Dehydration and Heat Injury

**Humidity is not your friend.** The rate of sweating is higher in humid conditions but the cooling is less. The reason is that because the air is already very saturated with water, sweat can't evaporate. Sweat that beads up and rolls off doesn't function in the cooling process. However, this "futile sweat" does deplete the body of vital water and salt. As dehydration progresses cooling becomes more difficult. Performance drops and heat injury becomes a real threat. Deaths have occurred when the air temperature was less than 75 degrees F (24 degrees C) but the relative humidity was above 95%.

**Recognizing symptoms of heat injury.** There are three stages to heat illness; heat cramps, heat exhaustion, and heat stroke -- listed in order of increasing severity. Often the border between them is blurred into a continuous spectrum. Heat cramps are due to muscle spasms and often occur in the arms, legs, or abdomen. They are thought to be caused by dehydration and loss of salt and other electrolytes. Heat exhaustion is due to more profound loss of water and electrolytes. It is characterized by generalized weakness, headache, dizziness, low blood pressure, elevated pulse, and temperature elevation as high as 104 degrees F (40 degrees C). Both can usually be treated by moving out of the sun, drinking fluids, and eating salty food.
Prevention

As with most diseases, preventing one is always better than getting one. The environmental conditions that lead to dehydration and heat illness are out of your control, but there are many things that you can do to help prevent getting sick.

Clothing. Your choice of clothing can influence your cooling efficiency. Light colored clothing reflects light and so is cooler than dark colored clothing. The traditional black cycling shorts are not good for exercise in hot climates -- white is a better choice. Loose, lightweight material allows for better air circulation and facilitates evaporation of sweat. Clothing that is dry slows down evaporation of sweat, but once wet, cooling continues. Thus, changing into dry clothes during transitions is not a good idea. If practical, wear your biking clothes under your wet suit. This makes for a faster transition and ensures that the clothes are wet when you start the bike leg.

Adapting to the heat. One tried and true piece of advice is, "Make no new changes on race day". The same applies to environment. Heat acclimatization is a process by which the body makes adjustments to promote better cooling in hot environments. Sweat becomes more dilute. The threshold at which sweating begins is lowered and the sweat rate is increased. These, and other, changes take time to fully complete -- about 10 days of exercise in the heat -- and will only work if you are well hydrated. Make sure that you are properly adapted by training in conditions that you will experience during the race.
Some medications interfere with cooling. Certain drugs may cause dehydration or interfere with sweating. Antihistamines and some blood pressure medications decrease sweating. Caffeine and alcohol are diuretics and thus cause your body to lose water. You should avoid their use for several days prior to the race. For those under a physician's care it is best to check with your doctor about medication -- and about your ability to race in the heat.

Drink before, during, and after the race. Hydrate thoroughly the day before the race. How do you know if you are drinking enough? A good sign of hydration is the output of large volumes of clear, dilute urine.

Hyperhydrate just before the start of the race. Drinking approximately 400 - 600 ml (13 - 20 ounces) of cold water or an electrolyte solution can help delay the process of dehydration.

It may seem obvious to drink during the race, but many people underestimate the magnitude of their fluid loss. It is very difficult to avoid dehydration during a long race in the heat because the rate of sweat loss usually exceeds the rate of absorption of ingested fluids. The maximum rate of fluid absorption by the gastrointestinal (GI) tract during exercise is approximately 800 ml per hour (27 fluid ounces/hr). The rate of fluid loss through sweating may average as high as 1.5 - 2 liters per hour (50 - 68 fluid ounces per hour). Thus often, despite the best fluid intake, dehydration will occur. Drinking 150 - 250 ml (5 - 8 ounces) every 10 - 15 minutes is probably the best way to attempt to stay hydrated while racing. For some people, drinking a lot causes discomfort and a feeling of being "bloated". Thus guzzling a liter once per hour will likely cause problems. Also realize that the more dehydrated you get the harder it is for your GI system to absorb what
you drink. Dehydration also causes a variety of GI symptoms (nausea, cramping, and diarrhea). You must determine and plan you hydration strategy ahead of time.

**Choice of fluid**

A full discussion of all the available beverages and the science behind their content is beyond the scope of this article. For races lasting less than 1 hour, water alone is adequate. For longer races, there are many commercially available sports drinks. The most important features are taste, carbohydrate and sodium content.

Taste is important, because if you don't like it you won't drink it. Don't try a new sports drink on race day. Carbohydrate content in the range of 4 - 8% is best for endurance races. Levels above 10% are poorly absorbed and can cause diarrhea. Most sports drinks have a sodium content in the range of 10 - 20 mmol/liter (Gatorade is 23 mmol/liter = 1.3 grams of salt per liter). Higher levels are better for salt replacement, but tend to be less palatable. There doesn't appear to be any advantage gained from adding other electrolytes (e.g. potassium, magnesium) since the diet is usually adequate to replace these.

**Why is Salt important**

Sweat contains between 2.25 to 3.4 grams of sodium chloride per liter. A sweat rate of 1 liter per hour would thus cause a salt loss of 27- 40 grams for a 12 hour race. Failing to replace salt during the race can result in hyponatremia (low salt concentration in the blood). From experience with the Hawaiian Ironman, Hiller (1) has recommended that athletes ingest an average of 1 gram of sodium per hour for hot races lasting longer than 4 hours. (2.5 grams of sodium chloride has 1
gram of sodium and 1.5 grams of chloride. One teaspoon of salt weighs approx. 6.6 grams) It is also advisable to increase salt intake for several days before a long race.

**Exercise intensity and duration**

The higher the intensity of exercise the greater heat production by the muscles. Overheating causes more sweat production. The net fluid lost per hour is greater for an Olympic distance triathlon than an ultradistance event. However, the much longer exercise time in an ultradistance race causes a greater problem with dehydration.

Never forget that how hard you push yourself during a race is under your direct control. You can hammer, dehydrate, not finish and hurt yourself, or you can slow down, finish the race and survive. When faced with unusual circumstances be conservative and cautious.

**Know your body**

There is large variability between individuals with respect to net water loss while exercising in the heat. This depends upon sweat rate, rate of fluid ingestion, rate of gastric emptying, type of fluid ingested, percentage body fat, and many other variables. Because of this there is no simple answer for which fluid to drink, how much, and how often. So how do you know what is right for you? The best way to determine this is to test yourself (see fluid balance test) > Often we spend a lot of money and time on equipment, but neglect determining our body's needs. You should become familiar with what you need to do to stay hydrated under a variety of conditions. Keep a training log about your experiences. Change only one variable at a time to develop a plan that works.