelter
   b) Using body heat
   c) Drinking warm beverages
   d) Smoking cigarettes
   e) Removing wet clothing

3) During which stage of frostbite do ice crystals form?
   a) Pre-freeze
   b) Freeze-thaw
   c) Vascular stasis
   d) Ischemic

4) Which one of the following is an important medication that you must administer to the victim who has frostbite before he or she undergoes rapid rewarming of the frostbitten body part?
   a) Acetaminophen
   b) Epinephrine
   c) Heparin
   d) Ibuprofen
   e) Nitroglycerin

5) Which degree of frostbite is associated with full-thickness skin involvement in addition to muscle and tendon involvement with hemorrhagic bullae?
   a) First degree
   b) Second degree
   c) Third degree
   d) Fourth degree

6) When should frostbite not be treated in the field with rewarming?
   a) If the victim will be promptly evacuated.
   b) If the victim is diabetic.
   c) If there is a possibility of refreezing.

7) How does frostnip differ from frostbite?
   a) There is no ice crystal formation in frostnip.
   b) Permanent damage occurs, but it is very minor with frostnip but not with first-degree frostbite.
   c) Frostnip only involves the surface of the skin and frostbite goes down to the muscle.
   d) Frostbite has hemorrhagic bullae whereas frostnip has whit to clear bullae.

Answers:
1. a 5. d
2. d 6. c
3. b 7. a
4. d