Coping with Dehydration Using Glycerol Infusion

by David E. Martin, PhD, Sports Science Editor

The approaching warm weather months once again bring about the challenge of training and competing in the heat for a large region of the nation. Although few U.S. marathons are scheduled during the warm summer months, the chances are fairly good that some spring and early fall marathons will experience unseasonably warm weather. But training in warm weather must continue if competitive summertime fitness is to remain high, especially for the road circuit. Athletes racing at distances longer than 10 km must maintain their patterns of long weekly runs (20 miles or longer), coping with the heat the best way they can. We all know that the body has a powerfully effective cooling mechanism in the evaporation of sweat from the body surface. This process is only effective when there is plenty of available body fluids. *Is simply drinking lots of fluids after such runs adequate for maintaining normal hydration?* Or is it essential to drink fluids on the run during warm weather? Are there any alternatives that might be helpful? Plenty has been written about the benefits of various combinations of water and electrolyte beverages, but a new technique, namely, **glycerol hyperhydration**, has received little mention. This is described herein, together with a brief review of the dynamics of fluid intake and outgo during warm weather, which might be helpful for runners preparing for another warm summer.

Failure to maintain adequate body fluid levels in warm or hot weather produces **hypohydration** - scientific lingo for a reduced body water content. The process of losing body fluids is termed dehydration, and it occurs typically because of a combination of excessive fluid loss (by sweating) and inadequate fluid intake (through drinking). Fluid losses through sweat from fairly vigorous running on a warm day can easily reach1 to 1.5 liters per hour. For some who sweat profusely, this loss might reach two liters per hour during the first few hours of a hot weather race. Even under the best of conditions, however, fluid intake due to absorption of ingested fluids will reach barely one liter per hour. Thus, while fluid intake both during and after training and racing over long distances is important, having plenty of fluids on board *before* exercise begins is crucial.

During shorter training runs, and events such as a 10,000 meter race, elite-level runners typically do not drink fluids. There are at least two reasons. First, the race distance is short enough that neither fluid nor energy losses are sufficient to impair performance. Second, fluids may not be conveniently available. An additional aspect occurs during the racing situation, in that the high work intensity (about 92% of VO2-max pace for a 10 km race) greatly reduces bloodflow to the gastrointestinal system, due to its being shunted to the working skeletal muscles (for oxygen provision) and skin (for heat dissipation). Thus, absorption is reduced, and runners may be left with a bloated feeling and possible gastrointestinal distress if they attempted to drink. Despite this situation with the elite runners, it is common, however, to provide fluids during large road races conducted in hot weather. Many of the slower runners who are not working so intensely may be on the course for as long as an hour or more. Indeed, they may feel thirsty, and enjoy a brief stop to take a cool drink.

Longer races, however, such as marathons and ultra-distance events, are raced at a slower pace. As an example, the marathon is more than four times longer than a 10 km race, and is typically raced at from 80 to 85% of VO2-max pace. Not only does this slower pace make it easier for everyone to drink a cup of fluid and absorb it, but also specific provision for this is made along the race route - at water or energy replacement stations. It is during runs of greater than 30 km - very long training runs, marathon races, ultra distance races, etc. - where hypohydration can combine with energy depletion to cause real problems. The pace may slow, and athletes may not even be able to finish the planned distance. The explanation is simple.

Hypohydration and Its Effects

As hypohydration sets in, the body diminishes its skin blood flow and sweat rate to conserve remaining body fluid supplies. This reduction is necessary to ensure sufficient blood pressure to continue perfusion to the working muscles. But this can have severe consequences because now the body's evaporative heat loss mechanism is no longer functioning adequately. Unless the pace is slowed drastically, continuing loss of evaporative potential due to decreased skin blood flow very likely will cause the body to overheat, in turn causing potentially sizable performance decrements. During a long training run, or a long competitive race, it would be preferable that neither of these two situations, i.e., pace slowing and debilitation, occur.

Plain Water Not Enough

One possible method for overcoming this hypohydration during prolonged exercise in the heat - whether a long race or simply a very long training run - is to induce hyperhydration prior to the exercise. **Hyperhydration** is a condition whereby greater than normal amounts of water are stored in the body. One might logically think that a simple method for achieving this might be to drink large a volume of water or electrolyte drink, which will then be absorbed directly into the bloodstream and increase the total circulating blood volume. Unless this is done very close to the time of exercise, this ingested fluid will quickly be urinated away. Within the cardiovascular system are very sensitive receptors that detect changes in blood volume, and attempt to keep it constant. Drinking large volumes of fluid a few hours prior to a race or long training run stimulates the kidneys to increase their urine output, thereby restoring the blood volume to normal levels. (This helps to explain the very long lines at the Porta-Johns set up near the start line of road races!)

What is needed is a method that will permit the intake of additional fluid that can be distributed within *all* of the body's major fluid compartments - not just the intravascular compartment (the blood plasma), but also the two extravascular compartments, namely the interstitial fluid between cells and the intracellular fluid within cells. This will keep much more of the fluid on board. There is such a method for total-body hyperhydration, and that involves the ingestion of a mixture of glycerol with water. **Glycerol** (or glycerine) is a naturally-produced substance, is well-tolerated, can be taken orally, and is rapidly absorbed. By osmotic action, water absorbs along with the glycerol, and the combination distributes itself evenly within *all* of the