Firefighter Pre-Hospital Care Program
Module 15

Environmental Emergencies

( Heat & Cold Injuries, Drowning )
Firefighter Pre-Hospital Care Program

Module 15 – Environmental Emergencies

At the end of the lesson and upon completion of the post course quiz, the participant will demonstrate a level of knowledge of:

• how to accurately assess a patient experiencing hypothermia, hyperthermia, frost bite and drowning / near drowning

• how to determine priorities related to environmental injuries / illnesses

• how to provide emergency patient care in a safe manner consistent with local standards and base hospital direction

• how to evaluate the effectiveness of treatment measures

• how to perform ongoing assessments and interventions in response to the patient’s presentation, changing treatment requirements and environmental variables
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We wish to express our sincere THANKS & APPRECIATION to Toronto Fire Pics (www.tfspics.com) for allowing us to utilize their photo’s for this module.
The Skin and its Functions

- The skin has two principle layers: the epidermis and the dermis.
- The skin is the largest single organ in the body and serves to protect the body from the environment, regulate body temperature and transmit information from the environment to the brain.
- The body is composed of over 70% water that contains a delicate balance of chemical substances in solution.
- The skin is watertight and serves to keep the balanced solution intact.
Epidermis

- The epidermis is composed of several layers of cells.
- At the base of the epidermis is a layer that continuously produces new cells that rise to the surface.
- As the cells rise, they die and form the watertight covering.
- The epidermis varies in thickness and is thicker on the soles of the feet, the palms, back, and scalp.
- In other areas the epidermis is only two or three cell layers thick.
Dermis

- The deeper part of the skin is called the dermis
- A layer of germinal cells (a layer that grows new cells) separates the dermis from the epidermis
- Sweat glands, sebaceous (oil) glands, blood vessels and specialized nerve endings can all be found within the dermis
Subcutaneous Tissue & Muscle

- Immediately beneath and attached to the dermis is the subcutaneous tissue.
- Subcutaneous tissue is composed largely of fat which serves as an insulator for the body and reservoir to store energy.
- Amount of subcutaneous tissue varies greatly from person to person.
- Beneath the subcutaneous tissue lies the muscle and the skeleton.
As A Point of Interest...

- the human body maintains a constant core temperature of

$37\,^\circ\text{C} / 98.6\,^\circ\text{F}$
Factors Affecting Exposure

Physical Condition

• people who are in poor physical condition or have past medical conditions are not able to tolerate extreme temperature changes

Age

• Small infants are unable to generate heat by shivering until 12 – 18 months of age

• Older adults lose subcutaneous tissue which reduces their amount of insulation. Poor insulation and circulation contributes to rapid heat loss or gain.
Factors Affecting Exposure

Nutrition and Hydration

• The body requires calories for its metabolism to function. Calories provide fuel to create heat, and water provides sweat for evaporation, to remove heat. A decrease in either water or calories will aggravate both heat and cold stress.

Environmental Conditions

• Items such as air temperature, humidity and wind can complicate or improve situations. Hypothermia generally occurs below 10°C while heat emergencies such as heat stroke can occur above 26°C with high humidity
Ways We Gain / Lose Heat

Conduction

- is the direct transfer of heat from the body to a colder object by direct contact

- heat loss can be seen if skin touches metal or is immersed in water less than 37°C

- heat can also be gained if the item being touched is warm
Ways We Gain / Lose Heat

Convection

• occurs when heat is transferred to circulating air such as when a person is standing outside in the winter and wearing lightweight clothing.

• As with conduction, a person may also gain heat if the air passing across the body is hotter than body temperature. In our climate this is commonly found in industrial settings (such as foundries) as well as near spas and hot tubs.
Ways We Gain / Lose Heat

Evaporation

• Heat energy that converts a liquid to a gas
• Heat escapes along with the evaporating liquid
• this is the natural mechanism that allows sweat to cool the body
Ways We Gain / Lose Heat

Radiation

• is the transfer of heat by radiant energy which is a type of invisible light

• the body can lose heat if a person stands in a cold room or gain heat if they stand by the warmth of a fire
Ways We Gain / Lose Heat

Respiration

• body heat is lost as warm air is exhaled from the lungs and cool air is inhaled

• if air temperature is well above body temperature and the humidity is high, a person can gain heat with each breath
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Heat Related Environmental Emergencies
Heat Exposure

- Normal body temperature is 37° C (98.6° F)
- Body attempts to maintain normal temperature despite ambient temperature
- Body cools itself by sweating (evaporation) and dilation of blood vessels which brings blood to skin surface to increase heat radiation
- If the body is exposed to more heat energy than it loses or generates more heat than it can lose, hyperthermia results
Hyperthermia

- Core body temperature reaches 38.3°C (101°F) or higher
- When the body’s natural mechanisms to control heat are overwhelmed the body is unable to tolerate excessive heat and heat illnesses develop
- During vigorous work such as firefighting, the body can lose more than 1L of sweat per hour which causes loss of fluid and electrolytes
- Heat illness can take the following forms:
  - Heat Cramps
  - Heat Exhaustion
  - Heat Stroke
Hyperthermia

• All three forms of heat illness may be present in a patient since heat exhaustion can lead to heat stroke if left untreated

• Persons at the greatest risk for heat emergencies include:
  ✓ Children
  ✓ Geriatric patients
  ✓ Persons with limited mobility
  ✓ Persons with extensive medical concerns such as COPD, heart disease, diabetes, dehydration and obesity
Heat Cramps

- Painful muscle spasms that occur after strenuous activity

- May occur in cool weather if profuse sweat produced during strenuous work causes a change in the body’s electrolytes

- Usually occur in the leg and abdominal muscles. When abdominal muscles are affected, pain and muscle spasms may be so severe that it appears the patient is having an acute abdominal issue
Heat Exhaustion

• Is the most common serious illness due to heat

• Primary cause is loss of fluids and electrolytes from heavy sweating which is called hypovolemia

• In order for sweat to be an effective cooling mechanism, evaporation must occur. If evaporation does not occur, the body will continue to sweat

• High humidity will also decrease the amount of evaporation that can occur
Signs & Symptoms of Heat Exhaustion

- Dizziness, weakness or faintness with nausea and headache
- Cold, clammy skin with ashen pallor
- Dry tongue and thirst
- Normal vital signs, but pulse can be rapid and diastolic blood pressure can be low
Heat Stroke

- Is the least common but most serious illness due to heat

- Primary cause is when the body is subjected to more heat than it can handle thus resulting in normal cooling mechanisms becoming overwhelmed

- The body temperature rises rapidly and may reach 41°C (106°F) or more

- The first sign is a change in the patient’s behaviour followed by decreased level of consciousness
Signs and Symptoms of Heatstroke

- Hot, dry, flushed skin
- Change in behavior leading to unresponsiveness
- Pulse rate is rapid to begin (tachycardic) and then slows as the patient becomes unresponsive (bradycardic)
- Blood pressure falls
- Death can occur if the patient is not treated
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Patient Care for Heat Related Emergencies
Patient Care for Heat Cramps

- Remove the patient from the hot environment and loosen any tight clothing
- Have the patient sit or lie down in order to rest the cramping muscles
- If the patient is not nauseated, replace fluids by mouth. Use water or a diluted electrolyte solution such as Gatorade
- With adequate rest and fluid replacement, the cramps will disappear
- If they do not, notify EMS
Patient Care for Heat Exhaustion

• Remove the patient from the hot environment and loosen any tight clothing particularly around head and neck

• Administer oxygen at 10 lpm with a non-rebreather

• If the patient is alert and not nauseated, replace fluids by mouth. Use water or a diluted electrolyte solution such as Gatorade.

• If the patient is not fully alert, do not provide oral fluids. Notify EMS

• In most cases, the patient will feel better in 30 minutes

• If they do not, or become nauseated, notify EMS
Patient Care for Heat Stroke

- Remove the patient from the hot environment and remove clothing
- Set air conditioning to maximum cooling
- Administer oxygen at 10 lpm with a non-rebreather
- Apply cold packs to the patient's neck, groin and armpits
- Cover the patient with a sheet or spray with cool water and fan in order to quickly evaporate moisture
- Notify EMS immediately
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Cold Related Environmental Emergencies
Hypothermia

• Means “low temperature” and is diagnosed when the temperature of the heart, lungs and vital organs falls below 35°C

• Body can generally tolerate a core temperature drop of a few degrees

• Hypothermia can occur quickly if the person is immersed in cold water or slowly if exposed to a cool environment for several hours

• Weather does not have to be below freezing for hypothermia to occur
Protection from Heat Loss

• Blood vessel constriction in the skin is the body's first defense against the cold and will result in a characteristic appearance of blue lips and/or fingertips.

• Shivering will generate additional heat by actively moving many muscles and is the body's secondary defense.

• As defenses are overwhelmed and cold exposure worsens, many body functions slow which can lead to death.
## Characteristics of Systemic Hypothermia

<table>
<thead>
<tr>
<th>Core Temperature</th>
<th>33°C to 35°C</th>
<th>28°C to 32°C</th>
<th>24°C to 27°C</th>
<th>&lt; 24°C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Signs &amp; Symptoms</strong></td>
<td>Shivering, Foot stamping</td>
<td>Loss of coordination, Muscle stiffness</td>
<td>Coma</td>
<td>Apparent death</td>
</tr>
<tr>
<td><strong>Cardio Respiratory Response</strong></td>
<td>Constricted blood vessels, Rapid breathing</td>
<td>Slowing respirations, Slow pulse</td>
<td>Weak pulse, arrhythmias, Very slow respirations</td>
<td>Cardiac arrest</td>
</tr>
<tr>
<td><strong>Level of Consciousness</strong></td>
<td>Withdrawn</td>
<td>Confused, lethargic, sleepy</td>
<td>Unresponsive</td>
<td>Unresponsive</td>
</tr>
</tbody>
</table>
Characteristics of Hypothermia

Effects of fall in body temperature

- Time of useful consciousness
  - 37°C: Sensation of cold
  - 36°C: Shivering
  - 35°C: Impairment of manual dexterity
  - 33°C: Shivering increases
  - 30°C: Muscle function significantly impaired
  - 28°C: Slowing of mental and physical activity
  - 26°C: Shivering stops
  - 24°C: Unconsciousness
  - 24°C: Irregular heartbeat likely
  - 22°C: Slowing of respiration and heart rate
  - 22°C: Death (failure to rewarms)
As A Point of Interest...

- a patient may appear to be VSA
- NEVER assume that a cold, pulseless patient is dead
Frostnip

- A condition that is characterized as the skin beginning to freeze while the deeper tissue is unaffected
- Commonly affects the ears, cheeks, nose and fingertips
- Generally not painful and the person can be unaware of the condition
Immersion Foot

- Also known as trench foot and generally occurs after prolonged exposure to cold water
- Common in hikers or hunters who stand a long time in a river or lake
- May be seen in urban settings in people with inadequate footwear on a wet day (even with above freezing temperatures)
- As with frostnip, the patient may complain of loss of feeling / sensation but have no pain in the affected area
Frostbite

- Frostbite is the most serious cold injury due to the tissues actually freezing.
- The formation of ice crystals in the cells changes the concentration of critical electrolytes which create permanent changes within the cell.
- When the ice crystals thaw, a further chemical change occurs which causes permanent damage or cell death.
- Most frostbitten areas are hard, waxy and have a hard frozen feel when palpated.
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Patient Care for Cold Related Environmental Emergencies
Patient Assessment

- Check temperature by palpating the skin on the patient’s abdomen
- An altered mental status (AVPU) can be related to the intensity of the cold emergency
- Ensure adequate airway
- Palpate for carotid pulse for 30–45 seconds
Hypothermic Patient Care

• If possible, move patient from cold environment to prevent further heat loss
• Do not allow patient to walk if feet are affected
• Do not allow the patient to eat, do not use stimulants such as coffee or smoke
• Remove wet clothing and place dry blankets under and over patient
• Handle gently
• If oxygen administration is required, be aware oxygen flowing from a cylinder is cold, but it is still important to administer
  
  • Always suspect hypothermia in all outdoor trauma patients
  • Hypothermia in trauma will increase the amount of internal and external bleeding
As A Point of Interest...

- active re-warming (using heated fluids or heaters) should only be attempted by hospital staff as rapid re-warming may cause a fatal cardiac arrhythmia

- your key goal is to minimize further loss of body heat
Patient Care for Frozen Tissue

- Patient care should begin with removing the patient the cold environment
- Handle the injured part gently
- Administer oxygen
- Remove any wet or restrictive clothing that is in contact with the affected area
- Splint the extremity and cover loosely with a dry, sterile dressing
- Never rub the area as this may cause further cell damage
- Do not break blisters
- All tissue re-warming should occur at the hospital
Cold Exposure and You

- You are at risk for hypothermia when working in a cold environment
- Stay aware of local weather conditions
- Dress appropriately and be prepared
- Never allow yourself to become a casualty!
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Drowning and Near Drowning
Drowning and Near Drowning

- Drowning is death as a result of suffocation after submersion in water

- Near drowning is defined as survival, at least temporarily (24 hours), after suffocation in water

- Drowning is often the last cycle of events caused by panic in the water

- As the person struggles they become fatigued which will lead to them sinking deeper
Drowning and Near Drowning

- Inhaling small amounts of water can also stimulate the larynx to spasm which is called a laryngospasm.

- In a drowning, the patient’s lungs can’t ventilate causing the patient to become hypoxic and unresponsive.

- As the patient becomes unresponsive, the larynx will relax and rescue breathing is possible.

- If the patient has not been removed from the water, relaxation of the larynx may cause more water to enter their lungs.
The Drowning Process

Something Goes Wrong

Swallowing of water, Fatigue, Unable to cope with currents, Injuries, Cold, Entanglement, Loss of orientation

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Panic
(loss of control)

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Inefficient Breathing

CO₂ retention, O₂ deprivation

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Decreased Buoyancy

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Exhaustion

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Cardiac or Respiratory Arrest
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Patient Care for Drowning Emergencies
Patient Care for Drowning

• If the patient is still in the water, follow TFS SOG – G-WATR
• If the patient is on shore, ensure they are placed supine. If you have to roll the patient, ensure you take full spinal precautions (in case of a diving injury)
• Assess the patient’s airway and pulse. If the patient is VSA, proceed with your Hypothermic VSA protocol
• If the patient has a pulse, ensure the airway is clear prior to attempting to ventilate the patient. If you meet resistance, hyperextend the airway and attempt to ventilate again
• If resistance is still meet, perform 30 chest compressions followed by inspection of the airway and attempt to ventilate
• If ventilations go in, continue your patient assessment and ventilate as required
For All Questions Pertaining to this Module,
Contact Your E.M.S. Command Coordinator.