UNITED STATES MARINE CORPS
FIELD MEDICAL TRAINING BATTALION
Camp Lejeune, NC 28542-0042

FMST 110

Manage Environmental Heat Injuries

TERMINAL LEARNING OBJECTIVES

1. Given a casualty in any environment, treat environmental heat injuries to reduce the risk of further injury or death. (8404-MED-2013)

ENABLING LEARNING OBJECTIVES

1. Without the aid of reference, given a description or list, identify the predisposing factors associated with heat injuries, within 80% accuracy, per the Prehospital Trauma Life Support, Current Military Edition. (8404-MED-2013a)

2. Without the aid of reference, given a description or list, identify the proper treatments of heat injuries, within 80% accuracy, per the Prehospital Trauma Life Support, Current Military Edition. (8404-MED-2013b)

3. Without the aid of reference, given a description or list, identify the proper methods of cooling the heat casualty, within 80% accuracy per the Prehospital Trauma Life Support, Current Military Edition. (8404-MED-2013c)

4. Without the aid of reference, given a description or list, identify preventive measures for heat injuries, within 80% accuracy, per the Prehospital Trauma Life Support, Current Military Edition.
OVERVIEW

High internal temperatures produce stress on the body, which, if not effectively counterbalanced, may result in heat injury or death. Environmental as well as physiological factors influence the body's thermal equilibrium mechanism. Heat injuries can occur anywhere and at anytime of the year, depending upon physical activity and clothing worn. However, heat injuries most frequently occur during warm weather training and operations due to exposure to high temperatures, high humidity and sunlight. Sweating increases daily water requirements as well as electrolyte replacement. Dehydration leads to added heat stress, increased susceptibility to heat injury, reduced work performance and degraded mission capability.

Body temperature is regulated by the thermoregulatory center in the hypothalamus. The hypothalamus receives input from various thermal receptors located throughout the body. From this input, it can then tell the body to either conserve body heat or increase heat dissipation by increasing cardiac output, respiratory rate, vasodilatation and perspiration. Normal body temperature range is usually 97.6°F - 99.6°F.

1. PREDISPOSING FACTORS ASSOCIATED WITH HEAT INJURIES

Chronic Conditions

Fitness and Body Mass Index - Low levels of physical fitness will reduce tolerance to heat exposure. Being physically fit provides a cardiovascular reserve to maintain cardiac output as needed to sustain thermoregulation.

Age - Thermoregulatory capacity and tolerance to heat diminish with age. However, this state can be improved by maintaining a low body weight and high level of physical fitness.

Medical Conditions - Medical conditions that can increase the risk for heat intolerance and heat illness are diabetes mellitus, thyroid disorders and renal disease. Cardiovascular disease and circulatory problems that increase cutaneous blood flow and circulatory demand are aggravated by heat exposure.

Previous History of Heat Injury - Personnel who have a history of heat injury are highly susceptible to repeated heat injury because the hypothalamus has been damaged. Even after the patient recovers, the body may not repair the hypothalamus to its former effectiveness, therefore, the patient will become more sensitive to heat stressors.

Skin Trauma - The skin is the largest organ of the body. It serves as a layer of protection, controls the invasion of microorganisms, maintains fluid balance, and helps regulate temperature. Personnel suffering from skin conditions that hamper the heat regulatory mechanism (sunburn, heat rash, windburn, and dermatologic disease) have an increased risk of heat related injuries.
Medications - The use of specific prescription or over-the-counter medications can place individuals at a greater risk for heat illness (see figure 1). Certain medications can increase metabolic heat production, suppress body cooling, reduce cardiac reserve, and alter renal electrolyte and fluid balance. Sedative and narcotic drugs will affect mental status and can affect logical reasoning and judgment, suppressing decision-making ability, when the individual is exposed to heat.

Transient Conditions

Transient conditions include those affecting individuals who travel from cooler climates and are not heat-acclimated to warmer climates. Other transient factors are common illnesses including colds, fever, vomiting and diarrhea, along with poor dietary and fluid intake.

2. TYPES OF HEAT INJURIES

Heat Cramps – short-term, painful muscle contractions frequently seen in the calf muscles but also in the voluntary muscles of the abdomen and extremities.

Cause – muscle fatigue, body water loss and large sodium loss. Commonly observed following prolonged physical activity in warm to hot temperatures.

Signs and Symptoms

- Muscle cramps and tenderness
- The skin is usually moist, pale and warm
- Core temperature may be normal or slightly elevated

Treatment

- Rest in a cool environment
- Prolonged stretching of the affected muscles
- Consuming oral fluids and food containing sodium (sports drinks, electrolyte pouches, salty snacks)

Heat Exhaustion - the most common heat-related disorder. A systemic reaction to prolonged heat exposure (hours to days) and is caused by excessive heat strain with inadequate water intake.

Cause – Results from cardiac output that is insufficient to support the increased circulatory load caused by competing blood flow, reduced plasma volume and sweat-induced depletion of salt and water.
Signs and Symptoms - Any of the signs and symptoms of heat cramps may accompany heat exhaustion along with:

- Frontal headache
- Decreased urine output
- Drowsiness
- Nausea
- Vomiting
- Light-headedness
- Anxiety
- Fatigue
- Irritability
- Decreased coordination
- Orthostatic hypotension
- Moist, pale, clammy skin
- Rectal temp usually below 104° F (temp not always a reliable finding)

Treatment

- Move to cooler location
- Loosen or remove clothing
- Assess vital signs
- Oral rehydration with electrolyte fluids is preferred
- IV fluids if patient is unable to consume liquids by mouth
- Active cooling by wetting head and torso with water and fanning
- Transport if patient is unconscious or does not recover rapidly

Heat Stroke - severe, life-threatening condition; a true medical emergency!

Cause - It is a total failure of the thermoregulatory mechanism, resulting in an excessive rise in body temperature.

Signs and Symptoms - Heatstroke is characterized by an elevated core temperature of 104° F or greater and mental status changes such as confusion, disorientation, combativeness or unconsciousness.

Classic Heatstroke - a disorder of children, the elderly and sick patients.

- Dry, hot, red skin

Exertional Heatstroke - typically seen in men age 15-45 with poor physical fitness or lack of heat acclimation who are involved short-term, strenuous physical activity during a hot humid environment.

- Sweat soaked and pale skin at the time of the collapse
Treatment
- Remove patient from the source of heat
- **Immediately** begin cooling the patient
- Maintain ABC’s
- Give a 500 mL fluid challenge and reassess vital signs. Do not exceed 1-2 liters within the first hour.
- Monitor core temperature every 5 to 10 minutes. Active cooling should stop when the rectal temperature reaches 102.2° F.
- TACEVAC

3. **METHODS OF COOLING THE BODY**

   **Immersion**
   - Fastest method of cooling; uses conduction.
   - Immerse the patient in a tub filled with ice water (usually not available in a field environment).
   - Requires constant monitoring of the patient during the procedure.

   **Direct Cooling**
   - Apply ice packs on head, trunk and extremities.
   - Place ice water towels/sheets over the casualty.

   **Room Temperature Water Misting**
   - Remove excess clothing and wet the patient down from head to toe.
   - Provide fanning of the skin causing evaporation and convective heat loss.
   - Most effective method when cold water or ice is not available.

4. **PREVENTIVE MEASURES FOR HEAT INJURIES**

   **Education of Personnel**
   - Most important prevention measure.

   **Physical Conditioning and Health**
   - A person’s physical condition has been directly related to their susceptibility to heat related incidents

   **Proper Water Intake**
   - During hot weather operations, sweating can cause loss of body water in excess of 1 liter per hour. Personnel must be educated on drinking liberal quantities of water.
   - Water alone will not prevent an individual from becoming a heat casualty. Sodium and potassium must be replaced along with water. Personnel must be educated that an adequate diet (MRE's/Messhall) is essential for proper water/electrolyte balance. (See lesson on Dehydration Casualties).
**Proper Acclimatization**

- In some areas this may take from two to four weeks (3 weeks optimal)
- Gradual introduction of physical training program

**Proper Clothing**

- When situation permits, wear the least allowable amount of clothing
- Avoid skin exposure to direct sunlight (burned skin is less able to regulate body temperature)
- Clothing should be loose fitting to permit air circulation, especially at the neck, arms, waist and lower legs

**Work Schedules**

- Tailor work schedules to the situation with careful consideration to heat/humidity index, acclimatization time, type of work and place.

5. **HEAT CONDITION FLAG WARNING SYSTEM**

**Wet Bulb Globe Temperature (WBGT) Index** - This index uses the combination of a dry bulb for ambient temperature, wet bulb for humidity measurement, black globe for radiant heat and air movement to provide a more accurate impact of the environmental conditions. It is NOT the same as regular air temperatures. The WBGT can be monitored hourly and the corresponding colored flag placed on a flagpole outdoors for all personnel to see. Where appropriate, adjustments of clothing, physical activity, work/rest cycles and fluid intake can then be made based on these conditions. (See figure 2)

**Flag Warning System** - Color-coded flags are used to help prevent heat casualties during hot weather. These flags will be prominently displayed by all commands so that every one can see them, particularly in areas where physical training takes place.

- **Green Flag (80° F to 84.9° F)** - heavy exercises for unacclimatized personnel will be conducted with caution and under constant supervision.
- **Yellow Flag (85° F to 87.9° F)** - strenuous exercises, such as marching at standard cadence, will be suspended for unacclimatized troops in their first 3 weeks. Outdoor classes in the sun will be avoided.
- **Red Flag (88° F to 89.9° F)** - all physical training will be halted for those troops who have not become thoroughly acclimatized by at least 12 weeks of living and working in the area. Those troops who are thoroughly acclimatized may carry on limited activity not to exceed 6 hours per day.
- **Black Flag (90° F and above)** - all nonessential strenuous physical activity will be halted for all units.
<table>
<thead>
<tr>
<th>Heat Category</th>
<th>WBGT Index, °F</th>
<th>Easy Work</th>
<th>Moderate Work</th>
<th>Hard Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>78° - 79.9°</td>
<td>NL</td>
<td>½</td>
<td>NL</td>
</tr>
<tr>
<td>2 (GREEN)</td>
<td>80° - 84.9°</td>
<td>50/10 min</td>
<td>¾</td>
<td>30/30 min</td>
</tr>
<tr>
<td>3 (YELLOW)</td>
<td>85° - 87.9°</td>
<td>40/20 min</td>
<td>¾</td>
<td>30/30 min</td>
</tr>
<tr>
<td>4 (RED)</td>
<td>88° - 89.9°</td>
<td>30/30 min</td>
<td>¾</td>
<td>20/40 min</td>
</tr>
<tr>
<td>5 (BLACK)</td>
<td>&gt;90°</td>
<td>50/10 min</td>
<td>1</td>
<td>10/50 min</td>
</tr>
</tbody>
</table>

- The work/rest times and fluid replacement volumes will sustain performance and hydration for at least 4 hrs of work in the specified heat category. Fluid needs can vary based on individual differences (± ¼ qt/hr) and exposure to full sun or full shade (± ¼ qt/hr).
- **NL** = no limit to work time per hr.
- **Rest** = minimal physical activity (sitting or standing) accomplished in shade if possible.
- **CAUTION:** Hourly fluid intake should not exceed 1½ qts. Daily fluid intake should not exceed 12 qts.
- If wearing body armor, add 5°F to WBGT index in humid climates.
- If doing Easy Work and wearing NBC (MOPP 4) clothing, add 10°F to WBGT index.
- If doing Moderate or Hard Work and wearing NBC (MOPP 4) clothing, add 20°F to WBGT index.

Figure 2 WGBT Index Chart

**REFERENCES**

Pre-hospital Trauma Life Support, Current Military Edition
Heat Injuries Review

1. List two chronic and two transient predisposing factors associated with heat injuries.

2. List five signs or symptoms of heat exhaustion.

3. Identify the significant differences between heat stroke and heat exhaustion.

4. Name 3 ways to prevent heat injuries.

5. List and describe the three methods of cooling a patient suffering from a heat injury.