

Water/Electrolyte Balance Table

By Karl King

Over the last 12 years, ultra-endurance athletes such as ultramarathoners and adventure racers have become more aware of the need for water and electrolyte balance during their exercise. However, the information on how to stay in balance has been sparse and fragmented. Athletes generally learned through a trial and error basis. One would think that with only two components to consider – water and electrolytes – the solutions to stay in balance would be fairly simple. Unfortunately, the situation is actually complex. If a problem arises, a medical expert with the right diagnostic tools can determine in what state of water and electrolyte balance an athlete is. But most runners are not medical experts and do not have any technical diagnostic tools available to them while exercising.

Even at aid stations there are seldom either medical people or diagnostic tools available for analysis of an athlete in trouble. Some large 100 mile ultramarathon runs have good medical staff and diagnostic tools available, but smaller runs cannot afford much on-the-course medical staff.

Athletes need information that helps them determine their water and electrolyte status based on simple, observable signs that appear during exercise. Such information would also be useful for aid station personnel, and for an athlete's crew (if present). With useful information, minor imbalances can be addressed before they drift into serious problems which could require medical intervention.

Body systems that regulate hydration and electrolyte concentrations have a range of compliance in which small corrections can be made easily. When problems are not corrected, the body systems run out of the ability to comply, and problems can become very critical in a short time. Further, serious hydration problems often affect an athlete's mental status, making it unlikely that the athlete can self-diagnose and treat. Thus it is important to deal with problems when they are small. The goal of this article is to give a useful picture of the various possible states so that adjustments can be made by the non-expert, avoiding extreme problems.

The table

The accompanying table gives general information and guidance in helping determine and adjust an endurance athlete's hydration and electrolyte balance. The table is divided into boxes that represent the combination of various states: hydration low, hydration ok, hydration high and electrolytes low, ok and high. With three ranges for two parameters, we arrive at a table with nine boxes. While this table is arranged in discrete boxes for simplicity of presentation, hydration and electrolyte status are in fact continuous variables; one does not immediately go from one state to another – the process is a gradual shift until compliance is lost.

Comments on the various boxes

The center box represents the desired state where water and electrolytes are both ok. Boxes to the right are states of over-hydration, while boxes to the left show states of dehydration. Boxes above show states of excess electrolytes, while boxes below show states of electrolyte depletion. The four boxes on the corners represent states with both hydration and electrolytes out of range. These are dangerous states because two parameters need correction, and it may not be obvious to the average person how to make those needed corrections.

The Electrolytes-High states are quite rare except for the situation where sweat rate is high with little loss of electrolytes, which could take place in a race setting where the athlete doesn't drink enough. Body electrolytes can become concentrated from loss of water, resulting in hypernatremia. This is more likely in those runners who race and cannot replace water faster than it is being lost through sweating.

The Electrolytes-Low states are more common because athletes may neglect electrolyte intake or may not be aware of the need for electrolyte intake, particularly if the athlete is not acclimated to the warm conditions in late Spring or early Summer and loses substantial sodium in sweat. Athletes may take a sports drink with electrolytes, thinking they are protected from low electrolyte conditions without being aware that sports drinks with electrolytes may not supply enough electrolytes to be effective at maintaining desired electrolyte concentrations.

The Hydration-High states are generally the result of excessive fluid intake. Athletes have been conditioned to avoid dehydration but are not as aware of the dangers of excess fluid intake. Drinking "as much as possible" is to be avoided.

The Hydration-Low states are typically the result of athletes failing to keep up with their hydration needs. Athletes who are racing may have sweat rates that exceed water absorption rates, and cannot avoid being at least mildly dehydrated.

Accurately determining the state of someone's water and electrolyte balance is complex, even for those with medical training. Not all runners react the same way, nor do they have the same recent history of water and electrolyte intake. Thus, a simple table cannot be perfectly applicable in all cases.

Note that different conditions can give rise to similar symptoms, so before drawing conclusions, one should look for the occurrence of multiple symptoms that are consistent with the athlete's recent water and electrolyte intake practice.

The runner needs to consider his or her hydration and electrolyte intake practice during the exercise. Runners should be aware of the water and salt content of what they take in ultra-endurance exercise so that they avoid extremes.

It is also important to consider hydration practices in the 24 hours before exercise takes place. For example, some runners (falsely) believe that they should drink lots of water in the days preceding an event to store water. That is normally a bad practice, and the water is often urinated out, with no significant storage, but the excess water can also flush out needed electrolytes. Such a practice would likely pre-dispose an athlete to hyponatremia if electrolytes are not restored during the event. The athlete should arrive at the starting line neither under or over hydrated.

Post-event problems

The job of staying in balance and being aware of imbalance symptoms does not end immediately after the exercise. Athletes who are dehydrated and low on electrolytes are vulnerable to post-exercise dilutional hyponatremia. At the end of the event or exercise session their blood plasma sodium concentration may be in the acceptable range, and their symptoms may not strongly suggest problems. Some symptoms may be ignored as being part of post-event fatigue. If the athlete then consumes sodium-free fluids, those can dilute the blood plasma to the point where the sodium concentration falls out of the acceptable range and the athlete suffers from hyponatremia. Thus, signs of hyponatremia which show up in the hours after exercise must be taken seriously. Note that if the only fluids available after endurance exercise are sodium-free, then they should be consumed with foods or electrolyte supplements containing ample sodium.

Find your way in training

The best place to deal with hydration and electrolyte intake practice is in training – not on race day. Note that six of the nine boxes relate to problems with fluid intake. The average runner doesn't have a measurement tool for blood sodium content, but almost everybody has access to a bathroom scale. Using the scale in training to refine hydration practice will enable an athlete to avoid the most serious problems. If hydration levels are kept within a target range, any other problems will be easier to deal with. Being conservative with electrolytes but knowing how to add them when needed will keep an athlete out of dangerous hyponatremic states.

Medical disclaimer

This table is presented as an aid for the general understanding of causes of water/electrolyte imbalance, symptoms and adjustments that can be done in the field. It is a known fact that there is personal variation in athletes' responses to imbalances. Definitive diagnosis of such problems requires diagnostic medical

testing that is not addressed in this table. Severe dehydration or hyponatremia can be fatal without proper medical intervention. Treatment of severe problems should be undertaken only by medical staff.

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<p>Hydration: LOW Electrolytes HIGH Hypernatremia with dehydration Likelihood: moderate Weight is down a few pounds or more Thirst is high, and salty foods taste bad. Mouth and skin are dry Food acceptance is poor Absence of urination Causes: no access to water or voluntary restriction of water intake, body electrolytes concentrated by loss of water What to do: Get access to water and drink. Restrict electrolytes until weight is near normal.</p>	<p>Hydration: OK Electrolytes HIGH Hypernatremia Likelihood: rare, transitory if water available Weight is normal Thirst is high, and salty foods taste bad. Mouth is not very dry Causes: no access to water, or voluntary restriction of water intake, body electrolytes concentrated by loss of water What to do: Drink to satisfy thirst, so that excess electrolytes are removed by sweating and urination. Restrict salt intake until excess is urinated and sweated out.</p>	<p>Hydration: HIGH Electrolytes HIGH Hypernatremia with over-hydration Likelihood: very rare Weight is up a few pounds or more Thirst is high, and salty foods taste bad. Possible mental confusion Hands may be puffy Shortness of breath, rapid heart rate Food acceptance is poor Causes: over-consumption of salt, probably from a combination of sources What to do: Stop electrolyte intake, drink only to wet mouth until weight is normal.</p>
<p>Hydration: LOW Electrolytes OK Dehydration Likelihood: common Weight is down a few pounds or more Thirst is high, and salty foods taste normal. Mouth is dry, food acceptance is poor Skin is dry and may tent if pinched May have dizziness on standing up May have cramping Mental performance may be affected Causes: insufficient fluid intake What to do: Drink sports drink with electrolytes, or water</p>	<p>Hydration: OK Electrolytes OK Proper hydration and electrolyte balance Likelihood: common Weight is stable or slightly down Stomach is fine, food acceptance is normal Mouth is moist (can spit) and skin is normal Cramps: none Urination is normal Causes: proper water and electrolyte intake What to do: Continue with hydration and electrolyte practice unless conditions change</p>	<p>Hydration: HIGH Electrolytes OK Over-hydrated Likelihood: moderate Weight is up a few pounds or more Wrists and hands are probably puffy Stomach is queasy Thirst is low, and salty foods taste normal. Mouth is moist – can spit. Causes: fluid intake in excess of needs What to do: Drink only to wet mouth until weight is near normal</p>
<p>Hydration: LOW Electrolytes LOW Hyponatremia with dehydration Likelihood: very rare Weight is down a few pounds or more Thirst is high, and salty foods taste good Mouth is dry, can't spit May have cramping Skin is dry and may tent if pinched May have dizziness on standing up Causes: insufficient drinking, no electrolyte intake What to do: Take electrolytes and drink sports drink or water Copyright SUCCEED! Sportsdrink LLC, 2007</p>	<p>Hydration: OK Electrolytes LOW Hyponatremia Likelihood: mild form is common Weight is normal Stomach is queasy, with poor food acceptance Wrists may be puffy Salty foods taste good Thirst is normal Mouth is moist – can spit May have cramping Causes: Insufficient electrolyte intake What to do: Increase electrolyte intake until stomach feels ok.</p>	<p>Hydration: HIGH Electrolytes LOW Hyponatremia with over-hydration Dangerous! Likelihood: moderate Weight is up a few pounds or more Wrists and hands are puffy. Nausea, stomach sloshing, possible vomiting. Thirst is low, and salty foods taste very good. Athlete may show mental confusion, odd behavior Mouth is moist – can spit Urination may be voluminous and crystal clear Causes: over-hydration, insufficient sodium intake What to do: Drink only to wet mouth until weight is normal, then correct any sodium deficit</p>

This information does not substitute for medical diagnosis or treatment.

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