

## **LESSON ASSIGNMENT**

### **LESSON 11**

Heat Injuries.

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Paragraphs 11-1 through 11-4.

### **LESSON OBJECTIVES**

After completing this lesson, you should be able to:

11-1. Define the types of heat injuries.

11-2. Select the factors that influence heat injuries.

11-3. Select the measures to prevent heat injuries.

11-4. Compute the WBGT Index.

## LESSON 11

### HEAT INJURIES

#### 11-1. HEAT ILLNESSES

Minor heat related illnesses and conditions include heat edema, heat rash, sunburn, heat tetany, parade syncope and heat cramps.

a. **Heat Edema.** Heat edema refers to the swelling of the hands and feet associated with heat exposure. It is not a sign of underlying cardiac or hepatic disease. Victims of heat edema may complain that their shoes feel tight or are ill fitting. The symptoms usually resolve within a few days, as the person becomes heat acclimatized.

b. **Heat Rash.** Heat rash is also known as prickly heat or miliaria rubra. It occurs usually in areas where the clothing is restrictive, and gives rise to a prickling sensation, especially as sweating increases. Heat rash may be more than an annoyance. It may interfere with sleep resulting in sleep deprivation which increases the risk of heat exhaustion and heat stroke.

c. **Sunburn.** Sunburn impairs sweating over the affected skin and predisposes soldiers to heat injury from systemic effects, including fever, that influence central thermoregulation. Sunburn should be prevented by making sun blocking lotions available to soldiers, insisting that they use them, and ensuring soldiers are protected from sun overexposure with protective clothing and adequate shelter or shade.

d. **Heat tetany.** Heat tetany is the result of hyperventilation by an individual after being exposed to heat stress. It generally occurs before heat acclimatization. Symptoms include muscle spasm and perioral (around the mouth) numbness and tingling.

e. **Parade Syncope.** Parade syncope or heat syncope is a temporary circulatory failure due to pooling of blood in the peripheral veins, especially those of the lower extremity, and a consequent decrease in diastolic filling of the heart. Parade syncope often, but not always, occurs during prolonged standing and is often associated with hot weather environments. In addition, it may occur while standing still after completing a vigorous activity. Victims of parade syncope will recover rapidly once they sit or lay supine, though complete recovery of stable blood pressure and heart rate may take an hour or two. If standing is required in hot environments where injury from a fall is likely, heat syncope should be considered a significant safety concern.

f. **Heat cramps.** These are painful muscle cramps that may occur after exposure to heat and are caused primarily by the excessive loss of mineral salts in the body.

- (1) Cramps normally involve the muscles of the arms, legs, and abdomen.
- (2) Cramps may be severe enough to render a soldier ineffective.
- (3) Cramping may be accompanied by symptoms of heat exhaustion (abnormal body temperature).
- (4) Cramps differ from exertional muscle cramps in that the entire muscle is not involved. Exertion muscle cramps are more apt to occur during exercise.

**g. Heat exhaustion.** Heat exhaustion is the most common form of heat casualty and is not associated with evidence of organ damage. This condition is the result of excessive loss of both salt and water, usually due to profuse sweating as the body attempts to cool itself. As evidenced by the profuse sweating, with heat exhaustion the body's heat balance mechanism is still functioning normally.

(1) Classic symptoms include profuse sweating, trembling, weakness, lack of coordination, and anything from a slight sensory clouding to a momentary loss of consciousness.

(2) Additional symptoms may include headache, tingling in the hands and feet, paleness, difficulty breathing, irregular heartbeat, loss of appetite, nausea, and vomiting.

(3) The skin generally is cool and moist from the evaporation of sweat, the pulse rate is rapid, blood pressure may be low, and body temperature may be lower than normal.

**h. Heat stroke.** Heat stroke results when the body's heat balance mechanism collapses and the primary method of heat loss (cooling by evaporation of sweat) is shut down.

**WARNING:** Heat stroke is a medical emergency. There is a high death rate associated with heat stroke. The condition of a person suffering from heat stroke will deteriorate rapidly. Therefore, treatment should begin immediately.

(1) Early signs of heat stroke include headache, dizziness, delirium (mental confusion), weakness, nausea, vomiting, and excessive warmth.

(2) A classic sign of heat stroke is hot, red, dry skin, although sweating may be present.

**NOTE:** Notice that these symptoms are very similar to heat exhaustion. Therefore, care must be taken to treat the victim immediately to avoid having heat exhaustion develop into heat stroke.

(3) In the past, a heat stroke victim was described as always having hot, dry skin as opposed to the moist clammy skin of a heat exhaustion victim. It has been found that although the skin may be hot and dry, just as often it may be moist from sweat. Therefore, upon initial evaluation, the skin can not be the differentiating factor in deciding on the degree of the heat injury.

(4) Most significant sign is a body temperature over 106° Fahrenheit or 41° Celsius.

(5) After one attack of heat stroke, the individual remains very susceptible to repeated heat injuries. Therefore, these individuals should avoid subsequent exposure to hot weather conditions.

## 11-2. FACTOR THAT INFLUENCE HEAT INJURY

There are several factors that cause heat load on the body, thereby increasing the likelihood of heat injury. Understanding these factors will enable you to caution leaders and soldiers and aid you in your prevention efforts.

a. **Acclimatization.** Acclimatization refers to how well adapted a soldier is to a particular environment.

(1) Soldiers who grow up in cool climates but are deployed to a warm or hot climate for training are more susceptible to heat injury. Their bodies do not handle the heat stress well.

(2) Soldiers who serve in hot climates but are then stationed in a cool geographical region, such as Germany, lose their acclimatization to heat in about one month.

b. **Being overweight or unfit.** Being overweight or unfit makes a soldier more susceptible to heat injury. This susceptibility is increased if the soldier also has a previous history of heat injury.

c. **Fatigue levels.** Fatigue impairs the body's ability to lose heat. It takes more energy to lose heat so an already tired body can not perform this function as well as someone who is less tired.

d. **Foods and alcohol.** Heavy meals and hot foods on a hot day put additional stress on the body. Alcohol should be avoided. Especially when consumed in an amount that causes a hangover, it decreases the body's ability to deal effectively with heat stress.

e. **Medications.** Both over-the-counter and prescription medications can alter the body's functioning and impair the body's ability to handle heat stress.

(1) Cold medications, antihistamines and antidiarrheal medicines all contain drying agents that reduce the amount of water in the body. With less water available, you can't sweat as much. Therefore, your body's ability to cool itself is reduced.

(2) Some drugs may cause a slight fever. Fever increases the amount of heat to be dissipated by the body. Some of the immunizations received by soldiers induce a temporary fever. Care should be taken if you must be exposed to heat when you have a fever.

f. **Clothing.** Tight fitting clothes restrict the flow of air around the body, reducing the cooling effects of evaporation. If properly worn, the BDU helps prevent heat injury because, when worn loosely, it does not restrict the flow of blood and allows air to move freely over the skin.

### 11-3. PREVENTING HEAT INJURIES

The best way to avoid becoming a heat casualty is to prevent the injuries before they occur.

a. **Replace water lost through perspiration.** One of the most important measures you can take is to make sure you replace any water your body has lost. Through sweating, a soldier can lose more than one quart of water per hour. Leaders must be aware that unless this water is replaced, a rapid decrease in the ability to work, a rise in body temperature and heart rate, deterioration in morale as well as heat injuries can occur.

(1) To replace the water lost, you need to make sure that soldiers are being encouraged to drink small amounts of water frequently, and given time to do it, throughout the work period. Small amounts of water should be consumed regardless of thirst since normal thirst is not a true indication of the body's need for water.

(2) Use the chart found in FM 21-10 and FM 4-25.12 (Figure 11-1) to determine the amount of water to have on hand while soldiers are working in the heat.



*Table 3-1. Fluid Replacement Guidelines for Warm Weather Training  
(Applies to Average Acclimated Service Member Wearing Hot Weather Uniform)*

HEAT CATEGORY	WBGT INDEX DEGREES F	EASY WORK		MODERATE WORK		HARD WORK	
		WORK/REST MIN	WATER INTAKE QT/HR	WORK/REST MIN	WATER INTAKE QT/HR	WORK/REST MIN	WATER INTAKE QT/HR
1	78-81.9	NL	½	NL	¾	40/20	¾
2 (GREEN)	82-84.9	NL	½	50/10	¾	30/30	1
3 (YELLOW)	85-87.9	NL	¾	40/20	¾	30/30	1
4 (RED)	88-89.9	NL	¾	30/30	¾	20/40	1
5 (BLACK)	> 90	50/10	1	20/40	1	10/50	1

The work/rest times and fluid replacement volumes will sustain performance and hydration for at least 4 hours of work in the specified heat category. Individual water needs will vary ± ¼ quart/hour. NL= no limit to work time per hour. Rest means minimal physical activity (sitting or standing) accomplished in shade, if possible. **CAUTION:** Hourly fluid intake should not exceed 1¼ quarts. Daily fluid intake **should not exceed 12 liters.** Wearing body armor adds 5° F to WBGT Index. Wearing all MOPP overgarments adds 10° F to WBGT Index.

EASY WORK	MODERATE WORK	HARD WORK
WEAPON MAINTENANCE WALKING HARD SURFACE AT 2.5 MPH, ≤ 30 LB LOAD GUARD DUTY MARKSMANSHIP TRAINING DRILL AND CEREMONY	WALKING LOOSE SAND AT 2.5 MPH, NO LOAD WALKING HARD SURFACE AT 3.5 MPH, ≤ 40 LB LOAD CALISTHENICS PATROLLING INDIVIDUAL MOVEMENT TECHNIQUES, SUCH AS LOW CRAWL, HIGH CRAWL DEFENSIVE POSITION CONSTRUCTION	WALKING HARD SURFACE AT 3.5 MPH, ≥ 40 LB LOAD WALKING ON LOOSE SAND AT 2.5 MPH WITH LOAD FIELD ASSAULTS

Figure 11-1 Heat injury prevention chart.

**CAUTION:** Soldiers need to be provided adequate water at all times. The belief that our bodies can be taught to adjust to decreased water intake is incorrect. When water is in short supply, limiting physical activity to the early morning or late evening hours when the heat load is less and sweating is reduced can save a substantial amount.

b. **Replace salt lost through perspiration.** In addition to water, sodium chloride or salt, is lost when you sweat. Normally meals provided by the Army provide

adequate amounts of salt. MREs include a salt packet which, when consumed with the rest of the meal, provides enough sodium for soldiers to reduce their chances of becoming heat casualties.



**NOTE:** There may be operations where a doctor determines that even more salt is required in the diet. In those rare instances, guidance will come down to the units through their medics, physician assistants, and doctors. This decision is NOT an FST member decision.

c. **Allow for periods of acclimatization.** Normally a period of ten to fourteen days is required for acclimatization. Periods of heat exposure and physical exertion should be increased gradually.

(1) The body's acclimatization to heat begins with the first exposure and it's usually well developed by the end of the first week. However, soldiers who are unusually susceptible to heat will require additional time to become fully acclimatized.

(2) Once acclimatized to heat, a soldier will retain adaptation for about one week after leaving the hot environment, but if he's not exposed to work in high temperatures the acclimatization will decrease at a variable rate. Most acclimatization is completely lost within one month.

d. **Maintain good general health.** The general physical condition of a soldier has a significant bearing on his or her reaction to heat stress. A variety of conditions that may increase an individual's risk of heat injury include infections, fever, immunization reaction, heat rash, sunburn, fatigue, excess weight and previous history of heatstroke.

e. **Establish work/rest schedules.** As the heat load increases, work/rest schedules should be established. Table 3-1 in FM 21-10 (Figure 11-1) gives an example of suggested work/rest periods. Leaders should also be encouraged to take advantage of cooler hours to accomplish a portion of the work.

(1) For essential tasks that must be completed, arrange for two work details so that one group of soldiers can work while the other group rests. Always ensure that adequate water is available to the soldiers.

(2) The work/rest schedules in Table 3-1 are based upon work equal to that of marching with a 20-pound pack at a rate of 2.5 miles per hour. Lighter work can be carried out for a longer period, while heavier work should be carried out for shorter periods of time.

(3) Soldiers should be allowed to rest and stay in the shade as much as possible during midday hours when the temperature is at its hottest.

f. **Protection from the environment.** The best protection a soldier has from the environment is his uniform. The BDU is designed to protect your skin from harmful UV rays.

(1) Although clothing reduces exposure, it also decreases the movement of air over the surface of the body. Therefore except when exposed to the direct rays of the sun, soldiers in a hot environment should wear the least allowable amount of clothing.

(2) There are other ways to protect soldiers from the environment that are often overlooked. For example, simply marching over grass instead of a paved surface will protect a soldier from the heat reflected off of the hard surface.

g. **Education.** An essential element of prevention is education. Education should occur at all levels within the unit. Heat injuries are more likely to be avoided when soldiers are trained and when informed leaders supervise them.

(1) Soldiers should be informed of the potentially serious results of heat injury, the general nature of these conditions, and how they can be prevented.

(2) Leaders should be trained to identify conditions under which heat injuries are most likely to occur. They should be able to recognize the earliest signs of heat injury and take action to prevent the development of serious cases.

(3) All personnel should also be trained and efficient in the common soldiers' task of providing first aid to heat injured soldiers.

(4) Medical personnel should assist commanders in the development of local programs for heat injury prevention.

#### **11-4. THE WET BULB GLOBE TEMPERATURE (WBGT) INDEX**

a. Purpose and general use of the WBGT.

(1) The amount of heat stress on the body is measured by the WBGT index. Monitoring the index will help you, and other leaders in your unit, to determine the proper preventive measures needed during hot conditions.

(2) Physical activity recommendations and fluid replacement guidelines for the various heat categories can be found in FM 21-10 and FM 4-25.12.

(3) Compute the WBGT index on site, where the soldiers are working. If this isn't possible, you can obtain the information from preventive medicine or the meteorological service.



(4) Peak conditions usually occur between 1200 and 1600 hours. Local and regional conditions may warrant modification of the work schedule during these peak hours.

b. **The WBGT kit.** The WBGT kit is enclosed in an aluminum case sealed with a stainless steel clasp. There is a threaded hole on the bottom of the case to attach it to a photographer's tripod. Inside the case are a wet bulb thermometer, a black globe thermometer, and a dry bulb thermometer. Each thermometer is mounted on a hinged assembly that can be lifted out of the case, enabling you to take the necessary readings.

(1) Wet bulb thermometer. The wet bulb thermometer is a standard laboratory glass thermometer with the bulb encased in a cotton wick. The wick is inserted in a small flask filled with the distilled water, and the flask is hung at least  $\frac{3}{4}$  of an inch below the bulb of the thermometer. The water in the flask should be maintained at a level that allows the wick to stay wet.

(2) Black globe thermometer. The black globe thermometer consists of a six inch hollow copper sphere painted flat (matte) black on the outside, containing a thermometer with its bulb at the center of the sphere. The thermometer should have a range of 23 °F to 212°F.

(3) Dry bulb thermometer. The dry bulb thermometer is a standard laboratory thermometer. The bulb of the thermometer is shaded from the sun by a white hood.

c. **Compute the WBGT index.**

(1) Prepare the kit for operation.

(a) Open the kit and lift out the thermometer assembly. Check the assembly for deficiencies or damage.

(b) Wet the cotton wick and fill the plastic flask of the wet bulb thermometer with distilled water.

(c) Attach the tripod and position the kit approximately four feet off the ground.

(d) Let the tripod sit undisturbed for at least ten minutes to allow the thermometers to stabilize.

(2) Take the readings. After the thermometers have stabilized, observe and record the readings from each of the three thermometers.

NOTE: The WBGT index can be calculated by using method, (3) OR (4), below.

- (3) Use the WBGT index calculator to determine the WBGT index.
  - (a) Locate the dry bulb temperature on the dry bulb thermometer scale.
  - (b) Holding the wet bulb scale, slide the dry bulb scale until the wet bulb temperature is directly under the dry bulb temperature.
  - (c) Locate the black globe temperature on the bottom scale. Read the WBGT index from its scale directly above the black globe temperature.
- (4) Use mathematical formulas to determine the WBGT index.
  - (a) Multiply the wet bulb temperature by 0.7.
  - (b) Multiply the black globe temperature by 0.2.
  - (c) Multiply the dry bulb temperature by 0.1.
  - (d) Add the products of the three calculations. The sum is the WBGT index.
- (5) Add 10°F if wearing of NBC clothing (MOPP) for easy work, 20°F for moderate and hard work, and 5°F for wearing body armor in humid climates to the final WBGT index.
- (6) Find the heat category associated with the WBGT index you have calculated.

