GARY MYERS ON HEAT STRESS

As you descend to the wooded valley floor from the long escarpment trail, the cool breeze ruffling your hair moments ago disappears. The forest around you steams in the afternoon heat. A mile later your sweat is flowing, your breath is rasping, your heart is pounding. Your pack seems heavier, as if gravity were somehow stronger here nearer the center of the earth. Another mile and the dead, hot air is unsatisfying; your rasps become gasps. Rivers of sweat pour into your eyes, stinging; torrents cascade down your back and off your chest to pool above your belt at buttocks and navel. You shuck your pack and stumble to the nearest log exhausted, luminously hot, dizzy and nauseous. You're mildly thirsty, but the canteen is out of reach and your jellied legs won't lift you to it. You'd like to curse, but you haven't the energy. Your head is pounding. Between throbs, a thought surfaces. **This is supposed to be fun?**

This little scenario is repeated—with variations—time and again, whenever backpackers, cyclists, and canoeists venture forth in a heat wave. Are the stricken only the pasty-faced weekend wanderers, the fair-weather wilderness faddists? Not necessarily. Heat stress can exact its toll from anyone who is unprepared.

As a homeotherm, man must continually lose heat to this environment to survive. Heat production in muscles and deep tissues is a result of oxidative combustion of fuel in the form of carbohydrates, fats and proteins. Sitting quietly, the average man produces about 400 BTU/hour. Casual walking raises heat production to about 800 BTU/hour; carrying a moderate load increases the value to as much as 1600 BTU/hour, and the hardest sustained work pushes it up to 2400 BTU/hour.

As work output increases, the deep-body (core) temperature rises. The temperature-regulating centers of the body sense this core temperature increase (largely through increased blood temperature), and initially respond by increasing the blood supply to the skin; there the blood can be cooled by contact with the air. If this isn't enough—and it usually isn't if work output and/or air temperatures are much above normal—sweat glands are stimulated to secretion, to add an evaporative cooling effect. The number of glands activated (and the rate of their secretion) depends on the rate of cooling needed to prevent the core temperature from rising above 102° F.

As the blood supply to the skin is increased, heartbeat and respiration rate rise in an attempt to compensate for the decreased blood supply to muscles, organs, and brain. A limit is soon reached, however, and though the heart pumps valiantly it simply can't get blood back to it fast enough to supply the oxygen demand of the laboring muscles. Muscle and organ

systems partially shut down, much as in an electrical brownout, since the body's main priority at this point is the prevention of overheating. Forced into a continuation of work output, oxygen-starved muscles begin to derive their energy from anaerobic metabolism of muscle glycogen; lactic acid is produced, accumulates in tissues, and impairs contractions. The result is rapid fatigue.

Reduction in blood supply to the viscera causes reduced appetite and constipation. Meanwhile the brain—in an unfavorable gravitational position to start with—responds to this condition by reducing activity. One's senses are dulled, and lassitude sets in. In some cases, this process may extend to loss of consciousness.

When capillaries become dilated, they also become more permeable to blood fluids. Leakage into the surrounding tissues is increased, reducing the total blood supply and aggravating the above conditions. Legs, feet, and ankles may swell and become puffy, because gravity opposes the return of this fluid through the lumphatic system.

Under extreme conditions, sweat rates may exceed ½ gallon per hour. This is a serious drain on body fluid reserves, including blood volume. Loss of salt easily may exceed intake, leading to a reduction in chloride concentration in the body fluids. The body attempts to restore chloride balance by eliminating water, causing further dehydration. Giddiness, headache, and nausea ensue.

The net result of heat stress, then is **dis**tress. Let's examine the heat-related disorders that the wilderness traveler might encounter.

Heat Cramps

These painful spasms of the arm, leg, or abdominal muscles, usually those which are being called upon to do the most work, are caused by large water intake without adequate salt replacement. The resulting upset in chloride balance permits osmotic transfer of water into active muscle fibers. Lightly salted water or electrolyte/glucose drink (Body Punch, Sportade, Gatorade) should be taken. Recovery is usually rapid if salt is replaced.

Heat Exhaustion

This is the most common heat disorder. Symptoms are extreme fatigue, giddiness, nausea, and headache. The skin is clammy and moist, and can be either pale or flushed. If the victim is sitting, he may faint on standing. He may exhibit a weak pulse. Caused by depletion of body water because of insufficient water or salt intake (often both). In the former case, urine is highly concentrated and small in volume, and thirst is powerful; in the latter, urine is dilute and of near-normal volume, and thirst is less prominent—or even absent. Treatment is relatively simple. The victim should rest in a cool area, either lying on his back with his knees up or seated with his head down. Lightly salted water or electrolyte/glucose drink should be swallowed in moderate amounts, but at frequent intervals. Recovery should be rapid if treated promptly, but cases of extreme salt depletion may require medical treatment.

Heatstroke (Hyperthermia)

Sometimes called sunstroke, but this term is obsolete and inaccurate. This condition is **EXTREMELY SERIOUS!** Symptoms are: hot, **dry** skin which is red or mottled, or even bluish in the face area with blue lips and tongue; temperature of 106° F and rising; and mental disorders, including confusion, delerium, and loss of consciousness, and convulsions. Condition results from failure of the thermoregulatory centers and the resultant depression of sweating. It is a **major medical emergency.** It is **irreversible** and **uniformly fatal** if untreated! First aid treatment is to cool the entire body rapidly, without delay. This may be accomplished by immersion in cool water accompanied by vigorous massage of the skin, or by soaking the clothing with water and fanning rapidly. Cooling should be interrupted when body temperature begins to fall, since too much cooling may induce shock. Professional medical treatment is imperative, as serious organ damage may have occurred—but first aid treatment **must** be immediate; do not delay first aid while awaiting the arrival of a professional. Fortunately, true heatstroke is rare in the context of this article, and is usually prevented by incapacitation from heat exhaustion.

Like most of life's unpleasantries, heat disorders are avoidable. Here are some proven hints which may help you avoid heat cramps, heat exhaustion, or worse on your next outing.

1. **Keep in good physical shape.** Physical fitness alone will not prevent heat disorders, but it will improve heat tolerance ot a degree. Obesity contributes heavily to heat disorder susceptibility, so try to shed those extra pounds before your next July trip.

2. **Acclimatize yourself.** If possible, perform hard work in the heat each day for an hour or two, for at least ten days prior to your trip (be careful not to overdo it the first few days—the idea is to **prevent** heat disorders, not **cause** them!) The body will adjust to hot work over this period, primarily by increasing blood and other fluid volume, and by greatly reducing salt concentration in the sweat. Once achieved, acclimatization will last up to a week after the last heat exposure.

3. **Avoid immoderate amounts of alcohol** prior to and during the trip. Alcohol suppresses the pituitary's antidiuretic hormone production, leading to excessive loss of water; similar effects may result from the use of other drugs. Industrial cases of heatstroke have been attributed to excessive alcohol intake.

4. **Dress properly.** The head is well-supplied with blood, so shield it from the sun with a light-colored hat or pith helmet. Conversely, doff your headgear in the shade to allow cooling air to circulate about the head. Light-colored clothing materially reduces the heat input from direct sunlight, but all clothing impedes cooling by sweat evaporation. Laboratory tests have shown that, in the absence of direct radiant heat in air temperatures below 95° F, less clothing means more comfort (these tests did not, however, consider the effect of mosquitos and black flies). In direct sunlight or air temperatures above 95° F, the wearing of lightweight clothing increases comfort.

5. **Drink plenty of water, and make sure your salt intake is adequate.** Water lost by sweating **must** be replaced if heat disorders are to be avoided, and this can require an intake of more than ½ gallon per hour. Drink whenever you're thirsty...and then some; tests have shown that most people who are not used to hot work tend to drink less than they need. If you're well acclimatized, normal salting of foods will be adequate to assure salt replacement. Chances are that you won't be completely acclimatized unless you work in a steel mill or foundry, so initially you should supple-

ment your salt intake. Drinking lightly salted water (1 teaspoon of salt per gallon) or increasing salt on foods is an easy way. Electrolyte/glucose drinks are excellent, and some can be obtained in dehydrated form for trail use. Salt tablets are ok also, but cause gastric distress in some people. Excess salt will be excreted in the urine, but don't overdo it: 15 grams (2-3 teaspoons) of extra salt per day is all you're likely to need. If your trip is an extended one in hot weather, you should cut down on your salt supplement after the first 5 days, since acclimatization will be well underway and salt loading of the body should be avoided.

6. **Pace yourself.** Individual tolerances to heat vary widely. Generalizations are possible: stocky individuals, with their lower surface-to-volume ratio, dissipate heat less effectively than do wiry types—but on the other hand, people who are downright skinny tend to have low heat tolerance. The fat person has several factors working against him, and generally doesn't tolerate heat well; women tend to have lower heat tolerance than men. In the final analysis, **you** are the only judge of your ability to perform in hot weather.

If you can't stand the heat, get off the trail. . . and rest until you're cool. It will save you the discomfort of heat cramps or the debilitating effects of heat exhaustion. It may even save you your life.

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