Environmental Emergencies

Our bodies need to maintain a certain temperature range to function properly, much like automobiles. Simply stated, our bodies and mind work best in a preferred body temperature zone and our bodies and our behavior change to keep our bodies at that preferred temperature zone. The hypothalamus is responsible for temperature regulation in the body. Encyclopedia Britannica defines Homeostasis as “any self-regulating process by which biological systems tend to maintain stability while adjusting to conditions that are optimal for survival. If homeostasis is successful, life continues; if unsuccessful, disaster or death ensues”. Much like the thermostat in your home the hypothalamus maintains temperature regulation in the body in the most basic sense via vasoconstriction (body too cold) or vasodilation (body too warm) and with compensatory adjustments in the breathing rate, the level of blood sugar, and the metabolic rate. In an average human, homeostasis occurs when the body’s temperature is between from 97°F (36.1°C) to 99°F (37.2°C). This range is impacted greatly according to the location the temperature is obtained.

Average human temperature is approximately 98.6 °F (although this may vary due to a variety of factors). Rectal (core) measurements may be as much as a degree higher, with the average temperature being 99.5 °F. Inversely, axillary (under arm) measurements tend to be lower, with an average temperature being around 97.7 °F. Even oral temperatures, on average, are lower than core body temperature.

When summarizing studies with strong or fairly strong evidence, the range for temperatures were wide including significant differences between temperature range in women and men (see table of daytime temperature ranges). Body temperature normally fluctuates over the day, with the lowest

<table>
<thead>
<tr>
<th>Method</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral</td>
<td>33.2–38.2 °C (91.8–100.8 °F)</td>
<td>35.7–37.7 °C (96.3–99.9 °F)</td>
</tr>
<tr>
<td>Rectal</td>
<td>36.8–37.1 °C (98.2–98.8 °F)</td>
<td>38.7–35.5 °C (99.5–99.9 °F)</td>
</tr>
<tr>
<td>Tympanic</td>
<td>35.7–37.5 °C (96.3–99.5 °F)</td>
<td>35.5–37.5 °C (95.9–99.5 °F)</td>
</tr>
</tbody>
</table>


levels around 4 a.m. and the highest in the late afternoon, between 4:00 and 6:00 p.m. (assuming the person sleeps at night and stays awake during the day). An individual's body temperature typically changes by about 0.5 °C (0.9 °F) between its highest and lowest points each day.

Many factors influence the body’s ability to maintain homeostasis. A person’s age and co-morbidities, certain medications, and the temperature of the person’s environment all play a role in thermoregulation.

Based on information from death certificates, 10,649 deaths were attributed to weather-related causes in the United States during 2006–2010. Nearly one-third of the deaths were attributed to excessive natural heat, and almost two-thirds were attributed to excessive natural cold. Studies have found that older persons, males, and non-Hispanic black persons had higher weather-related mortality rates than other ages, females, and other race and ethnicity subgroups. Among adults, heat-related and cold-related death rates increased with age, particularly for those aged 75 and over. Age-adjusted weather-related death rates for males were higher than those for females.
Cold-Related Illness

When exposed to cold temperatures, your body begins to lose heat faster than it can be produced. Prolonged exposure to cold will eventually use up your body’s stored energy. The result is hypothermia, or abnormally low body temperature. Body temperature that is too low affects the brain, making the victim unable to think clearly or move well. This makes hypothermia particularly dangerous because a person may not know it is happening and won’t be able to do anything about it.

Exposure to extreme natural cold also is associated with morbidity and mortality. It can lead to hypothermia, which may result in death, because it can exacerbate preexisting chronic conditions (including cardiovascular and respiratory diseases), and because persons with conditions that impair thermoregulatory function and those taking various medications are more susceptible to cold effects. Subpopulations at risk for cold-related mortality are similar to those at risk for heat-related mortality: older adults, very young children, males (alcohol and outdoors), and persons with preexisting chronic medical conditions. Alcoholics, persons taking recreational drugs (especially alcohol), homeless persons, those with inadequate winter clothing or home heating, those who go on wilderness excursions, and those who participate in winter sports also are at increased risk of cold-related mortality. Persons who live in places with rapid temperature changes, large shifts in nighttime temperatures, or are at high elevations also are at increased risk.

Even mild hypothermia can result in devastating physiologic consequences. The lethal triad of hypothermia, acidosis and coagulopathy has been recognized as a significant cause of death in patients with traumatic injuries. Hypothermia in trauma patients is caused by a multitude of factors. Hemorrhagic shock, traumatic brain injuries, and alcohol intoxication impair the body’s ability to regulate its core temperature. In addition, patients at the extremes of age and those with certain medical condition, such as diabetes or thyroid disease, are at higher risk to develop hypothermia after trauma. Furthermore, those patients with prolonged exposure to the environment as during extrication and those with severe burns are at risk for rapid heat loss causing profound hypothermia. Lastly, an important care consideration for a trauma patient is the temperature of the fluids and blood products we infuse as well-intentioned therapy. Room temperature normal saline (20–25 degrees C) is very hypothermic relative to the desired normal body temperature. Thus, large volume resuscitations with even room temperature IV fluids can significantly contribute to hypothermia. Of particular concern is the effect of hypothermia on the coagulation system. The coagulation system is a temperature- and pH-dependent - series of complex enzymatic reactions that result in the formation of blood clots to stop both internal and external hemorrhage. Hypothermia causes the blood not to clot or to not clot efficiently.

Nonfreezing Cold Injury

Trench foot - also known as immersion foot, is an injury of the feet resulting from prolonged exposure to wet and cold conditions. Trench foot can occur at temperatures as high as 60 degrees F if the feet are constantly wet. Injury occurs because wet feet lose heat 25-times faster than dry feet. Therefore, to prevent heat loss, the body constricts blood vessels to shut down circulation in the feet. Skin tissue begins to die because of lack of oxygen and nutrients and due to the buildup of toxic products.
Symptoms of trench foot include:

- Reddening of the skin
- Numbness
- Leg cramps
- Swelling
- Tingling pain
- Blisters or ulcers
- Bleeding under the skin
- Gangrene (the foot may turn dark purple, blue, or gray)

**Chilblains** - are caused by the repeated exposure of skin to temperatures just above freezing to as high as 60 degrees F. The cold exposure causes damage to the capillary beds (groups of small blood vessels) in the skin. This damage is permanent and the redness and itching will return with additional exposure. The redness and itching typically occurs on cheeks, ears, fingers, and toes.

Symptoms of chilblains include:

- Redness
- Itching
- Possible blistering
- Inflammation
- Possible ulceration in severe cases

**Cold urticaria** - involves the formation of localized or general wheals (hives) and itching after exposure to cold. It is not the absolute temperature that induces this form of urticaria, but the rate of change of temperature in the skin.

**Freezing Cold Injury**

**Frostbite** - is the term that is used to describe tissue damage from direct freezing of the skin. Modern equipment and clothing have decreased the risk of frostbite resulting from adventure tourism, and frostbite occurs mainly during an accident, severe unexpected weather/wind, or as a result of poor planning.

Once frostbite injury has occurred, little can be done to reverse the changes. Therefore, taking great care to prevent frostbite is crucial. Frostbite is usually graded like burns.

- First-degree frostbite involves reddening of the skin without deeper damage. The prognosis for complete healing is virtually 100%.
- Second-degree frostbite involves blister formation. Blisters filled with clear fluid have a better prognosis than blood-tinged blisters.
Third-degree frostbite represents full-thickness injury to the skin and possibly the underlying tissues. No blister forms, the skin darkens over time and may turn black, and if the tissue is completely devascularized, amputation will be necessary.

Frostbitten skin is numb and appears whitish or waxy. The generally accepted method for treating a frozen digit or limb is through rapid rewarming in water heated to 104°F–108°F (40°C–42°C). The frozen area should be completely immersed in the warm water. A thermometer is needed to ensure the water is kept at the correct temperature. Rewarming can be associated with severe pain, and analgesics can be given if needed. Once the area is rewarmed, it must be safeguarded against freezing again. It is thought to be better to keep digits frozen a little longer and rapidly rewarmed them, than to allow them to thaw out slowly or to thaw and refreeze. A cycle of freeze-thaw-refreeze is devastating to tissue and leads more directly to the need for amputation.

Once the area has rewarmed, it can be examined. If blisters are present, note whether they extend to the end of the digit. Proximal blisters usually mean that the tissue distal to the blister has suffered full-thickness damage. Treatment consists of avoiding further mechanical trauma to the area and preventing infection. Reasonable field treatment consists of washing the area thoroughly with a disinfectant such as povidone-iodine, putting dressings between the toes or fingers to prevent maceration, using fluffs (expanded gauze sponges) for padding, and covering with a roller gauze bandage. Prophylactic antibiotics are not needed in most situations.
Once the patient has reached a definitive medical setting, there should be no rush to do surgery. The usual time from injury to surgery is 4–5 weeks. Technetium (Tc)-99 scintigraphy and magnetic resonance imaging can be used to help define the extent of the damage. Once the delineation between dead tissue and viable becomes clear, surgery that preserves the remaining digits can be planned.

**Hypothermia** - is most likely at very cold temperatures, but it can occur even at cool temperatures (above 40°F) if a person becomes chilled from rain, sweat, or submersion in cold water. Humidity, rain, and wind can produce hypothermia even with temperatures around 50°F (10°C). Hypothermia can be defined, in general terms, as having a core body temperature below 95°F (35°C).

When people are faced with an environment in which they cannot keep warm, they first feel chilled, then begin to shiver, and eventually stop shivering as their metabolic reserves are exhausted. At that point, body temperature continues to decrease, depending on the ambient temperatures. As the core temperature falls, neurologic functioning decreases until almost all hypothermic people with a core temperature of 86°F (30°C) or lower are comatose. The record low core body temperature in an adult who survived is 56°F (13°C).

**Mild hypothermia (32-35°C): 90-95°F**
- 34-35°C, most shiver vigorously.
- Less than 34°C (93.2°F), develop altered judgment, amnesia & dysarthria. Respiratory rate may increase.
- 33°C, ataxia and apathy present. Stable hemodynamically and able to compensate for the symptoms.

**Moderate hypothermia (28-32°C) 82-90°F**
- 32°C (90°F) or lower present in stupor.
- 31°C (88°F) or below, the body loses its ability to generate heat by shivering. Atrial arrhythmias may occur
- 30°C (86°F), at risk for ventricular arrhythmias. Pulse & cardiac output reduced.
- 28°C (82.4°F), Metabolism reduced 50%

**Severe hypothermia (less than 28°C) (less than 82°F)**
- Markedly susceptible to VFIB (max 22°C), Rigidity, may stop breathing and lose pulse
- 26°C (78.8°F) Major acid-base disturbances; no reflexes or response to pain
- 25°C (77°F) Cerebral blood flow one third of normal; loss of cerebrovascular autoregulation; cardiac output 45% of normal; pulmonary edema may develop
- 23°C (73.4°F) No corneal or oculocephalic reflexes; areflexia
- 22°C (71.6°F) Maximum risk of ventricular fibrillation; 75% decrease in oxygen consumption
- 20°C (68°F) Lowest resumption of cardiac electromechanical activity; pulse 20% of normal
- 19°C (66.2°F) Electroencephalographic silencing
- 18°C (64.4°F) Asystole
- 13.7°C (56.8°F) Lowest adult accidental hypothermia survival
- 15°C (59.2°F) Lowest infant accidental hypothermia survival
• 10°C (50° F) 92% decrease in oxygen consumption
• 9.0°C (48.2° F) Lowest therapeutic hypothermia survival

Victims of hypothermia are often (1) elderly people with inadequate food, clothing, or heating; (2) babies sleeping in cold bedrooms; (3) people who remain outdoors for long periods—the homeless, hikers, hunters, etc.; and (4) people who drink alcohol or use illicit drugs.

A person with severe hypothermia may be unconscious and may not seem to have a pulse or to be breathing. In this case, handle the victim gently, and get emergency assistance immediately. Even if the victim appears dead, CPR should be provided unless the patient meets criteria for cold death. CPR should continue while the victim is being warmed, until the victim responds or medical aid becomes available. In some cases, hypothermia victims who appear to be dead can be successfully resuscitated.

Warnings signs of hypothermia:
Adults:
- shivering, exhaustion
- confusion, fumbling hands
- memory loss, slurred speech, drowsiness

Infants:
- bright red, cold skin
- very low energy

Cold water immersion - creates a specific condition known as immersion hypothermia. It develops much more quickly than standard hypothermia because water conducts heat away from the body 25 times faster than air. Typically people in temperate climates don’t consider themselves at risk from hypothermia in the water, but hypothermia can occur in any water temperature below 70°F. Immersion hypothermia can render a person unable to swim or keep floating in <15 minutes. Survival times can be lengthened by wearing proper clothing (wool and synthetics and not cotton), using a personal flotation device (PFD, life vest, immersion suit, dry suit), and having a means of both signaling rescuers (strobe lights, personal locator beacon, whistles, flares, waterproof radio) and having a means of being retrieved from the water.

The most common misunderstanding about Cold Water Immersion is that it leads to immediate Hypothermia. The real truth is other serious events occur long before hypothermia sets in, each with its own physiological challenges. The four phases are:
- Cold Shock Response
- Cold Incapacitation
- Hypothermia
- Circum-rescue Collapse
Cold Shock Response - lasts for only about a minute after entering the water and refers to the affect that cold water has on your breathing. Initially, there is an automatic gasp reflex in response to rapid skin cooling. If the head goes underwater, water may be breathed into the lungs during the gasp. The result is simple: drowning. That’s one of the many benefits of a life jacket or PFD: it helps to keep your head above water during this critical first response.

A second component of the Cold Shock Response involves hyperventilation. Like the gasp reflex, this is a natural reaction to the cold. Although this physiological response will subside, panic can cause a psychological continuance of hyperventilation. Prolonged hyperventilation can lead to a faint, so the key thing is to concentrate on controlling your breathing.

The other significant Cold Shock Response is cardiac related. As the arteries narrow (vasoconstriction), the heart has to work harder to pump the same volume of blood throughout the body. Especially for people with underlying heart disease, this additional workload can cause the heart to go into cardiac arrest.

Cold Incapacitation - occurs within 5 - 15 minutes in cold water. Vasoconstriction decreases blood flow to the extremities in an effort to preserve heat in the core, thereby protecting the vital organs but allowing the periphery to cool. Unfortunately, muscle and nerve fibers don’t work well when cold. Within this critical time frame you will lose meaningful movement in your hands and feet, and then your arms and legs, so if you’re not wearing a floatation device, you will be unable to stay afloat and will drown. Other important life-saving/survival activities will also become more difficult and then impossible.

Hypothermia - There are a number of misconceptions when it comes to hypothermia. The first deals with how long it will take to become hypothermic. While it varies with water temperature and body mass, it can take 30 minutes or more for most adults to become even mildly hypothermic in ice water. Knowing this is vitally important in a survival situation, since people would be far less likely to panic if they knew that hypothermia would not occur quickly and that they have some time to make good decisions and actions to save themselves.

In order to fully understand the advancement of hypothermia from entry into the water until death, consider it in three stages. (Mild, Moderate and Severe)
### Stage of Hypothermia

<table>
<thead>
<tr>
<th>Stage of Hypothermia</th>
<th>Body Temperature</th>
<th>In Water Duration (minutes)</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>35°C</td>
<td>&gt;30 mins</td>
<td>Shivering</td>
</tr>
<tr>
<td>Moderate</td>
<td>32°C</td>
<td>30-120 mins</td>
<td>Unconscious, will drown without floatation</td>
</tr>
<tr>
<td>Severe</td>
<td>28°C</td>
<td>90-180 mins</td>
<td>Cooling to Cardiac Arrest</td>
</tr>
</tbody>
</table>

Note: Water can be quite cold even in summer. Don’t let your guard down just because it’s July or August. Hypothermia can still occur, although its onset will take longer.

**Circum-rescue Collapse** can happen just before, during or after rescue. There are many clinical examples of victims being rescued from cold stress (usually from cold water immersion) in an apparently stable and conscious condition, only to experience a rewarming shock or post rescue collapse, with symptoms ranging from syncope to ventricular fibrillation and cardiac arrest. It has been noted that deaths can occur shortly before, during, or after rescue and have used the term *circum-rescue collapse*. Deaths have been described just before, during, or soon after rescue, as well as up to 24 hours after rescue.

It has been proposed that removal from cold water results in a precipitous fall in blood pressure, inadequate coronary blood flow, and myocardial ischemia that possibly precipitates ventricular fibrillation. Some researchers demonstrated decreases in aortic blood pressure and central venous pressure during vertical lifting by helicopter strap from cold water. This has led to a widespread practice of using a double sling (under the arms and knees), which can raise a victim in a more horizontal position.

The importance of further cooling of the heart cannot be discounted. Fibrillation of a cold heart can be initiated by mechanical stimuli, hypoxia and acidosis, and rapid changes in pH. Regardless of the etiology, it is important to note that in severely hypothermic patients, there is a significant risk of further deterioration.\(^3\)

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\(^3\) [http://www.expeditionmedicine.co.uk/index.php/advice/resource/r-0024.html](http://www.expeditionmedicine.co.uk/index.php/advice/resource/r-0024.html)
### Aurora Health Care Protocol for Cold Emergencies

#### Hypothermia

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Mild/Moderate Hypothermia: 86-95° F, Conscious or altered sensorium with shivering.</th>
</tr>
</thead>
</table>
| FR B A I P | 1. Initial Care:  
| A I P | - Obtain temperature  
| | - Use warm IV fluids |

| FR B A I P | 2. Rewarm patient:  
| | - Place in warm environment. Remove wet clothing and dry patient  
| | - Apply hot packs wrapped in towels to axillae, groin, neck, thorax. Wrap patient in blankets. |

| FR B A I P | Severe Hypothermia: Temperature of 86° F or less. Patient may appear uncoordinated with poor muscle control or rigidity, simulating rigor mortis. There will be NO shivering.  
| | - Sensorium: confused, withdrawn, disoriented or comatose. EKG: anticipate bradycardia→asystole. |

| 1. Initial Care - |  
| | - Assess rhythm before beginning CPR; check pulse for 30-60 seconds. If pulse/breathing are absent, start CPR.  
| | - Prevent further heat loss; remove wet clothing and dry patient |

| 2. | May give only one round of IV drugs if body temperature less than 86° or ordered by medical control. |

| 3. | If rhythm V-fib/pulseless VT: **Defibrillate x 1.** |

| 4. | Advanced airway, if indicated. |

| 5. | Transport patient very gently to avoid precipitating V-fib. |

| FR B A I P | Criteria for Cold Death  
| | Any one of the following:  
| | - Frozen solid preventing chest from being compressed.  
| | - Ice in airway  
| | - Signs of Predation  
| | - Head underwater for more than 60 minutes in an adult or 90 minutes if a child. |
An analysis of the ECGs\textsuperscript{4} from 60 patients with accidental hypothermia reveals several facts concerning rhythmicity. Echocardiograms were useful to determine the precise rhythm in cases without discernible P waves. Atrial fibrillation (AF) was unusual in mild hypothermia (greater than 32.0 degrees C). AF was often observed in moderate (32.0-26.0 degrees C) and moderately deep (less than 26.0 degrees C) hypothermia. However, about half of the cases with moderately deep hypothermia remained in sinus, atrial, or junctional rhythm. AF was usually converted to sinus rhythm without any antiarrhythmic agents soon after normothermia was restored. There was no significant difference in the mortality rate between the AF and non-AF groups. Therefore, no aggressive treatment for atrial arrhythmia seems to be necessary.

**Heat-Related Illness**

People suffer heat-related illness when the body’s temperature control system is overloaded. The body normally cools itself by sweating. But under some conditions, sweating just isn’t enough. In such cases, a person’s body temperature rises rapidly. Very high body temperatures may damage the brain or other vital organs. Several factors affect the body’s ability to cool itself during extremely hot weather. When the humidity is high, sweat will not evaporate as quickly, preventing the body from releasing heat quickly. Other conditions that can limit the ability to regulate temperature include old age, youth (age 0-4), obesity, fever, dehydration, heart disease, mental illness, poor circulation, sunburn, and prescription drug use and alcohol use.

Tolerance to heat depends largely on physiologic factors, unlike cold environments where adaptive behaviors are more important. The major means of heat dissipation are radiation while at rest and evaporation of sweat during exercise, both of which become minimal with air temperatures above 95°F (35°C) and high humidity.

Numerous studies have identified subpopulations at increased risk of heat-related morbidity and mortality: older adults, young children (0–4 years), males, and black persons. Moreover, alcoholics, narcotics users, persons confined to bed or unable to care for themselves, socially isolated persons, those living on the top floor of multistory buildings, those without access to air conditioning, and persons who work or exercise outdoors are also at increased risk. The combined effects of a warming climate, the aging U.S. population, and the increasing number of people living in urban areas (where the urban heat island effect exacerbates the effects of high ambient temperatures) may result in an increasing number of people at risk of heat-related death\textsuperscript{5}.

The major organs involved in temperature regulation are the skin, where sweating and heat exchange take place, and the cardiovascular system, which must increase blood flow to shunt heat from the core to the surface, while meeting the metabolic demands of exercise. Cardiovascular status and conditioning are the major physiologic variables affecting the response to heat stress at all ages. In addition to environmental conditions and intensity of exercise, dehydration is the most important predisposing factor in heat illness. Dehydration also reduces exercise performance, decreases time to exhaustion, and increases internal heat load- with temperature and heart rate increasing in direct


\textsuperscript{5} http://www.cdc.gov/nchs/data/nhsr/nhsr076.pdf
proportion to the level of dehydration. Sweat is a hypotonic fluid containing sodium and chloride. Sweat rates commonly reach 1 L per hour and may exceed this level, which results in substantial fluid and sodium loss\(^6\).

**Heat syncope** - is sudden fainting in heat that occurs in unacclimatized people while standing in the heat or after 15–20 minutes of exercise. Consciousness rapidly returns to normal when the patient is supine. Rest, relief from heat, and oral fluids are sufficient treatment.

**Heat edema** - is mild swelling of the hands and feet, more frequent in women during the first few days of heat exposure. It resolves spontaneously and should not be treated with diuretics, which may delay heat acclimatization and cause dehydration.

**Heat rash** - (miliaria or Prickly heat) is a skin irritation caused by excessive sweating during hot, humid weather. It can occur at any age but is most common in young children. Heat rash looks like a red cluster of pimples or small blisters. It is more likely to occur on the neck and upper chest, in the groin, under the breasts, and in elbow creases. It is best prevented by wearing light, loose clothing and avoiding heavy, continuous sweating. The best treatment for heat rash is to provide a cooler, less humid environment. Keep the affected area dry. Dusting powder may be used to increase comfort.

**Heat cramps** - are muscle pains or spasms – usually in the abdomen, arms, or legs – that may occur in association with strenuous activity. People who sweat a lot during strenuous activity are prone to heat cramps. This sweating depletes the body's salt and moisture. The low salt level in the muscles causes painful cramps. Heat cramps may also be a symptom of heat exhaustion. If you have heart problems or are on a low-sodium diet, seek medical attention for heat cramps. Rest and passive stretching of the muscle, supplemented by fluids and salt, will rapidly relieve symptoms. Water with a salty snack is sufficient; an oral salt solution, as in rehydration solutions, can be made by adding one-fourth to one-half teaspoon of table salt (or two 1-g salt tablets) to 1 L of water. To improve taste, add a few teaspoons of sugar and/or orange juice or lemon juice.

- Stop all activity and sit quietly in a cool place.
- Drink clear juice or a sports beverage.
- Do not return to strenuous activity for a few hours after the cramps subside because further exertion may lead to heat exhaustion or heat stroke.
- Seek medical attention for heat cramps if they do not subside in 1 hour.

**Heat exhaustion** - is a milder form of heat-related illness that can develop after several days of exposure to high temperatures and inadequate or unbalanced replacement of fluids. Those most prone to heat exhaustion are elderly people, those with high blood pressure, and those working or exercising in a hot environment.

Most people who experience acute collapse or other symptoms associated with exercise in the heat are suffering from heat exhaustion, simply defined as the inability to continue exertion in the heat. The presumed cause of heat exhaustion is loss of fluid and electrolytes, but there are no objective markers to define the syndrome, which is a spectrum ranging from minor complaints to a vague boundary shared with heat stroke. Transient mental changes, such

as irritability, confusion, or irrational behavior may be present in heat exhaustion, but major neurologic signs, such as seizures or coma, indicate heat stroke or hyponatremia. Body temperature may be normal or mildly elevated.

Most cases can be treated with supine rest in the shade or other cool place, and oral water or fluids containing glucose and salt; subsequently, spontaneous cooling occurs, and patients recover within hours without progression to more serious illness. An oral solution for treating heat exhaustion can be made by adding one-fourth to one-half teaspoon of table salt (or two 1-g salt tablets) to 1 L of water plus 4–6 teaspoons of sugar. To further improve taste, add one-quarter cup of orange juice or 2 teaspoons of lemon juice. Commercial sports-electrolyte drinks or water with snacks are also effective. Plain water plus salty snacks may be more palatable and equally effective.

Sub acute heat exhaustion may develop over several days and is often misdiagnosed as “summer flu” because of findings of weakness, fatigue, headache, dizziness, anorexia, nausea, vomiting, and diarrhea. Treatment is as described for acute heat exhaustion.

The warning signs of heat exhaustion include the following:

- Heavy sweating
- Paleness
- Muscle cramps
- Tiredness
- Weakness
- Dizziness
- Headache
- Nausea or vomiting
- Fainting

The skin may be cool and moist. The pulse rate will be fast and weak, and breathing will be fast and shallow. If heat exhaustion is untreated, it may progress to heat stroke. Seek medical attention if symptoms worsen or last longer than one hour.

Exercise-associated Hyponatremia (low sodium [salt] levels in the blood) occurs in both endurance athletes and recreational hikers, likely due to loss of sodium through sweating and replacement of fluids with excessive amounts of plain water. The kidney fails to correct the excess water because of inappropriate influence of a hormone (antidiuretic hormone) that results in retention of water and loss of sodium.

In the field setting, altered mental status with normal body temperature and a history of large volumes of water intake suggest hyponatremia. The vague and nonspecific symptoms are the same as those described for hyponatremia in other settings (for example, anorexia, nausea, emesis, headache, muscle weakness, lethargy, confusion, and seizures). Symptoms of heat exhaustion and early hyponatremia are similar. Hyponatremia can be distinguished by persistent alteration of mental status without elevated temperature. Delay in onset of major neurologic symptoms (confusion, seizures, or coma) or deterioration after cessation of exercise and removal from heat point to hyponatremia.

The recommendation to force fluid intake during prolonged exercise and the attitude that “you can’t drink too much” are major contributors to exercise-associated hyponatremia. Prevention includes drinking only enough to relieve
thirst and to maintain dilute urine output. During prolonged exercise or heat exposure, supplemental sodium should be taken. Most sports-electrolyte drinks do not contain sufficient amounts of sodium to prevent hyponatremia; however, salt tablets often cause nausea and vomiting. For hikers, food is the most efficient vehicle for salt replacement. Trail snacks should include salty foods (such as trail mix, crackers, pretzels, and jerky) and not just sweets.

**Heat stroke** - is the most serious heat-related illness. It occurs when the body becomes unable to control its temperature: the body’s temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. Body temperature may rise to 106°F or higher within 10 to 15 minutes. Heat stroke can cause death or permanent disability if emergency treatment is not provided.

Heat stroke is an extreme medical emergency requiring aggressive cooling measures and hospitalization for support. Heat stroke is the only form of heat illness in which the mechanisms for thermal homeostasis have failed, and the body does not spontaneously restore the temperature to normal. As a result of uncontrolled fever and circulatory collapse, organ damage can occur in the brain, liver, kidneys, and heart. Damage is related to duration, as well as peak elevation of body temperature. The onset of heat stroke may be acute (exertional heat stroke), which can affect healthy people who are exercising in the heat, or gradual (nonexertional heat stroke, also referred to as classic or epidemic), which occurs in those with chronic illness from passive heat exposure.

Early symptoms are similar to those of heat exhaustion, with confusion or change in personality, loss of coordination, dizziness, headache, and nausea that progress to more severe symptoms. A presumptive diagnosis of heat stroke is made in the field when people have elevation of body temperature (hyperpyrexia) and marked alteration of mental status, including delirium, convulsions, and coma. Body temperatures in excess of 106°F (41°C) can occur in heat stroke; even without a thermometer, people will feel hot to the touch. If a thermometer is available, a rectal temperature is the safest and most reliable way to check the temperature of someone who may have heat stroke.

Warning signs of heat stroke vary but may include the following:

- An extremely high body temperature (above 103°F)
- Red, hot, and dry skin (no sweating)
- Rapid, strong pulse
- Throbbing headache
- Dizziness
- Nausea
- Confusion
- Unconsciousness

If you see any of these signs, you may be dealing with a life-threatening emergency. Have someone call for immediate medical assistance while you begin cooling the victim. Do the following:

- Get the victim to a shady area.
- Cool the victim rapidly, using whatever methods you can. The most effective low tech means of cooling is room temperature water sprayed in a fine mist onto skin with blown air over the skin (evaporative
cooling). Other alternatives include: immerse the victim in a tub of cool water; place the person in a cool shower; spray the victim with cool water from a garden hose; sponge the person with cool water; or if the humidity is low, wrap the victim in a wet sheet and fan him or her vigorously.

- Monitor body temperature and continue cooling efforts until the body temperature drops to 101-102°F.

**Older adults** - (that is, people aged 65 years and older) are more prone to heat stress than younger people for several reasons:

- Older adults do not adjust as well as young people to sudden changes in temperature.
- They are more likely to have a chronic medical condition that changes normal body responses to heat.
- They are more likely to take prescription medicines that impair the body's ability to regulate its temperature or that inhibit perspiration. Do not give the victim alcohol to drink.

### Aurora Health Care Protocol for Heat Emergencies

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<th>LEVEL</th>
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| **FR B A I P** | Heat Cramps | 1. **Initial Medical Care:**
• Move patient to a cool environment, remove excess clothing |
| **FR B A I P** | Heat Exhaustion | 2. **Initial Medical Care**
• Move patient to a cool environment.
• Cold packs to axilla and groin.
• Place in supine position.
• Remove as much clothing as possible to facilitate cooling.
• IV as needed |
| **A I P** | Heat Stroke: Elevated body temperature with altered mental status | 3. **Initial Medical Care:** special considerations:
• Monitor EKG
• IV as needed; 500 to 1000 mL bolus
• Anticipate development of elevated ICP
• Move patient to a cool environment.
• Place in supine position. Semi-fowler’s position with head elevated 15°-30° if systolic BP greater than 90 mmHg. |
| **FR B A I P** | | 4. Initiate rapid cooling:
• Remove as much clothing as possible to facilitate cooling
• **Cold packs to groin, axillae, carotid arteries, temples, and behind knees**
• Spray water mist that is body temperature on to body with source of rapid air movement over body. If spray is not available, cover patient with wet sheet or blanket. |