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 32-35 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 ethanol use, homelessness, psychiatric disease and older age. 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 mediated 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 is 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

King Airways or BVM ventilation should be performed in patients with respiratory distress or who cannot protect their airway. Suctioning can facilitate clearance of secretions produced by cold-induced bronchorrhea (Excessive mucal secretion from bronchial mucous membranes) in patients with altered mental status and/or a decreased cough reflex.

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. Theses 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. 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 after drop 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 after drop.

Core temperature after drop 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 [8]. These phenomena may explain the fatal dysrhythmias that sometimes occur during rewarming.

MWLCEMS System Protocols for Cold Emergencies.

Additional considerations in management of the hypothermic patient include:

⇒ Protect against heat loss and wind chill; 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 seconds. Pulse and RR may be slow and difficult to detect.
⇒ IV NS. Warm IV fluids to 43 degrees C (109 degrees F); coil tubing if possible. Do not infuse cold fluids.
⇒ Monitor ECG and GCS continuously; may observe Osborn or J wave in lead II and V6
⇒ Obtain core temperature if possible; assess for local thermal injury (frostnip, frostbite)
⇒ Assess for local thermal injury
⇒ Minimize movement to decrease myocardial demand; prevent translocation of cold blood from periphery to the core and severe muscle cramping

Mild Hypothermia: Core temp 90.6-95 F: Confusion, tachycardia, shivering
Moderate Hypothermia: Core temp 82.4-90.6 F: Lethargy, bradycardia, arrhythmias, shivering ceases < 87.8 F heat production falls, slowed speech/ataxia (mimics stroke) replaced by muscle rigidity, slowed reflexes, slow RR, CO2 retention, pupils dilated and minimally responsive. Conscious or altered sensorium with shivering (86 degrees F or above)

⇒ Passive rewarming generally adequate for pts w/T > 93.2 F: cover with blankets; protect head from heat loss.
⇒ Active external rewarming (T 82-93.2F) continue passive + apply surface warming devices (wrapped hot packs to axillae, groin, neck and thorax; warming mattress if available). Passive rewarming alone inadequate for these pts.
⇒ Warm IV NS fluid challenges in 200 ml increments to maintain hemodynamic stability.
Severe Hypothermia: Core temp <82.4 F; coma, muscle rigidity, cardiac dysrhythmias: bradycardia, VF (cardiac arrest/absent pulse); hypotension, slowed RR to apnea, pupils fixed & dilated, no shivering.

⇒ Core rewarming (not generally available in the 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.
⇒ Oxygen 12 – 15 L/NRM or BVM; do NOT hyperventilate – chest will be stiff
⇒ Vascular access: (Warm) NS 200 ml IVP/IO fluid challenges up to 1 L.. Patients with moderate or severe hypothermia frequently become disproportionately hypotensive from severe dehydration and fluid shifts.
⇒ If unresponsive with no breathing or no normal breathing (only gasping); check for a pulse. If 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.
⇒ ROSC: Support CV status per VF/Asystole SOP’s; look for & treat causes of severe hypothermia.
⇒ If induced hypothermia indicated: Continue to warm to goal temp of 93.2 F
⇒ If hypothermia contraindicated (trauma patient); continue rewarming to normal temp
⇒ Transport very gently to avoid precipitating VF.
1. Severe hypothermia is defined as a core temperature of:
   A. 90 – 95 degrees F
   B. 86 – 90 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 and 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 ADDRESS IS: CENTEGRA MCHENRY EMS, 4201 MEDICAL CENTER DRIVE, MCHENRY, IL 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 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.