TRAINING SAFETY TIPS FOR LONG DISTANCE RUNNERS

By John Robertson, M.D., Seattle, Washington

The following paper was presented by Dr. John Robertson at the latest TAC Convention. Robertson is Chairman of the Long Distance Running Safety Sub-committee. While the information presented on training and racing in hot weather is valuable, it is his presentation on altitude training that may be most relevant for today's coaches.

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Heat Stress Problems

70% of the energy developed by runners is in the form of heat. Thus a runner only spends 30% of his energy actually in locomotion. Heat is a real danger. Along with traffic accidents, heat can contribute to injuries that can lead to the death of runners.

Heat is dissipated by being conducted to the surface of the body where a small amount of it is irradiated to the atmosphere and a large amount of it is lost by the physical act of evaporation of sweat. The body can sweat at a maximal rate which is twice as fast as the maximal rate that it can absorb fluids from the gastrointestinal tract. Thus it is impossible to work at a sustained rate continuously just on heat and fluid loss alone. If 3% or 4% of the body weight is lost, there is a decrease in actual measurable performance. As the body continues to generate heat its internal temperature (core temperature) increases. After running for one hour the average runner's core temperature is 103 degrees Fahrenheit. There is a critical core temperature in which the body no longer functions and metabolic processes start shutting down. That is a 107 degree core temperature, which is equivalent to a 106 degree oral temperature.

Alberto Salazar's sweating rate is approximately 3 liters of fluid per hour. A normal individual sweats during maximal exercise 1 to 2 liters per hour. Thus the environment in which a runner competes in truth limits his performance by his ability to lose heat and fluid. It should be known that the fluid lost is most conveniently measured as loss in body weight. If one loses 1 lb. he has lost 1 pint of fluid. If one loses 1 kg. of weight, he has lost 1 liter of fluid.

The ideal temperature for prolonged work or distance competition running is between 50 and 65 degrees Fahrenheit. At 65 degrees Fahrenheit there are virtually no thermal injuries sustained in large road runs. When the outdoor temperature reaches 70 degrees there is a 1% incidence of heat injury among competitors in road runs lasting over 30 minutes. At 75 degrees there is a 3% incidence of heat injury, at 80 degrees there is a 5% heat injury rate. It has been established that above 82 degrees environmental temperature there should be no competition in races over 3 miles or 5k. This is illustrated by the fact that the Gulf TAC Association will not sanction any races that occur during the months of June, July and August at which time the environmental temperature exceeds 82 degrees 24 hours a day.

Heat injury is a combination of dehydration and excessive internal temperature elevation, or hyperthermia. A loss in fluid results in a critical loss in circulating blood volume. To prevent injury to vital internal organs such as the brain, the liver, the kidneys, the body automatically shuts down circulation to the skin. Thus the hotter one's internal temperature becomes, the more fluid they lose, and the more fluid they lose, the less ability they have to lose further heat through sweating. Heat injury is addressed primarily by re-infusing fluid and establishing a cooling surface where heat can be conducted away from the body. If heat injury is not treated promptly there is a very poor prognosis, with a reasonably high fatality rate. The institution of fluids and cooling is mandatory to commence promptly within the first 15 minutes of collapse. If the temperature is not normalized within 1 hour, the fatality rate increases markedly. Thus it is not appropriate during hot days to rely on competitors to tell race personnel that there is a runner who is in trouble on the course, for such a delay could well be fatal in delivering effective treatment to combat hyperthermia.

There can be some acclimatization to one's environment. Wearing sweat clothes while training in warm environments will allow the body to somewhat adapt its

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A classic example of hot weather racing—the 1988 Olympic Trials 10K in Indianapolis.

response to hyperthermia. More importantly, it is very difficult for an untrained competitor to consume and absorb fluids at a rate fast enough to allow a high level of competition. In truth, training for fluid drinking needs to be pursued. The suggestion of 12 to 16 ounces of water approximately 5-10 minutes before running and the continued ingestion of 3 to 6 ounces every 15 minutes during running is recommended but may not be initially well tolerated by runners who are not trained in consuming fluids this rapidly. Another factor that needs to be addressed by the runner who is running in warm environments is the consideration of loss of fluids through diarrhea, etc. Large amounts of fluid can be lost through loose bowels and thus limit the competitor's ability to compete. It is difficult to treat such diarrhea, for the medications that stop the overactive bowel reduce blood flow to the skin and thus limit effective sweating. The replenishment of fluids is mandatory, the use of antidiarrheal drugs is dangerous.

Fluid and Nutrition Tips

Carbohydrates are the major fuel used during endurance activities, and must be replaced during and after exercise.

Rule 1.

Do not take carbohydrates during the 90 minutes before a race. Drink plain water instead. Rebound hypoglycemia occurs secondary to a high insulin production in response to the taking of the carbohydrates. During the initial phases of competition, blood glucose is rapidly lowered by exercise but the insulin is left unbalanced. Rebound hypoglycemia occurs and it is not unusual to find runners falling to the ground or certainly hitting the "wall" sooner from the starting line after drinking orange juice or other sugar based drinks immediately before the race.

Take carbohydrates *during* the race, and within 15 minutes at the end of the exercise period. There is evidence that the repletion of liver and muscle glycogen, which is the main storehouse for blood sugar, is more effective when "carbos" are consumed within the first 15 to 30 minutes at the end of intense or prolonged exercise. Liquid sources are tolerated best.

Rule 2.

What type of Glucose to take?

Glucose Polymers are a combination of glucose molecules which have been tied together into a single megamolecule by polymerization. If one consumes glucose or table sugar (sucrose) before or during running the concentration of the liquids in the stomach bring water out of the blood and hence causes nausea and perhaps some minor degree of dehydration. Using a glucose polymer allows one to have six to eight times more glucose available in a dilute non-concentrated solution in the stomach during exercise. Thus, the same volume of water carries 6-8 times more available carbohydrate to exercising muscle and prevents hypoglycemia or hitting the "wall" during intense or prolonged exercise.

Cold Environment Problems (Hypothermia)

The heat production by runners during competition and training is immense. This heat is dissipated primarily through the head and skin surface with the most ample circulation near the skin of the face, scalp and the neck. Heat loss from the arms and legs is more of a local problem of cooling hands, for feet are actively participating in work and encased in shoes. Hands and the body should be covered with gloves and a sweatsuit and perhaps layered clothing with pockets of air in between each layer which can be shed or donned in succession as the environment and the running activity changes. There is very little danger of hypothermia or cold injury to runners who are running or jogging. The most at risk group are marathon runners who "hit the wall" at 20 miles and walk in the rest of the way. While walking, their body can rapidly chill and become hypothermic.

Altitude Training and Racing

Training at altitude is probably less of a learned art than was previously thought. The benefits of altitude training accrue primarily to those who are born and reared in this environment. While acclimatization can occur and be of benefit, the maximum benefit with true changes in tissue oxidation and gas exchange in the lungs occurs only in permanent residents of altitude.

Training at altitude for short term gain needs to be staged. When training at 2000 meters elevation (6500 feet) approximately two weeks is required to reach a static balance of exercise and performance at this modest elevation. At 2500 meters (8200 feet) it takes approximately four weeks for this equilibrium to occur.

Training at altitude with acclimatization and adaptation involves several levels of adaptive change.

Transportation of oxygen molecules from the atmosphere to the blood stream and hence to the muscle cells occurs in a chain-line fashion. There are fewer molecules of oxygen available at elevated atmospheres and aerobic metabolism is limited by the availability of oxygen. The first link in the chain is the runner's ability to move the atmospheric oxygen into his lungs rapidly enough to allow oxygenation of the red blood cells as they pass through the lung circulation and before they are pumped back to the exercising muscles. Thus the efficiency and mechanical act of breathing is a limiting factor as to how well one can run at altitude. The maximum ability to move air in and out of the lung varies among individuals. Approximately two weeks of altitude training is required to improve one's maximal breathing capacity to allow one to breathe more comfortably at high breathing rates while exercising.

The second link in the chain occurs simultaneously with the first. This link is the transference of oxygen molecules from air within the lung into the blood stream and onto the red blood cells. This is called the diffusion of oxygen through the lung. This is a major limiting factor in how much oxygen one is maximally able to pick-up over a given time while exercising at a given work rate. Aerobic metabolism is gradually replaced by anaerobic metabolism as one approaches 75% of maximal aerobic work rate and becomes almost totally insufficient when one is working over 85% of maximum work rate. Thus approximately the last 15-25% of work intensity on the way to reaching your maximum aerobic work intensity is performed in an anaerobic (without oxygen) manner. As oxygen molecules become fewer at higher elevations, the anaerobic threshold occurs sooner as one approaches his maximum working capacity.

The pulmonary blood flow through the lung at rest is usually limited to the lower portions of the lung in the upright posture. As one ascends in elevation there is a more uniform blood flow distribution toward the top of the lung utilizing more of the lung at lower work rates and improving the lung's efficiency at an earlier stage. This becomes more pronounced with acclimatization to altitude. The real change in altitude is the ability to get oxygen to muscles by an increase in the number of red blood cells. An increased density of red blood cells occurs in three to four weeks of residence at elevations above 3000 meters. Hence the majority of the improvement during the last two weeks of residence at 3000 meters is that of an increasing red cell mass.

Thus in effect the athlete performs his own "blood doping" by living at altitude. This blood doping effect rapidly dissipates upon return to sea level so that its total effect has been negated within seven to ten days after descent.

Unfortunately, it seems relatively difficult to change one's maximum oxygen capacity ($V0_2$). Improvement in cardiac parameters occurs in a much slower time frame, with increased strength of the right side of the heart pumping the blood into the lungs taking many months to develop. Changes such as these are probably limited to permanent residence.

Death During Exercise

Every year two to four athletes may die in any area which has an active distance running program. A heart attack occurs in one of every 10,000 marathoners per year. These are usually runners who are trying to beat their genetic endowment. It is not unusual to expect a runner who manifests the Jim Fixx profile to die during competition. individuals who have a very strong family history for heart disease, who have high blood pressure, hypercholesterolemia (serum Cholesterol above 260), diabetes, and smoke cigarettes are a walking disaster for cardiovascular disease. lt is doubtful that exercise can deny these individuals the endowment of a premature death from heart disease. Other measures to reduce their risk must be taken prior to participation in road races.

How to monitor and assess the health of a large group of runners in a road race is a very complicated and perhaps un-solvable problem, at least at this time. However, it is essential that the race medical committee is prepared to deal with heart attacks during road races.