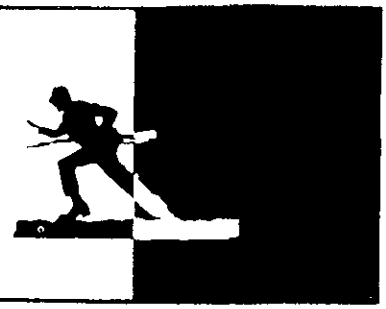
TRAINING NOTES



Training in the Heat

CAPTAIN DEIRDRE CHRISTENBERRY
LIEUTENANT COLONEL DAVID E. JOHNSON

A combat leader's task is never an easy one. He must use the manpower he has to its fullest to accomplish his mission, but at the same time he must not work his soldiers so hard that he loses many of them to combat exhaustion.

He must be aware, too, that combat exhaustion involves mental as well as physical factors. The mental factors enter into it when a soldier is overcome by an awareness of his own physical vulnerability. The leader's job, then, is to build up his soldiers' defenses by helping them to identify strongly with their organization and to believe that their leaders and comrades will take care of them.

But this task is especially difficult in hot climates. A unit's activities are easily and often unduly thwarted by the heat; the troops are frequently incapacitated or injured by the absence of clearly defined policies regarding the heat; and the soldiers fail to take care of their comrades because they have not been taught how to recognize the need or what to do about it when they do.

Leaders therefore need to learn how to lessen their soldiers' biological vulnerability in hot climates. This includes knowing how to recognize physical responses to the heat, how to evaluate the environment in which their soldiers must work, how to plan for and hasten their acclimatization, and how to get the best performance out of them safely by controlling both human and environmental factors.

Exposure to high temperatures places stress on the body. Among the normal physiological responses to this stress are a dilation of the blood vessels in the skin and a corresponding increase in the heart rate. Both of these adjustments increase the amount of heat that circulating blood transfers from the center of the body to the skin, where heat is lost through convection, radiation, and evaporation. But such adjustments place a strain on the circulatory system, and this stress, usually in combination with other stresses such as work, dehydration, and fatigue, may lead first to diminished performance, then to disability and heat disorders.

Heat injuries have been observed at wet-bulb temperatures of 75°F and lower temperatures, expecially if the soldiers must lower temperatures expecially if the soldiers must wear protective equipment.

The environmental conditions that influence the heat equilibrium of the body and its physiological adjustment are humidity, air temperature, air movement, and radiation (the temperature of surrounding objects). The physiological effects of these conditions are influenced by the intensity of activity, physical fitness, and type and amount of clothing.

Heat stress that cannot be adequately relieved by physiological adaptation may result in a variety of heat injuries, the type dependent on the above factors. There are three major types of heat-related injuries — heat cramps, heat exhaustion, and heat stroke. Each of these three conditions produces distinctive signs that should be recognized at once, not only by the physician but also by medical and non-medical personnel in the duty area. Immediate attention is often necessary.

Heat cramps are painful muscle spasms that occur in the extremities, the back, and the abdomen of individuals who drink large amounts of water but fail to replace the salt they lose through sweating. Cramps may

occur during or after exertion, last a few minutes, and then disappear spontaneously. The body temperature is normal unless heat cramps are accompanied by heat exhaustion.

Heat exhaustion is the most common heat-related injury seen clinically. It occurs when the blood volume is reduced by uncompensated salt or water loss during sweating. This in turn results in a blood supply that is inadequate for regulating the heat and taking care of other bodily needs.

A soldier with heat exhaustion may experience extreme weakness or fatigue, dizziness (including fainting), loss of appetite, nausea, headache, abdominal distress, vomiting, shortness of breath, and increased pulse rate (120-200 beats per minute at rest). The skin is clammy and moist with either flushed or pale complexion, and the body temperature is usually elevated to the range of 99-104 °F (37-40 °C). If untreated, heat exhaustion can progress to heat stroke.

Heat stroke occurs when the temperature regulating system breaks down under heat stress and, consequently, sweating stops. And when sweating stops, the body loses its most effective means of removing heat. Temperatures can then rise to critical levels, and the victim may die unless he gets immediate first aid. (First aid for a victim in the field should include removing his excess layers of clothing, dousing him with water, and then transporting him for medical care.)

A heat stroke victim has hot, dry skin, which can be red or spotted; he is mentally confused or delirious, may have convulsions, and may be unconscious. His body temperature is generally 106 °F (41 °C) or higher and rising. Body temperatures this high must be reduced immediately.

A leader can avoid such extreme heat-related injuries if he learns how to evaluate the environment and the health of his troops.

Of the various devices available for determining thermal stress, both the Wet Bulb Globe Temperature (WBGT) Index and the Botsball thermometer reflect the cumulative effects of the radiant heat, air temperature, humidity, and air velocity in manners that most closely correlate with the actual heat stress placed upon the human body. (Both are readily available through the supply system.)

The WBGT Index is the one most widely used for characterizing the effect of heat stress on a person. It was developed for military training in which conditions of high solar radiation are encountered. It has proved very successful in evaluating heat stress and reducing heat injuries. (The WBGT Index has been adopted as the standard by the American Conference of Governmental Industrial Hygienists as the principal index for heat stress.) It does have some drawbacks, however. It is expensive and easily broken, and it requires pencil and paper calculations.

BOTSBALL

The Botsball thermometer, which has recently been determined to have an excellent correlation with the WBGT Index, consists of a single-dial thermometer with a heat sensor enclosed by a six-centimeter black copper sphere completely covered with a black cloth. The cloth covering is constantly moistened by water from an attached reservoir. (See "The Botsball," Major David E. Johnson, INFANTRY, July-August 1981, pages 42-43.)

Outdoors on hot days, the globe of the Botsball is generally warmed by the ambient air and radiant heat and cooled by the evaporative effect of the wind and low relative humidity. Equilibrium is established when these heating and cooling effects come into balance. The Botsball temperature is a direct physical measure of the thermal environment and an extremely good index of human response to that environment.

The Botsball is the simplest, cheapest, most portable, and most accurate piece of equipment available for monitoring heat stress.

Preventing heat stress depends largely upon educating personnel — those exposed to heat and especially those charged with command and leadership responsibilities. Specifically, troops should be alerted when dangerous heat conditions exist; measures should be taken to reduce the severity and duration of their exposures; and techniques should be adopted to increase the resistance of soldiers who are exposed to the heat.

The degree of body heat load can be lessened in various ways — by reducing physical activity, by increasing the frequency or duration of rest or relief periods, and by reducing the heat of the environment. Resistance is increased by gradually acclimatizing soldiers to hot environments, by replacing water and salt that has been lost, and by physically conditioning the soldiers.

The human body is highly dependent upon sweat production for cooling. Soldiers who are subjected to the stress of heat may lose excessive amounts of water. If this water is not replaced, body temperature and heart rate will rise rapidly, ability and motivation to work will decrease, morale will deteriorate, and heat exhaustion will eventually occur.

Thirst is not an adequate stimulus for water intake. Soldiers should drink from 200-300 milliliters (about one pint) of water every half hour throughout the training period regardless of their desire to drink. (The water should be cool but not iced.) Carbonated beverages, especially those containing alcohol, a diuretic, should be avoided because they quench thirst. Flavoring or sweetener can be added to overcome the taste caused by chlorinating and salting water without making the drink too filling.

Salt, in addition to water, is lost in sweat. Unless a person is sweating continuously, he does not need salt tablets or saline fluids during the first few days of exposure to heat. The safest procedure is to replace salt losses with food intake at mealtimes. If salt must be replaced during heat stress, it should be in fluid form. A convenient way to provide enough salt to a large number of soldiers is to salt all their drinking water to a concentration of 0.1 percent.

It should be noted, however, that so much salt intake can reduce the sweat production rate and therefore increase heat accumulation. This, in turn, can result in the elevation of body temperature.

Heat acclimatization programs for personnel should be assessed in terms of the duration and the intensity of their exposure to heat (see accompanying table). A period of about two weeks with progressive degrees of heat exposure and physical exertion should be allowed for acclimatization. During this period, soldiers should be exposed to heat for several hours each day while undergoing reasonably heavy training. The heat tolerance they develop during this time will continue to increase, but more slowly, for several more weeks. The most important changes in the troops will be an increase in their sweat rate (increased evaporative cooling), an increase in blood fluids, and a decrease in the rate of salt excretion through sweat and urine. If soldiers are required to perform heavy physical training before they are properly acclimatized, their training will tend to be poorly performed, their acclimatization will be retarded, and their risk of heat injury and disability will be high.

A schedule should be established for increasingly longer training periods alternated with rest periods. The intensity of the training affects the length of time during which training can be healthfully sustained since training itself generates body heat. Once they have become acclimatized, soldiers will retain most of their adaptation for about one week after leaving the hot environment. The acclimatization will then decrease at a variable rate, with most of it being lost, usually, within one month.

CONDITIONS

A soldier's physical condition has a significant bearing on his reaction to heat stress. His susceptibility to the ill effects of heat may be increased by:

- Acute and chronic infections, including convalescence.
- Fevers.
- Reactions to immunizations.
- Vascular diseases.
- Diarrhea.
- Conditions or drugs that decrease sweat secretion.
- Skin trauma, such as heat rash or acute sunburn.
- Previous occurrence of heat stroke.
- Recent use of alcohol (24 hours).
- Chronic use of diuretics.
- Dehydration.
- Lack of sleep.
- Fatigue.
- Obesity.
- Poor physical condition.
- Increasing age.

The risk of heat injury is greatly increased in overweight, unfit soldiers, and special care should be exercised when such persons are exposed to high temperatures. One attack of either heat stroke or severe heat exhaustion (but not heat cramps) predisposes a person to a second attack. An individual once affected should therefore be exposed to subsequent heat stress with caution.

Higher heat exposures than those shown in the table are permissible if the soldiers have been undergoing medical surveillance or have been carefully acclimatized, and if it has been determined that they can tolerate training in heat better than the average soldier.

Work and training schedules should be tailored to fit the climate, the condition of the soldiers, and the situation or potential threat. Close supervision is essential if the most training or work is to be achieved with the least hazard. As the amount of heat produced by the body increases with the workload, certain schedule modifications should be considered.

Either the workload or the duration of physical exertion, or both, should be less during the first days of heat exposure and then increased gradually to allow acclimatization. Heavy work should be scheduled, if feasible, for the cooler hours of the day (early morning or late evening).

Training and work in the direct sun should be avoided as much as possible on hot days. Alternating training and

WORK REGIMENS FOR HEALTHY, UNACCLIMATIZED WORKERS IN HOT ENVIRONMENTS

Work-Rest Regimen (Continuous Work per Hour)	WORK LOAD									
	Light		Moderate				Heavy			
	WBGT		Botsball		WBGT		Botsball		WBGT		Botsball	
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
100% work	30.0	86.0	26.9	80.4	26.7	80.0	24.3	75.8	25.0	77.0	22.9	73.2
75% work 25% rest	30.6	87.0	27.3	81.2	28.0	82.5	25.4	77.6	25.9	78.6	23.7	74.6
50% work 50% rest	31.4	88.5	27.9	82.3	29.4	85.0	26.4	79.6	27.9	82.3	25.3	77.5
25% work 75% rest	32.2	90.0	28.5	83.3	31.1	88.0	27.7	81.9	30.0	86.0	26.9	80.4