Death from exposure and accidental hypothermia occurs throughout the world and can present significant management problems. While typically associated with severe winters, it can be seen in times of milder weather also. Cases of hypothermia occur during the summer months and in hospitalized patients. Even with modern supportive care, the in-hospital mortality of patients with moderate or severe accidental hypothermia approaches 40 percent.

Hypothermia is defined as a core temperature below 35 degrees C (95 degrees F), and can be further classified by severity:

⇒ Mild hypothermia – Core temperature 32 – 35 degrees C (90.6 – 95 degrees F)
⇒ Moderate hypothermia – Core temperature 28 – 32 degrees C (82.4 – 90.6 degrees F)
⇒ Severe hypothermia – Core temperature below 28 degree C (82.4 degrees F)

Pathophysiology

Body temperature reflects the balance between heat production and heat loss. Heat is generated by cellular metabolism (most prominently in the heart and liver) and lost by the skin and lungs via the following processes:

- Evaporation – Vaporization of water through both insensible losses and sweat
- Radiation – Emission of infrared electromagnetic energy
- Conduction – Direct transfer of heat to an adjacent, cooler object
- Convection – Direct transfer of heat to convective air currents

Of these convective heat loss to cold air and conductive heat loss to water are the most common mechanisms of accidental hypothermia.

Hypothermia causes altered cell membrane function, efflux of intracellular fluid, enzymatic dysfunction, and electrolyte imbalances (including prominent hyperkalemia). Cell death results from cell membrane damage, protein dysfunction or crystallization of intro- and extracellular water.

In addition to hypothermia from environmental exposure, many medical conditions can result in hypothermia, including hypothyroidism, adrenal insufficiency, sepsis, neuromuscular disease, malnutrition, thiamine deficiency and hypoglycemia. Ethanol abuse and carbon monoxide intoxication have been implicated in some cases of hypothermia.
Risk Factors

Risk factors associated with death from accidental hypothermia include exposure, extremes of age, cold IV fluids, burns, head/SCI, shock, co-morbidities, drug and alcohol use, impaired thermoregulation, stroke, malnutrition, endocrine failure and vascular compromise. The elderly are at increased risk of developing hypothermia and its complications, and should be urgently assessed if found to be hypothermic. The reasons for this increased risk include decreased physiologic reserve, chronic diseases and medications that impair compensatory responses, and social isolation. Hypothermia may go unrecognized in isolated older patients and they may be unable to obtain assistance when the condition is recognized. In elderly patients sepsis can manifest as hypothermia.

Compensatory Mechanisms

In response to a cold stress, the hypothalamus attempts to stimulate heat production through shivering and increased thyroid, catecholamine and adrenal activity. Sympathetically medicated vasoconstriction minimizes heat loss by reducing blood flow to peripheral tissues, where cooling is greatest.

Clinical Presentation

As compensatory mechanisms preventing hypothermia are overwhelmed, the following changes typically occur:
⇒ Patients in mild hypothermia demonstrate tachypnea, tachycardia, initial hyperventilation, ataxia (lack of co-ordination), dysarthria (poor articulation), impaired judgment, shivering and so-called “cold-diuresis (large volume of dilute urine resulting from renal cell dysfunction and decreased levels of ADH).
⇒ Moderate hypothermia is characterized by proportionate reductions in pulse rate and cardiac output, hypoventilation, central nervous system depression, hyporeflexia, decreased renal blood flow, and loss of shivering. Paradoxical undressing may be observed. Atrial fibrillation, junctional bradycardia and other arrhythmias can occur.
⇒ Severe hypothermia can lead to pulmonary edema, oliguria, areflexia (absence of neurologic reflexes), coma, hypotension, bradycardia, ventricular arrhythmias (including V-fib) and asystole.

Beware of vital signs inconsistent with the degree of hypothermia. A relative tachycardia inconsistent with temperature suggests hypoglycemia, hypovolemia or an overdose. Relative hyperventilation implies an underlying organic acidosis (eg. diabetic ketoacidosis), since CO2 production should be decreased in moderate or severe hypothermia. Neurologic manifestations vary widely. If the level of consciousness is not proportional to the degree of hypothermia, suspect a head injury, central nervous system infection, or overdose. Do not assume that areflexia or paralysis are due to hypothermia until spinal injury has been ruled out.
Independent of the arrhythmia changes noted above, hypothermia causes characteristic ECG changes because of slowed impulse conduction through potassium channels. This results in prolongation of all the ECG intervals, including RR, PR, QRS and QT. There may also be elevation of the J point (only if the ST segment is unaltered), producing a characteristic J or Osborn wave that represents distortion of the earliest phase of repolarization. The height of the Osborn wave is roughly proportional to the degree of hypothermia. These findings are most prominent in the precordial leads V2 to V5. Note that available software for ECG interpretation is unable to recognize Osborn waves, and often misinterprets them as ischemic changes.

**Electrocardiogram in hypothermia**

The ECG reveals marked sinus bradycardia (about 40 beats/min) with first degree atrioventricular block (PR interval = 0.23 sec). The slow heart rate in this patient is due to hypothermia (90°F, 32.2°C), which also produces prominent convex deflections at the J point (junction of QRS and ST segments) that are best seen in the precordial leads. The J waves or Osborn waves (arrows) are characteristic of severe hypothermia and resolve with rewarming; how they occur is not known.

**Management**

The management of hypothermia requires:
- Initial evaluation and support of the airway, breathing, and circulation
- Prevention of further heat loss
- Initiation of rewarming appropriate to the degree of hypothermia
- Treatment of complications

Consider the need for airway support: If King Tube is indicated; use gentle technique to prevent vagal stimulus and Ventricular Fibrilation. Endotracheal Intubation should only be attempted if trouble placing the King tube.
Active external rewarming
During active external rewarming, some combination of warm blankets, heating pads, radian heat or forced warm air is applied directly to the patient’s skin. These methods are indicated for moderate or severe hypothermia and for patients with mild hypothermia who are unstable, lack physiologic reserve or fail to respond to passive external rewarming. Active external rewarming should take place by applying hot packs to axillae, groin, neck and thorax as well as warming mattress if available.

Individuals should be extracted from the hypothermic environment in the horizontal position when possible. Even low intensity use of peripheral muscles should be avoided, as muscular perfusion and consequently core temperature afterdrop is accelerated by exertion. Rewarming of the trunk should be undertaken BEFORE the extremities. These actions are performed in order to minimize hypotension and acidemia (low blood pH) due to arterial vasodilation and core temperature afterdrop.

Core temperature afterdrop is a risk of active external rewarming. This complication occurs when the extremities and trunk are warmed simultaneously. Cold, acidemic blood that has pooled in the vasoconstricted extremities of the hypothermic patient returns to the core circulation, causing a drop in temperature and pH. At the same time, removal from the cold environment results in peripheral vasodilation, potentially contributing to precipitous hypotension, inadequate coronary perfusion, and ventricular fibrillation. These phenomena may explain the fatal dysrhythmias that sometimes occur during rewarming.

Below is a nice chart that was distributed to all of the EMS Agencies from the CDC that outlines the importance of dressing for cold weather, a review of your high risks, how to spot and treat frostbite and hypothermia as well as our system SOP for Cold Emergencies.
Environmental: COLD Emergencies

FROSTBITE
1. ITT: Move to a warm environment as soon as possible. Remove wet/constrictive clothing/jewelry.
2. Rapidly rewarm frozen areas. Do NOT thaw if chance of refreezing.
   - Immersed in warm water (90°-105°F) if available
   - May use hands/heat packs wrapped in a towel. Use warming mattress if available.
   - HANDLE SKIN GENTLY like a burn. Do NOT rub. Do not break blisters.
   - Protect with light, dry, sterile dressings; cover with warm blankets and prevent re-exposure
3. Anticipate severe pain when rewarming: NITROUS OXIDE if available, FENTANYL: Standard dosing per IMC.

HYPOTHERMIA: Risk factors: Exposure, extremes of age, cold IVF, burns, head/SCI injuries, shock, co-morbidities, drugs & alcohol use, impaired thermoregulation, stroke, malnutrition, endocrine failure, vascular compromise

1. ITT special considerations:
   - Prevent further heat loss & begin rewarming immediately: place in warm environment, remove wet clothing; dry patient; insulate from further environmental exposures.
   - Position supine; handle gently when checking responsiveness, breathing and pulse
   - Assess breathing and pulse for 30-45 sec. Pulse & RR may be slow and difficult to detect
   - IV NS. Warm IV up to 43°C (109°F); coil tubing if possible; do not infuse cold fluids
   - Monitor ECG & GCS continuously; may observe Osborn or J wave in leads II and V6
   - Obtain core temperature if possible; assess for local thermal injury (frostnip, frostbite)
   - Minimize movement to ↓ myocardial demand; prevent translocation of cold blood from periphery to the core and ↓ severe muscle cramping

MILD/MODERATE Hypothermia (Lower acuity to EMERGENT)
Mild: Core temp 90.6-95°F (32-35°C): Confusion, tachycardia, shivering
Moderate: Core temp 82.4-90.6°F (28-32°C): Lethargy, bradycardia, arrhythmias, shivering ceases <31°C (87.8°F); heat production falls, slowed speech/ataxia (mimics stroke) replaced by muscle rigidity, slowed reflexes, slow RR, CO2 retention, pupils dilated & minimally responsive

2. Passive rewarming generally adequate for pts w/ T > 93.2°F: Cover with blankets; protect head from heat loss.
   - Active external rewarming (T 82°- 93.2°F): Continue passive + apply surface warming devices (wrapped hot packs to axillae, groin, neck, & thorax; warming mattress if available). Passive rewarming alone inadequate for these pts.
3. Warm NS IVF challenges in 200 mL increments to maintain hemodynamic stability

SEVERE Hypothermia (CRITICAL): Core temp <28°C (82.4°F), coma, muscle rigidity, cardiac dysrhythmias: bradycardia, VF (cardiac arrest/absent pulse); hypotension, slowed RR to apnea, pupils fixed & dilated, no shivering

2. ITT special considerations:
   - Core rewarming (not generally available in field). Rewarm trunk only with hot packs; avoid rewarming extremities.
   - Consider need for Airway support: If KING Tube indicated; use gentle technique to prevent vagal stimulus and VF
   - O2 12-15 L/NRM or BVM (warm to 42°C / 107.6°F if possible); do NOT hyperventilate - chest will be stiff
   - Vascular access: Warm NS 200 mL IV/P/IO fluid challenges up to 1 L
   - Will require large volume replacement due to leaky capillaries, fluid shift, and vasodilation as rewarming occurs
3. If unresponsive with no breathing or no normal breathing (only gasping) check for a pulse.
   - Pulse is not definitely felt in 30 seconds: Start CPR - TRIPLE ZERO CANNOT BE CONFIRMED on these patients
   - Rhythm shockable: Defibrillate per VF SOP
   - Treat patient per VF or Asystole/PEA SOP concurrent with rewarming
4. ROSC: Support CV status per VF / Asystole SOPs; look for & treat causes of severe hypothermia
   - If induced hypothermia indicated: Continue to warm to goal temp of 34°C / 93.2°F
   - If hypothermia contraindicated (trauma patient); continue rewarming to normal temp
5. Transport very gently to avoid precipitating VF
In cold temperatures, your body begins to lose heat faster than it can be produced, which can lead to serious health problems.

**Avoid**

When going outside be sure to wear:
- A SCarf OR Knit mask that covers face & mouth
- MittenS or Gloves
- Water-Resistant boots
- A hat
- A water-Resistant coat
- Several layers of loose-fitting clothing

When going outside in winter make sure body parts most often affected by frostbite are covered in warm, dry clothing.

**Frostbite**

Signs & Symptoms — Redness or pain in any skin area may be the first sign of frostbite. Other signs include:
- a white or greyish-yellow skin area
- skin that feels unusually firm or waxy
- numbness

**Hypothermia**

Hypothermia often occurs at very cold temperatures, but can occur at cool temperatures (above 40°F), if a person is wet (from rain, sweat or cold water) and becomes chilled.

Signs & Symptoms

Adults:
- shivering
- exhaustion
- confusion
- fumbling hands
- memory loss
- slurred speech
- drowsiness

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

If a person's temperature is below 95°F get medical attention immediately.

**Treat**

If a person is experiencing hypothermia or frostbite…

1. Seek medical attention as soon as possible
2. Get them into a warm room or shelter
3. Remove any wet clothing
4. Warm them under dry layers of blankets and clothing
5. Place areas affected by frostbite in warm-to-touch water

**Frostbite Caution**

Since skin may be numb, victims of frostbite can harm themselves further. Use caution when treating frostbite and:

- Unless necessary, do not walk on feet or toes with frostbite
- Do not use a fire/pace, heat lamp, induction, or stove for warming
- Do not use a heating pad or electric blanket for warming
- Do not rub or massage areas with frostbite

**SPOT**

Know who is at high risk:
- Older adults without proper food, clothing, or heating
- People who stay outdoors for long periods (homeless, hikers, hunters, etc.)
- People who drink alcohol in excess or use illicit drugs
- Babies sleeping in cold rooms

❄❉❄❉

**ERROR**

A victim is often unaware of frostbite because frozen tissue is numb.
1. Severe hypothermia is defined as a core temperature of:
   A. 90.6 – 95 degrees F
   B. 82.4 – 90.6 degrees F
   C. 82.4 degrees F or less

2. The most common mechanisms of accidental heat loss are
   A. Evaporation and Conduction
   B. Convective and Conductive
   C. Radiation and Evaporation
   D. Convection and Evaporation

3. List three medical conditions that can result in accidental hypothermia.
   A. ______________________
   B. ______________________
   C. ______________________

4. Explain why an elderly person is at risk for developing hypothermia.

5. Signs and symptoms of a patient presenting with moderate hypothermia include:
   A. Hypoventilation, Central nervous system depression, atrial fib or junctional bradycardia.
   B. Cold-diuresis, shivering, ataxia
   C. Hypotension, ventricular arrhythmias, coma, oliguria
   D. Poor articulation, lack of co-ordination, shivering

6. Characteristic ECG changes caused by hypothermia include:
   A. Shortened PR interval, Osborn wave,
   B. Prolonged QT segment, Osborn wave
   C. Prolonged RP interval, shortened QT segment
   D. Osborn wave, narrow QRS
7. When rewarming a patient in moderate or severe hypothermia it is important to rewarm the extremities prior to rewarming the trunk.
   A. True
   B. False

8. Explain core temperature afterdrop.

9. Explain why it is important to minimize movement when caring for a hypothermic patient.

10. When treating a hypothermic patient with a temperature of less than 82.4 degrees, they should be treated like any other full arrest and full ACLS medication and electrical treatment should be carried out.
    A. True
    B. False

If you are NOT a member of the McHenry Western Lake County EMS System, Please include your address on each optional quiz turned into our office. Our mailing address is: Northwestern Medicine – McHenry Hospital EMS, 4201 Medical Center Drive, McHenry, Illinois 60050. We will forward to your home address verification of your continuing education hours.
If you ARE a member of our EMS System, your credit will be added to your Image Trend record. Please refer to Image Trend to see your current list of continuing education credits. Any questions regarding this can be addressed to Cindy Tabert at 224-654-0160. Please fax your quiz to Cindy Tabert at 224-654-0165.