Remote Areas Emergency Medical Systems

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CME 600 Heat Emergencies

Course Supplement

HEAT EMERGENCIES

Our bodies try to maintain a constant core temperature of 37°C (98.6°F) no matter what the outside temperature is. If the core temperature drops too low (hypothermia) many of the body's chemical reactions slow down resulting in loss of consciousness and eventually death. Hyperthermia potentially results in crucial proteins governing the enzymatic reactions of the body being damaged (denatured) resulting in loss of consciousness and eventually death.

Hyperthermia

Hyperthermia is defined as an abnormally high body temperature. It is often associated with high environmental heat and humidity and can lead to death.

Sources of Body Heat

Heat is a by-product of metabolic processes. There are three basic sources of heat production: metabolism, exercise and heat absorption.

The first occurs when the body is at rest. The body mainly produces heat by the metabolism of nutrients and other chemical reactions. The majority of basal heat production occurs in the liver and skeletal muscles. The rate of heat production in the adult at rest is about 75 kcal per hour.

The second source is heat produced through exercise. Heavy physical work may produce heat at a rate as high as 900 kcal per hour.

A third potential source of heat is the absorption of heat from the outside environment. As you can imagine, this occurs when the environmental temperature is higher than the body temperature.

Loss of Heat

In response to a rising core temperature, the thermal centre (in the anterior hypothalamus) activates the autonomic nervous system to produce vasodilatation and increase the rate of sweating.

Heat is lost through a variety of mechanisms: conduction, radiation, convection, and respiration.

Influence of the Environment on Heat Loss

Conduction, radiation and convection all depend on a temperature gradient between the environment and body. Obviously our skin temperature must be hotter than the environment in order for us to lose heat. The problem is when outside air temperature exceeds skin temperature:

- Inhaled air may be warmer than exhaled air.
- No breeze or air conditioning causes decreased convection and evaporation
- The skin may absorb more heat than it loses and, in fact, peripheral vasodilation will contribute to heat absorption at this point.

When the environment is warmer than the body temperature, the only way left for the body to dissipate heat is by the evaporation of sweat. People can only sweat about 1 litre per hour and only for a few hours at a time.

What will happen if the relative humidity increases?
- Increasing humidity causes a decreased evaporation rate of perspiration and can greatly decrease the effectiveness of evaporation.

Physiological Responses of the Body to High Humidity and Environmental Temperature

A. Vasodilation
The heart rate must increase due to decreased circulating blood volume. The person may present as being in shock if there is a complete loss of vasomotor control. Vasodilation also causes shunting from vital organs such as the brain resulting in symptoms such as headache, vertigo, altered level of awareness, and emotional instability.

B. Sweating
Sweating results in a loss of fluid, sodium, chloride and other electrolytes causing muscle cramps and dehydration.

Factors Associated with Heat Emergencies

- High temperature and humidity
- Dehydration
- Prolonged or excessive exercise
- Excess clothing
- Alcohol
- Some medications
- Cardiovascular disease
- Sweat gland dysfunction
- Hyperthyroidism
- Obesity
- Children/animals locked in hot vehicles

CATEGORIES OF HEAT EMERGENCIES

Heat emergencies can be categorized as mild or severe.

1. Mild which is further broken down into two categories:
    a. Heat cramps,
    b. Heat exhaustion
2. Severe (life threatening):
    a. Heat Stroke

Mild Heat Illness

With mild heat emergencies, the body temperature is normal as the patient is able to compensate. Symptoms occur because of the body's response mechanisms to dissipate the heat.

Heat Cramps

What are heat cramps? They are muscle pain. They are very painful (think about when you have experienced a muscle cramp) but generally are benign. Why do they occur? Muscle cramps result from sweating and the consequent loss of salts. The patient often drinks water but often doesn't replace the salts lost (sweat is salty, right!). Heat cramps often occur suddenly during strenuous activity.

Treatment

- Rest in a cool environment with oral fluid replacement with isotonic solutions. Gatorade is one such drink.
- IV saline if indicated.
- Do not massage the cramping muscles as this rarely helps and may aggravate the pain.
- Relax for at least 12 hours as there is potential further exertion may lead to heat exhaustion or heat stroke.

Heat Exhaustion

Heat exhaustion is an acute heat injury with mild hyperthermia. Heat exhaustion is a result of salt and water being lost and peripheral pooling of blood. Heat exhaustion tends to occur in people who are dehydrated, elderly or who have hypertension. Remember hypertensive patients may be taking medications that deplete the body of fluid and electrolytes and also interfere with reflex changes in the calibre of blood vessels.

Symptoms

Heat exhaustion may present suddenly with syncope or collapse. Often non-specific symptoms may occur with heat exposure.

- Malaise, flu-like symptoms, headache, vertigo

- Dehydration, nausea
- Pale, clammy skin
- Pulse rapid and weak
- Tachypnea, which may produce symptoms secondary to hyperventilation (Tingling, carpal/pedal spasms)

Heat exhaustion may progress to heat stroke.

Treatment

- Move the patient to a cool environment
- Sponge or cool with water but do not overdo it
- Rehydrate by IV saline
- Do not give fluids by mouth if nauseated
- Cardiac monitor

Heat Stroke

With heat stroke, the body's normal heat dissipation mechanisms are overwhelmed. The core temperature increases and heat stroke ensues. Heat stroke is the least common of the heat related illnesses but the most deadly. The mortality rate can be as high as 70%.

There are two forms of heat stroke:

A. **Classic (non exertional or passive) heatstroke** normally occurs during summer heat waves affecting the elderly, the poor and children. As their core temperature rises these patients present with hyperthermia and dehydration. Both the elderly who often have marginal cardiovascular reserve and patients on any medications that interfere with heat dissipation or that affect the patient's ability to compensate (phenothiazines, beta blockers, tranquilizers and anticholinergics) are at risk. A lack of air conditioning may be a contributing factor. Combining this group's innate risks with high heat and high humidity not only puts these people in a high-risk category for heat stroke, but also results in a very high mortality rate of up to 70%.

B. **Exertional heat stroke** is the other form of heat stroke and this typically occurs in the young and fit, especially the athletic, as a result of strenuous physical activity. Unlike classical heat stroke, hyperpyrexia occurs without dehydration because significant fluid loss through sweating has been prevented by high humidity. The mortality in this group rarely exceeds 20% due to the young age and health of the victim.

Assessment

Early signs:

- Rectal temperature greater than 40^{o} Celsius
- History of heat stress or exposure

- Tachycardia, strong and bounding pulse in exertional heatstroke and a weak and thready pulse in classical heat stroke
- Skin tends to be hot and flushed, often sweaty initially
- CNS dysfunction, altered level of consciousness to delirium and coma. The elderly may appear to have had a stroke. You may see fixed and dilated pupils, decerebrate or decorticate posturing.

Late Findings:

- Cardiovascular collapse may be caused by dehydration, maximal cutaneous vasodilation and direct heat may induce myocardial depression
- Liver dysfunction: coagulopathies from increased levels of bilirubin and trasaminases may be seen much later.
- Renal failure from myoglobinuria and acute tubular necrosis may be seen much later.

Treatment

- The priority is rapid cooling to prevent further damage and reverse heat stress. Remember we do not want this patient to start shivering (this generates heat). Use conduction and evaporation to cool the patient. Spraying the patient with tepid water and fanning him will promote heat loss.
- ABCs and Oxygen.
- Start an IV and if volume depleted/hypotensive the patient will need IV fluids. Some sources recommend 1200 ml over 4 hours, 2 litres over 1hour and 1 L/hour for 3 more hours.
- Cardiac monitoring.
- Be prepared to treat seizures.
- It is now recommended that we avoid covering the patient with sheets soaked with ice water as the sheets actually impede heat loss by evaporation.

Remember

- Once the thermoregulatory system fails, for whatever reason, the core temperature will soar. There is potential for the core temperature to rise from normal to as high as 41°C (106°F) in less than 15 minutes, thus resulting in a potentially lethal situation. The diagnosis of heat stroke is very easy to miss.
- Patients with heat exhaustion who think they have the “flu” can rapidly develop heat stroke. Paramedics must be suspicious of heat stroke during the hot, humid summer months.
- Anhydrosis (lack of sweat), the classical sign associated with heat stroke, is typically found to be a late sign. For this reason, paramedics should consider the diagnosis of heatstroke in any diaphoretic patient who presents with an altered level of awareness.

Medications That Influence Heat Loss

Paramedics may not be able to recognize the name of medications carried by international travellers. Many medications, while classified and named differently, are used for similar purposes. Many of the drugs are used for the purpose of relieving signs and symptoms of motion sickness (nausea, vomiting and dizziness), ulcers and as antihistamines. Tranquilizers act as depressants to the central nervous system and are used to calm, induce sleep, or decrease anxiety.

Beta-blockers block the receptors for the physical effects of a person's natural fight or flight response. Beta-blockers are not sedatives, and they can't help anxiety of a purely psychological nature. Sometimes people will take beta-blockers for the purpose of keeping their heart from racing or to decrease sweating.

Examples of Medications

Anticholinergics	**Phenothiazines**	**Beta Blockers**	**Tranquilizers**
Anti-motion sickness	*Antihistamines Antipsychotic Antiemetic*		
Transderm-V oral/patch	Promethazine HCL	Tenormin/Atenolol	Clonazepam
Propanthelene	Trimeprazine	Lopressor/Metoprolol	Flurazepam
Dicyclomine	Methdilazine	Inderal/Propranolol	Oxazepam
Bentyol	Largactil	Acebutolol	Ativan/Lorazepam
Buscopan	Chlorpromazine	Pindolol	
	Stemetil		
	Dimenhydrinate		

Summary

During a hot, humid heat wave the signs and symptoms seen are the body’s attempt to try and maintain a constant core temperature. Normally people only experience mild heat illness and paramedics rarely see these patients. Generally supportive care and rehydration are all these patients need.

As patients continue to lose fluids and salts, they often complain of flu-like symptoms but at this point they are actually experiencing heat exhaustion. These people are at risk of progressing to heat stroke. If that occurs they will present with altered levels of awareness and are in serious trouble if they are not cooled off quickly and rehydrated by IV. Don’t forget to treat any concurrent injuries or medical problems at the same time.

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