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CME 700 Cold Emergencies

Course Supplement

COLD EMERGENCIES

Cold emergencies are a serious risk in Canada. Cold injuries such as frostnip and frostbite are a common event, and hypothermia kills a few Canadians every winter, even in urban areas. EMS providers need to understand how cold emergencies occur so that patients can receive appropriate care.

HOW THE BODY RESPONDS TO COLD TEMPERATURES

When exposure to cold occurs, nerves in the skin detect the external low temperature, while the hypothalamus detects any drop in the blood temperature. The CNS increases epinephrine output, causing a two-pronged response: (a) more heat production and (b) reduced heat loss. The pulse and breathing rates increase, the liver breaks down glycogen in order to release extra glucose, and the pancreas releases more insulin. Skeletal muscles use the extra fuel and oxygen to produce heat through rapid involuntary contractions – shivering. Muscles also burn fat for thermogenesis (heat generation).

Vital organs, particularly the brain and heart, are the most sensitive to cold, so compensatory responses keep them warm at the expense of other tissues. Normally, the skin and extremities act as radiators to disperse excess body heat. Upon exposure to cold, blood vessels in the skin and extremities constrict reducing blood flow to those areas to decrease heat loss. If cooling continues, further vasoconstriction drastically reduces blood flow to the extremities, which are allowed to cool in order to keep the core organs warm.

If the person can neither escape the cold nor generate enough heat, these responses become part of the problem. The extremities get colder due to reduced blood flow, and direct cold injury can occur, i.e., frostnip and frostbite. Deprived of fuel and oxygen, skeletal muscles gradually stop producing heat. Peripheral blood vessels get hypoxic and lose the ability to constrict, so vasodilation occurs. Blood pressure drops and cold, acidotic blood returns to the core. The core organs cool, leading to vital organ failure and death.

COLD INJURIES – RECOGNITION AND TREATMENT

Two general rules apply for treating cold injuries and hypothermia: (1) stop the cooling and (2) **gentleness is more important than speed.** Move the patient gently, and drive as smoothly as possible.

As paramedics, we are used to working quickly, but with cold injuries working too fast can cause additional harm. Cold makes tissues inflexible and fragile, and frostbitten tissue can be badly damaged by rough handling. More importantly, the heart becomes irritable when core temperature drops. A bumpy ride that would not affect a warm patient can put a hypothermia victim into cardiac arrest. Cold also slows down the

progression of damage, so that speed is not as necessary or as helpful as on other types of calls.

LOCALIZED COLD INJURIES – FROSTNIP AND FROSTBITE

Frostnip and frostbite occur in below-freezing conditions. Frostnip is a reversible injury caused by skin becoming close to freezing. The affected areas are firm, white and cold. When tissues become very cold, the cell membranes become less flexible and more easily ruptured, so affected skin is easily injured.

Frostbite is the actual freezing of tissue. Ice crystals form in cells, rupturing or damaging them. Reflex vasoconstriction causes very low blood flow, and freezing causes blood to clot in capillaries. This causes tissue hypoxia and ischemia, leading to further injury or death of tissue. The affected area is cold, white and waxy-looking, with no sensation. Surrounding tissue may still have sensation and may be very tender. Deep frostbite causes permanent damage, and distal tissues such as fingers and toes may be lost.

Treatment of Frostnip and Frostbite

Frostnip will resolve itself with gentle rewarming. Careful, gentle handling is important because the cold tissue is fragile and vulnerable to damage. Rewarming may be painful.

The management of frostbite will depend on the situation. If the patient will have to walk out or you cannot ensure that the patient can be kept warm (for example, if the patient has to be rescued from a location far from the ambulance), it is better to leave the affected part frozen. Subsequent re-injury to frostbitten tissue increases the damage, and the thawed tissue is even more fragile than if it was left frozen.

If the patient can be kept warm, the affected part can be gently rewarmed. Hot packs should not be applied to frostbitten tissue, as it is easily burned and is insensitive. Friction and minor bumps can do further damage, so frostbitten areas must be handled carefully and should be padded as much as possible. Any parts that may rub together, such as fingers or toes, should have soft dressings placed between them. Do not let the person rub the area – frostbitten skin can separate and come off if rubbed.

Every frostbite victim is at risk for hypothermia. This may cause arrhythmias, so the cardiac monitor should be used for these patients. Rewarming can be very painful, and pain control may be needed.

HYPOTHERMIA

Hypothermia is defined as a core body temperature below 37^{o} C (98.6^{o} F). Normal body temperature varies from 37^{o} C to 37.5^{o} C. The body tightly regulates its internal temperature within this very narrow range because cell and organ function depends on temperature-dependent chemical processes. If the cells get even a few degrees too cool, metabolism slows and energy output falls. Energy-dependent ion pumps, necessary for nerve, muscle and organ function, slow down and eventually fail. Toxic products build up and attack cellular machinery. If the core temperature gets below 32^{o} C, the CNS function stops, vital organs fail, the heart slows down and becomes irritable, and eventually death results.

Mild to Moderate Hypothermia – Core Temperature 36^{o} C to 34^{o} C

The mildly hypothermic patient is usually awake and shivering, but may be lethargic and confused. In healthy patients, this usually resolves itself once the person is moved to a warm place. Getting the patient to a warm area and passive rewarming may be all that is needed.

The cardiac monitor should be attached to all potential hypothermia patients due to the possibility of arrhythmias. Recall that peripheral blood vessels constrict in response to cold and dilate, as they get warm. As the patient gets warmer, blood pressure may drop suddenly due to peripheral vasodilation.

Patients who are elderly, intoxicated, have other health problems, or who are taking certain medications may present differently (see below). Be wary of patients who appear drunk as moderate hypothermia resembles drunkenness including slurred speech, decreased coordination and impaired judgement. In addition, alcohol and hypothermia tend to go together. Intoxicated patients can be hypothermic in mild weather due to reduced movement and diminished protective responses. Remember that patients who cannot shiver or generate heat will progress rapidly to more severe hypothermia and should be treated more aggressively.

Treatment of Mild to Moderate Hypothermia

Recognition of the problem is key in the treatment of mild to moderate hypothermia. Consider why the patient is hypothermic. Removing wet clothing, protecting the patient from cold, and gradually rewarming using warmed blankets is usually sufficient. Recheck vitals and level of awareness (LOA) frequently, and attach the cardiac monitor. Warm oral fluids can be given if the patient is alert (no fluids with alcohol or caffeine).

A sudden drop in blood pressure may occur, as the extremities get warm, due to vasodilation. Keep the patient supine if possible. ACP responders should ensure that if an IV is required the fluid should be warmed before use (see **cold IV fluids + cold patient = instant hypothermia**).

Moderate to Severe Hypothermia - Core Temperature 34^{o} C to 30^{o} C

Moderately hypothermic patients will be mentally impaired and may be mistaken as "drunk". They may have sensory problems such as hallucinations and may not want help. The heart will be very irritable and prone to fibrillation, so do not permit the person to move around much. When shivering stops, the patient is deteriorating. Be prepared for resuscitation, and notify the receiving hospital if possible.

ECG Note: Sinus bradycardia or atrial fibrillation is common in hypothermic patients. The cardiac monitor may show a change in the QRS called the Osborne or "J" wave.

Treatment of Moderate to Severe Hypothermia (Patient is Still Conscious)

Move the patient gently, and drive smoothly with as few bumps as possible. The cardiac monitor must be attached, and resuscitation equipment should be ready.

Active rewarming (very warm blankets) should be applied to the torso and head only. Extremities should be passively rewarmed (allowed to warm up on their own). As the core warms, the extremities will warm gradually if they are protected from the cold.

Apply warm IV bags or hot packs wrapped in towels to the neck, armpits and groin. Apply warmed O_2 if available.

ACP Care: Have warmed 1000 ml IV bags ready in case of a major drop in blood pressure (BP) with rewarming. Avoid giving cool boluses (see **cold IV fluids + cold patient = instant hypothermia**).

Handle these patients **very** gently. Gentleness is more important than speed. Rough handling of hypothermic patients can cause ventricular fibrillation (see "Caught Cold" in JEMS, April 2001).

Severe Hypothermia – Below 32^{o} C

Severely hypothermic patients are either extremely lethargic or completely unresponsive. The severely hypothermic patient usually "looks dead", and may even appear to be "Code 5", with white, waxy skin and rigid extremities. The pulse and breathing may be faint and very hard to detect.

Treatment of Severe Hypothermia

Do not actively rewarm the extremities. No heated blankets or warm IV bags should be put on the arms or legs as vasodilation may cause cold, acidotic blood to flow back to the core causing ventricular fibrillation and cardiac arrest. It also worsens the hypothermia by making the core cold and can cause severe hypotension. Use

unheated blankets to prevent further heat loss and permit the periphery to warm up gradually on its own.

Apply warm IV bags or hot packs wrapped in towels to the neck, armpits and groin. Apply warmed O_2 if available. The cardiac monitor must be attached. Be prepared for resuscitation.

ACP Care: Have warmed 1000 ml IV bags ready in case of a major drop in BP with rewarming. Avoid giving cool boluses (see **cold IV fluids + cold patient = instant hypothermia**).

Handle severely hypothermic patients **very** gently. Treating them as if they have a spinal injury is appropriate. Gentleness is more important than speed. Rough handling of hypothermic patients can cause ventricular fibrillation.

Unconscious Patients Suspected of Hypothermia

Slow down: gentleness counts for more than speed. Rough handling can cause cardiac arrest.

Airway
If the patient is unresponsive but has a pulse and is breathing, use manual methods to protect the airway (i.e., head-tilt-chin-lift or jaw-thrust if you cannot rule out trauma). Oropharyngeal airways and intubation stimulate nerves in the posterior pharynx that affect the heart, potentially causing severe bradycardia or ventricular fibrillation and cardiac arrest (if the patient is VSA, treat the airway in the normal manner).

Breathing
Take up to 45 seconds to assess for breathing. Severely hypothermic patients may be breathing very slowly. Ventilate normally but do not hyperventilate. Very cold patients will have decreased metabolism, so carbon dioxide buildup is less of an issue. Hyperventilating a hypothermic patient is likely to blow off too much carbon dioxide, causing blood alkalosis. When the blood is cold and alkalotic, O_2 tends to remain bound to hemoglobin rather that being released to the tissues, so the tissues get hypoxic even with 100% O_2 saturation.

Circulation
Take 30-45 seconds to assess for a pulse. If any pulse is present, even a very slow one, leave it alone. A very cold patient can remain viable for a long time even with a faint and very slow pulse.

Cardiac Arrest with Hypothermia

Recall the old rule for treating cardiac arrest patients who might be hypothermic: “You’re not dead until you’re warm and dead”. When *clinical death* (cardiac arrest) occurs at normal temperature *biological death*, irreversible breakdown of vital tissues occurs

within minutes. Severe hypothermia may delay biological death so that resuscitation is possible even after long periods in cardiac arrest. Therefore, severely hypothermic patients should not be declared dead in the field unless there are other indicators such as gross body destruction, transection, decomposition, or known downtime of several hours or more. Treat as a viable VSA and transport to hospital for rewarming.

If hypothermia is suspected but not obvious, treat a cardiac arrest as non-hypothermic, except that ACP providers should patch for consideration of longer intervals between drug doses.

If patient is VSA and is obviously severely hypothermic ***defibrillate a maximum of three times, then transport to hospital for rewarming.*** Hypothermic hearts respond poorly to defibrillation, and further defibrillation generally only damages the myocardium. Cardiac drugs are usually not effective for the very cold patient, since they depend on metabolic processes that are not happening.
New ECC guidelines are recommending only one defibrillation before transport.

Progression of Clinical Signs and Symptoms of Hypothermia

Severity	Core Temperature	Signs and Symptoms	Treatment Considerations
Mild	36° C (98° F)	Increased metabolic rate Maximum shivering and thermogenesis	Removal from cold Remove wet clothing Warm blankets, warm oral fluids If an IV is necessary, use warmed fluids
Moderate	34° C (93.2° F)	Patient appears drunk Impaired judgement Slurred speech Poor coordination	Recognition of true problem Warmed O_2 Warm IV fluids Restrict patient movement Handle patient gently
Severe	30° C (86° F)	Shivering stops, temperature drops rapidly Usually unconscious Sometimes conscious but very lethargic and confused May appear to be "just drunk" if conscious Respiratory depression Pulse often slow and weak, hypotension Atrial fibrillation or bradycardia Appearance of Osborne ("J") waves on ECG Myocardial irritability - any jarring or sudden movement can cause VF => cardiac arrest	**Handle very gently to avoid causing VF** Do not actively warm extremities Actively rewarm torso only Do not allow patient to move Ventilate normally Warm IV fluids If pt. is unconscious but has a pulse: avoid stimulating back of throat –use manual airway control if possible, avoid oral airways and delay intubation if possible If patient is VSA: consider longer gaps between drug doses. Patch.
Severe	Below 30° C (86° F)	Patient comatose, often looks dead Skin cold to touch, pale or greyish May be stiff, mimicking rigor mortis Either apneic or very slow shallow breathing Pulse very slow and weak if present at all ECG: profound bradycardia, often with atrial fib. Ventricular fibrillation occurs spontaneously Pupils fixed and dilated, loss of reflexes Basal metabolic rate 50% below normal	**Handle very gently – jarring causes VF and cardiac arrest** Do not actively warm extremities Use manual airway control unless patient is VSA or airway not maintainable Ventilate 8-12 resp/min, **do not hyperventilate** If any pulse is present, **do not attempt to treat bradycardia. If no pulse, defibrillate, then transport with CPR only** Further defib attempts usually are not effective and damage the myocardium, pacing and cardiac drugs are generally ineffective

Who is the Typical Hypothermia Patient?

When we think of hypothermia, we tend to think of people doing outdoor winter sports, where the risk is obvious. However, many hypothermia victims that York EMS providers will see will be less obvious, and we need to keep ourselves suspicious of the risk of hypothermia. These "hidden" hypothermia patients often present as "confusion" calls, "drunks", and/or trauma victims. There are documented cases of field providers failing to realize that a patient was hypothermic, because no one actually assessed for it (that is, no one checked the skin to see if it was cold).

"Drunks"

Hypothermia patients often present to EMS as "drunk" calls for two reasons. First, patients with moderate hypothermia look and act drunk due to slurred speech, impaired judgement, inappropriate behaviour and poor coordination. Unless you're working in your shirtsleeves with the air conditioning on in the vehicle, hypothermia should be kept in mind as a possible consideration with every "drunk" or "confused" call.

Alcohol is the number one factor in hypothermia other than the temperature. As we all know, alcohol interferes with judgement. Intoxicated people die fairly often from sleeping on the ground on a cold or rainy night. Alcohol also makes you feel warm, so people who have been drinking often do not realize that they are getting cold until they are already in trouble. Finally, alcohol impairs vasoconstriction, so that heat loss is increased and shivering tends to be reduced.

Diabetic Patients

Diabetics are more prone to both hypothermia and frost injuries than other individuals. Many diabetic patients have nerve damage. This makes them less sensitive to discomfort; therefore, they just don't feel that they're getting cold. They also tend to have poor peripheral circulation. Diabetes interferes with protective responses to early hypothermia. Diabetics have little or no ability to produce more insulin in response to cold stress. Conversely, diabetic patients who become cold may use up their available glucose stores quickly and then be unable to maintain increased heat production. As a result, they may become even more hypoglycemic.

Elderly Patients

Elderly people are less able to tolerate cold than younger people. As people age, their metabolisms slow down and they tend to lose muscle, so that they are less able to produce heat. Many older people have less subcutaneous fat - less insulation, so they lose the heat they have more readily. They are also less able to redirect blood flow in

order to conserve heat. As a result, elderly patients can become hypothermic in environments where younger people might be quite comfortable.

Children and Infants

Neonates and infants are very vulnerable to cold. They lose heat easily due to their relatively large surface area, low muscle mass and large heads. Infants also do not shiver until they are several months old. Infants can become hypothermic simply from being dressed only in a diaper in room at 20^{o} C (normal room temperature). Add at least a layer more of blankets than an adult needs and cover the head.

Trauma

Hypothermia is a big problem for trauma patients. It is part of the "triangle of death" in trauma patients, along with hypovolemia and coagulopathy (alteration of normal blood clotting). In York Region, most trauma victims are from MVCs. In our climate, a person trapped in a car or lying on the pavement is at risk of hypothermia during most of the year. Even in the warmer months, rain or water from irrigation of wounds can cause hypothermia in a trapped or immobilized person.

Cool Weather Trauma Tips

1. **If you don't feel warm in your t-shirt, it's too cold for your patient**. Trauma patients can get hypothermic even on mild days. Since they're usually not moving, they do not generate very much heat. Cold pavement also steals heat quickly from a patient. Patients with spinal injuries may lose the ability to redirect blood flow to the core, so that they lose heat rapidly and may not be able to shiver.

   Your patient should be covered (wrapped, ideally) with warmed blankets and a windproof outer layer (i.e., a yellow or silver blanket). The head must be covered, as it accounts for 30% of total heat loss. Think of what you would need to be warm if you lay down on the ground, then add a layer. If your patient is obviously suffering from severe hypothermia, use warm blankets only on the torso and head. Protect the extremities from further heat loss but do not actively warm them (see above regarding severe hypothermia).

   Prewarm blankets on every cool day (i.e., by placing them up against the vehicle heater). Preheating the patient compartment also helps to prevent further heat loss and helps with rewarming.

2. **Take the time to be gentle.** While speed is important in trauma, potential hypothermia makes gentle handling equally important. Remember that the myocardium becomes very irritable, and can go into ventricular fibrillation easily. Hypothermia often buys you time as it slows the process of getting worse. Use this time to carefully move the patient without any jarring.

3. **Cold IV bolus + cold patient = instant hypothermia.** IV bags in the ambulance are usually at or below "room temperature", which is 20^{o} C or 17^{o} C **below** normal body temperature. If the bag has been hanging in cold winter air, it can get close to freezing. Two litres of cold fluid rapidly infused cools the core, worsening the existing hypothermia. It also creates profound stress on an already irritable heart.

   On cool or cold days, warm some 1000 ml IV bags on the vehicle heaters until they are warm to the touch (about 40^{o} C) to prepare for the possibility of a trauma call. Wrap the bags in blankets and place them against the rear heater vent in the ambulance. While on scene, protect both the bag and the line from the cold air.

SUMMARY

Cold emergencies require paramedics to modify their approach to patient care. Rather than working and transporting as quickly as possible, paramedics have to take care and transport as gently as possible. Paramedics cannot usually make these patients better by working faster, but can make them worse by handling them too quickly or too roughly. Paramedics must also be careful to remind themselves of how important it is to simply keep patients from getting colder. They must also remind themselves how insidious cold emergencies can be; by the time the problem is obvious, the patient may be critically ill. The symptoms of hypothermia can deceive paramedics into thinking the patient is "drunk", or the problem of cold may simply not be noticed, so that patient does not receive the proper care. Paramedics must maintain a high index of suspicion so that these patients can be quickly identified and be appropriately treated.

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