Section V. PREVENTION OF HEAT INJURIES

9-31. General. Heat injuries are a major threat to field operations, and will be discussed briefly in the following section. The internal temperature of the human body is regulated within a vary narrow range. High internal temperatures produce stress on the body which, if not effectively counterbalanced, may result in heat injury or death (See figure 9-23). Environmental as well as physiological factors influence the body's thermal equilibrium mechanism. A detailed discussion of heat stress, its identification, treatment and prevention is contained in Chapter 3 of this manual.

9-32. Environmental Factors.

1. Ambient air temperature dictates the direction of heat flow from (or to) the body. When air temperatures are below normal body temperature, heat loss to the surrounding environment is rapid. When air temperatures are high the body can only dissipate heat by sweating where the heat is carried away by sweat evaporation at the skin surface.
2. Wind velocity. Body heat is carried away by air currents. The higher the velocity of these currents, the faster the heat loss. The rate of heat loss diminishes as air temperatures increase. When the body stops sweating (as in heat stroke), the condition reverses itself and the body absorbs heat rapidly. High wind velocity can also produce windburn which will influence thermal regulation.
3. Humidity. Ambient air, at any given temperature, can only absorb so much moisture. When the moisture content (humidity) of the air is high, sweat evaporates slowly and the rate of heat loss is diminished. When humidity is low, sweat evaporates quickly and the rate of heat loss is rapid.
4. Radiant heat is the heat produced by the reflective energy of the sun or equipment in close proximity to a human body. The radiated heat is absorbed into the surrounding air or directly into the body. In either case, the body's ability to cool itself is hampered.

9-33. Physiological Factors. Predisposing factors which may adversely effect heat injury prevention are:

1. Illness. Personnel suffering from or recovering from an acute or chronic disease.
2. Previous history. Personnel who have a history of heat illness (exhaustion, stroke or cramps).
3. Skin trauma. Personnel suffering from sunburn, heat rash or other dermatologic malady. The body's heat regulatory mechanism is hampered at the skin surface.
4. Dehydration. Individual's fluid output is greater than fluid intake. Causes include vomiting, diarrhea and insufficient water intake.
5. Fatigue. Physical and mental weariness can cause a lack of concern and result in a failure to take proper precautions against heat injuries.
6. Obesity. Body fat will interfere with the heat regulatory mechanism, cause the individual to expend more energy to accomplish a given amount of work and could be an indicator of poor physical conditioning.
7. Poor physical conditioning.
8. Alcohol and drug use. Alcohol and certain medications, including immunizing agents, decongestants and allergy remedies interfere with the body's heat regulatory mechanism. Alcohol should not be consumed for 24 hours prior to heat stress.
9. Sickle cell trait. Sickling of blood cells impairs circulation and increases risk of injury. Persons with sickle cell trait should be advised of their risks and preventive methods.

9-34. Types of Heat Injuries. The type and number of heat injuries anticipated changes with environmental and physical factors. The spectrum of heat illnesses ranges from mild to severe as body temperature increases as seen in figure 9-23 below. Table 9–7 summarizes prevention, symptoms and treatment methods for each type of heat injury.

1. Heat cramps. These are painful and severe cramps of the voluntary muscles, primarily in the extremities

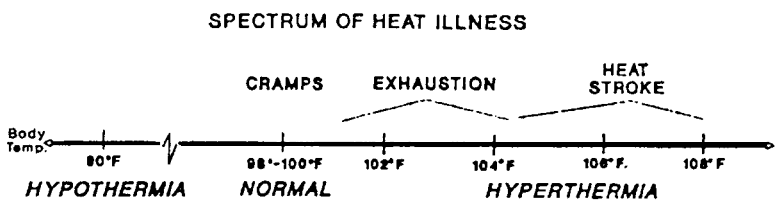

Figure 9–23.

HEAT ILLNESS SUMMARY

HEAT ILLNESS	PREVENTION	SYMPTOMS	TREATMENT
CRAMPS	Training-Education Pre-Exercise Hydration Conditioning-Salt Foods	Muscle Contraction in Legs and Arms	Stop Exercise-Hydration-Extension
EXHAUSTION	Training-Education	N&V-Vertigo-Syncope-Dyspnea Body Temp < 104°F	Loosen Clothing-Monitor Temp. Rectally-Water Spray-Fan-Shade-Replace Fluids-Transport
HEAT STROKE	Training-Education Physical Conditioning	Confusion-Disorientation-Drowsiness-Irrational Behavior, Body Temp > 104° F	Emergency Cooling-Water Spray-Fan-Shade-Water-IV Fluid Replacement Transport
HEAT SYNCOPE	Training-Education Physical Conditioning	Fainting or loss of consciousness while standing in the heat	Emergency Cooling Water Spray-Fan-Shade-Water-IV Fluid Replacement-Transport

Table 9-7.

and abdominal wall. Heat cramps result primarily from the excess loss of salt through sweating. The body temperature remains normal "unless accompanied by heat exhaustion. Treatment includes cooling and fluid/electrolyte replacement.

2. Heat Syncope. Heat syncope occurs when there is excessive pooling of the blood in the extremities, consequently the brain does not receive enough blood. There is peripheral vasodilation to dissipate the heat and if personnel have been standing still they are likely to faint. This is most likely to occur when standing after a march or exercise. Heat syncope may be avoided by not requiring personnel to stand still in the heat, particularly after exercise.

3. Heat exhaustion. Heat exhaustion results from peripheral vascular collapse due to excessive water and salt depletion. Symptoms include profuse sweating, headache, weakness, pallor, nausea, vomiting, mild dyspnea, and palpitations. The casualty may become faint and lose consciousness. The blood pressure may be low, the body temperature may be elevated or normal and the pupils may be dilated. Treatment includes cooling and fluid replacement, taking care that the victim does not go into hypothermia. Heat exhaustion should not be treated with aspirin, or other antipyretics.

4. Heatstroke. **HEATSTROKE IS A MEDICAL EMERGENCY!** It is the result of the collapse of the thermal regulatory mechanism. Early symptoms may include dizziness, weakness, nausea, headache, confusion, disorientation, drowsiness and irrational behavior. The skin may be hot and dry or there may be profuse sweating. The casualty may progress through the symptoms of heat cramps and heat exhaustion with the onset of heatstroke occurring with dramatic suddenness. There may be collapse and loss of consciousness; profound coma and convulsions may occur. Body temperatures rise to the critical levels above 104° F, and may reach 108° F. Treatment must be administered within minutes or irreversible damage or death will occur. Treatment includes **IMMEDIATE** cooling and evacuation to a medical treatment facility. Remove or loosen the casualty's clothing, move to a shaded area, spray or splash with water, rub with ice, (if available); fan to aid the cooling process, take whatever action is necessary to lower the body temperature and do it quickly. Take care that the victim does not go into hypothermia. If a thermometer is available core temperature as measured rectally should be taken as early as possible and monitored continuously. Taking the temperature orally is inadequate. Intravenous normal saline should be given as soon as possible and continued to guard against possible myoglobin-induced renal failure. Heat stroke should not be treated with aspirin or other antipyretics.

9-35. Prevention. The successful prevention of heat injuries depends largely on education of personnel, especially supervisory personnel. Equally important is the development of procedures to alert individuals to the existence of dangerous heat stress levels. The application of measures to reduce both the severity and duration of exposure and adoption of techniques to increase the resistance of exposed persons are:

1. Acclimatization. A period of three weeks is optimal

for acclimatization, with progressive degrees of heat exposure and physical exertion. Note that acclimatization at one level of heat stress does not guarantee any level of acclimatization at higher levels of heat stress.

2. Water Intake

a. Adequate water intake is the single most important factor in avoidance of heat injury. The human body is highly dependent on water to cool itself in a hot environment. An individual subjected to high heat stress may lose in excess of one quart of water per hour by sweating. This loss must be replaced or rapid rise in body temperature and heart rate may occur. This also decreases the ability and motivation to work, and deterioration in morale may occur. These are good indicators of impending heat injury.

b. Personnel exposed to heat must consume water frequently, preferably at 10 to 20 minute intervals. Water should be consumed before, during, and after exercise. The theory that personnel can discipline themselves to do without water is inaccurate and the practice can be deadly.

c. Thirst is not a reliable indicator of the body's need for water. Personnel with ample water supplies will frequently dehydrate by one or two quarts unless drinking water is encouraged or required. Personnel must be trained to drink liberal quantities of water even though they do not feel thirsty. Mandatory water consumption monitored by unit leaders and assigned medical personnel (water discipline) will be required during periods of extreme heat stress exposure. Individuals should be instructed to note the color of their urine. The color should be straw to clear. Dark colored, concentrated urine suggests dehydration.

d. When the WBGT index is above 80 degrees F, water requirements can range from 8 to 10 quarts per person per day, doing light work (i.e., desk work), to 13 to 19 quarts per person per day doing heavy work (i.e., forced march). When water is in short supply, water savings can be made only by reducing physical activity, or limiting it to the cooler hours of the day. Any attempt at water economy by restricting water intake must be paid for in reduced work capability, reduced efficiency and the increased risk of heat injury.

e. The optimum temperature for drinking water is between 50 and 60 degrees F.

3. Salt Intake. In addition to water, salt (sodium chloride) is lost in sweat. An adequate diet is essential to health and normally contains an adequate amount of salt intake when personnel simply salt their food to taste. Salt supplements are not necessary. Unsupervised, routine consumption of salt tablets is contraindicated.

4. Clothing

a. Except when exposed to the direct rays of the sun, an individual in a hot environment is better off wearing the least allowable amount of clothing. Clothing reduces the exposure of the skin to sunlight, but will decrease the movement of air over the surface of the skin.

b. Clothing should be loose fitting, especially at the neck, arms, waist and lower legs, to permit circulation of air, the exception being that trousers must be tucked inside the boots and blouses inside the trousers when operating in an area of tick and mite infestation.

c. Field uniforms must not be starched. The starch blocks the fabric pores and restricts air circulation.

d. The practice of wearing workout clothing specifically designed to restrict sweat evaporation (portable saunas) is not authorized in a hot field environment. The practice is extremely dangerous and has no place in a physical conditioning program.

5. Work Schedules. Work schedules must be tailored to the situation. When temperatures are high, work must be curtailed or even suspended under severe conditions. The temperature at which work schedule modification will take place depends on humidity, radiant heat, wind velocity, character of the work, degree of acclimatization, and other factors. Work can be scheduled during the cooler hours of the day, such as morning and evening, and still meet the workload requirement.

6. In Garrison Area Prevention. The effects of thermal stress can be lessened within an area while in garrison by employing a few shading techniques to provide protection from the radiant sun rays. Camouflaged netting can reduce temperatures inside tents and other facilities exposed to the direct rays of the sun. This is especially important in common use areas such as dining tents, recreation areas, and berthing. Hydration of troops should be promoted by providing protected sources of cool drinking water in numerous locations throughout the camp.

7. Careful monitoring of the WBGT index is essential to the prevention of heat injury (see article 9-36).

9-36. Wet Bulb, Globe Temperature (WBGT) Index.

1. The WBGT Index is the most effective means of assessing the effect of heat stress on the human body. Heat casualties can be expected at WBGT readings of 75 degrees F. and above unless preventive measures are instituted. Heavy work can cause heat injury at lower temperatures especially if body armor or protective clothing is worn.

2. While in garrison, area commanders and commanding officers are responsible for procuring and maintaining WBGT equipment and conducting readings for their area. While deployed to AOs in the field, medical personnel are relied upon to have, operate, and maintain WBGT equipment and post flag conditions. The WBGT kits are found in Appendix C. Procedures, recording, and posting requirements are listed in Appendix C. Careful monitoring and adherence of procedures and equipment maintenance is necessary to ensure valid assessment of WBGT conditions. Ensure readings are:

a. Taken in an unshaded area most likely to reflect conditions experienced by troops.

b. Taken with clean equipment, clean water etc.

c. Taken with appropriate materials, i.e. a clean 100% cotton wick which extends into the water and above the thermometer reservoir.

d. Recorded consistently in a heat stress log.

3. The WBGT Index is a single number derived mathematically from three distinct temperature measurements: wet bulb temperatures, dry bulb temperatures, and globe temperatures. Color coded flags are flown in strategic locations so that all personnel will be aware of the current heat stress index and make appropriate work

schedule adjustments.

a. When the WBGT Index is <80, extremely intense physical exertion may precipitate heat exhaustion or heat stroke, therefore, caution must be taken. A white flag is flown at this condition level.

b. When the WBGT index is between 80 and 84.9, discretion is required in planning heavy exercise for unacclimatized personnel. This is a marginal heat stress limit for all personnel. A green flag is flown at this condition level.

c. When the WBGT index is between 85 and 87.9, strenuous exercise and activity must be curtailed for new and unacclimatized personnel during the first 3 weeks of heat exposure. Outdoor classes in the sun must be avoided when the WBGT Index exceeds 85. A yellow (amber) flag is flown at this condition level.

d. When the WBGT index is between 88 and 89.9, strenuous exercise must be curtailed for all personnel with less than 12 weeks training in hot weather. A red flag is flown at this condition level.

e. When the WBGT index is 90 or above, physical training and strenuous exercise must be suspended for all personnel. (excludes operational commitment not for training purposes). A black flag is flown at this level.

f. Wearing body armor or NBC protective uniforms adds approximately 10 points to the measured WBGT. Limits of exposure should be adjusted accordingly.

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f. Wearing body armor or NBC protective uniforms adds approximately 10 points to the measured WBGT. Limits of exposure should be adjusted accordingly.

Section VI. PREVENTION OF COLD INJURIES

9-37. General.

1. Cold injury is defined as tissue damage produced by exposure to cold. The type of injury depends on the degree of cold, the duration of exposure, and environmental and physiological factors.

2. Cold injury can occur at nonfreezing and freezing temperatures although their pathology will be very similar.

a. Non-freezing, wet cold injuries are associated with prolonged exposure to cold water, dampness or high humidity. Keeping clothing and exposed extremities dry is the primary preventive measure against this type of injury.

b. Freezing, dry cold injuries are associated with extended exposure to subfreezing temperatures, usually 14 degrees F. or lower when the humidity is low. Whole body insulation is the primary preventive measure against this type of injury.

9-38. Environmental Factors.

1. Ambient air temperatures. The rate of body heat loss is inversely proportional to the temperature of the surrounding air. As temperatures decrease, heat loss increases. Air temperatures do not have to be below the freezing point of water to cause cold injuries. Prolonged exposure to temperatures as high as the 50 degree F. range can cause injury depending on other environmental factors and the degree of personal protection.

2. Humidity. Cold injury is due, in part, to the effect of low temperatures on moisture in or on the body. The higher the moisture content, especially on the skin surface, the more rapid the heat loss. As humidity rises, the temperature at which cold injury can occur also rises. High humidity can also induce sweating which will further reduce body heat.

3. Wind velocity. Heat loss is further influenced by wind velocity when humidity is high. Consult Table 9–8 for wind chill equivalent temperatures.

4. Field situation. Personnel in the field do not always have control over their situations or circumstances. Combat can induce prolonged periods of immobilization. Reduced blood circulation and the inability to generate internal body heat will result. Forces on the move, rapid marching, running or riding in open vehicles will greatly increase the effects of wind velocity.

9-39. Physiological Factors.

1. Age. Within the usual age range of sailors and Marines, age is not significant as a factor of susceptibility to cold injury.

2. Rank. Cold injuries are more likely to occur in “front line” troops and predominately those below the rank of E4. The decreased incidence of cold injury among higher ranks is a reflection of a combination of factors such as experience, receptivity to training, and significantly less exposure.

3. Previous cold injury. A previous episode of cold injury increases the individual's risk of subsequent cold injury. However, the individual with a previous cold injury is more sensitive to cold and is more likely to take protective actions.

4. Fatigue. Mental weariness may cause apathy leading to neglect of acts vital to survival.

5. Other injuries. Injuries resulting in significant blood loss, shock, or inactivity reduce effective blood flow to extremities and predispose to cold injuries.

6. Psychological factors. Cold injury is more common in passive individuals who tend to display little muscular activity and are prone to pay less attention to personal protective measures.