Ryon Reich takes a break to replenish electrolytes on the Tally Lake overlook in Whitefish, MT. Photo: Myke Hermsmeyer

Electrolyte Replenishment

Why It is So Important and How to Do It Right

By Steve Born

Introduction

Electrolytes are analogous to the motor oil in your car—they don't make the engine run, but they're absolutely necessary to keep everything running smoothly. Proper functioning of the digestive, nervous, cardiac, and muscular systems depends on adequate electrolyte levels.

Muscle cramping, though there are many theories as to why it happens, usually involves improper hydration and/or improper electrolyte replenishment. No one wants to cramp, of course, but remember, cramping is a place far down the road of electrolyte depletion. Cramping is your body's painful way of saying "Hey! I'm on empty! Resupply me now or I'm going to stop!" It's like the oil light on the dash; you never want it to get that low.

That's precisely why, just as you shouldn't wait until you bonk before you refuel, or you're dehydrated before you replenish fluids, you shouldn't wait for cramps to remind you to take electrolytes.

In this article, we'll look closely at this vital, but often neglected and misunderstood, aspect of fueling. We'll tell you why salt tablets don't work and why Endurolytes is unquestionably the finest electrolyte formula available.

Proper fueling during exercise requires more than replenishing calories and fluids; it involves consistent and adequate electrolyte support as well. Electrolyte needs vary much more than either caloric or hydration needs, so you will have to experiment quite a bit in training until you have this aspect of your fueling tailored to your specific requirements under various conditions.

Hammer Products Ideal for Replenishing Electrolytes

Our two forms of Endurolytes Endurolytes and Endurolytes Fizz are designed to help you easily and effectively replace any lost electrolytes.

Keep reading for a more in-depth discussion

What are electrolytes? Why do I need them?

Electrolytes are chemicals that form electrically charged particles (ions) in body fluids. These ions carry the electrical energy necessary for many functions, including muscle contractions and transmission of nerve impulses. Many bodily functions depend on electrolytes; optimal performance requires a consistent and adequate supply of these important nutrients. Many athletes neglect consistent electrolyte replenishment because they've never had cramping problems. Even if you've been fortunate enough to have never suffered the painful, debilitating effects of cramping, you still need to provide your body with a consistent and adequate supply of electrolytes. Why? Because the goal in replenishing electrolytes is not so much to prevent cramping, but to maintain specific bodily functions at optimal levels. Cramping is your body's way of letting you know that, in terms of electrolytes, it's on empty. When you've reached that point, your performance has been severely compromised for some time. Remember, you want your body to perform smoothly, without interruption or compromise, so just as you shouldn't wait until you're dehydrated or bonking before you replenish fluids or calories, you never want to wait until you're cramping before replenishing electrolytes. Consistent replenishment of electrolytes is just as important as the fuel you consume and the water you

drink during exercise.

Can't I just use salt tablets?

Salt tablets are an unacceptable choice for electrolyte replenishment for two reasons:

1. They provide only two of the electrolytes your body requires - sodium and chloride.
2. They can oversupply sodium, thereby overwhelming the body's complex mechanism for regulating sodium.

Each of these issues is important, and we'll discuss both of them. Right now, let's focus primarily on the second one.

Far too many athletes have suffered needlessly with swollen hands and feet from water retention due to ingestion of salt tablets or electrolyte products too high in sodium during prolonged exercise in the heat. The body has very effective mechanisms to regulate and recirculate sodium from body stores. Excess sodium consumption interferes with or neutralizes these complex mechanisms. Sweat generates large sodium losses, which is monitored closely through hormonal receptors throughout the body. However, rapid sodium replacement neutralizes the system, allowing water intake to dilute the sodium content. High-sodium electrolyte supplementation contravenes the natural physiological control of serum electrolytes, and once the body detects an increase in sodium from exogenous sources (i.e., food, salt tablets, or products too high in sodium), the hormone aldosterone signals the kidneys to stop filtering and recirculating sodium. Instead, the kidneys will excrete sodium; another hormone, vasopressin, will redominate and cause fluid retention. While ingesting large amounts of sodium may temporarily resolve a sodium deficiency, doing so substantially increases the risk of a number of problems, including increased fluid storage and thus swelling, or edema, in the distal extremities, elevated blood pressure, and increased rate of sodium excretion. All of these inhibit performance. If you've ever finished a workout or race with swollen hands, wrists, feet, or ankles, or if you have experienced puffiness under your eyes and around your cheeks, chances are your sodium/salt intake was too high.

The truth is that the human body needs only a minute amount of sodium to function normally. We require a mere 500 mg of sodium each day; athletes maybe 2,000 mg, which is easily supplied by natural, unprocessed foods. However, the average American consumes approximately 6,000-8,000 mg per day, well above the upper end recommended dose of 2,300 - 2,400 mg/day.* (See asterik on page 44) The average athlete stores at least 8,000 mg of dietary sodium in tissues and has these stores available during exercise. In other words, you already have a vast reservoir of sodium available in your body from your diet, ready to serve you during exercise. In addition, your body has a highly complex and efficient way of monitoring and recirculating sodium back into the blood, which it does to maintain homeostasis. You do need to replenish sodium during exercise, but you must do so with amounts that cooperate with, and do not override, these complex body mechanisms.

** In 2009, data from the U.S. Centers for Disease Control and Prevention provided additional scientific evidence that the majority of Americans over the age of twenty should limit the amount of sodium (salt) they consume daily to 1,500 milligrams (mg) to prevent and reduce high blood pressure.*

High sodium health consequences

Not only are high-sodium diets bad for your health, but those who consume large amounts of sodium in their diet are guaranteed greater sodium loss rates and require greater sodium intakes during exercise. Sodium, as you probably know, drives thirst, and thirst drives drinking until excess results . . . definitely not a performance-enhancing scenario.

Don't I need to replace what I sweat out?

It's easy to formulate a product that matches one of the many perspiration analysis studies and then sell it on the basis that athletes simply need to replace what they lose. Some products do just that. Unfortunately, there's a problem with this because individual sweat-loss differences vary greatly, and the human body does not and cannot efficiently replace what it expends during exercise at any intensity above a walking pace. Electrolytes lost are not replaced by electrolytes consumed.

The body is able to replace, at best, only about one-third of what it loses during exercise; this is true for fluids, calories, and electrolytes. If you try to replace all the fluids at once, you may end up with dilutional hyponatremia (overly diluted blood sodium levels) or water intoxication. If you attempt to replace all the fuel you expend, your stomach will back up in total rebellion, and refueling will grind to a halt. Likewise, if you try to replace in equal amounts all of the electrolytes you lose, a number of hormonal triggers may create all sorts of problems such as gastric distress, edema, muscle spasms, and cramping.

As emphasized in the LESS IS BEST *The right way to fuel * article at the beginning of this book, the key to successful fueling (fluids, calories, and electrolytes) is to NOT focus on what you lose, but rather on how much your body can effectively accept and absorb. Bill Misner, Ph.D., says, Give it [your body] 30-40%, even though it cries aloud for 110%. When it comes to the amount of fluids you drink, calories you eat, and electrolytes you replenish, this is an absolutely vital principle to remember. The closer you adhere to it, the greater your opportunity for success.

THOUGHTS ON REDUCING SODIUM

Consistent replenishment of fluids and calories is essential to maintain energy levels during workouts and races. Providing constant replenishment of electrolytes is an equally important component of proper fueling

Pre-loading sodium prior to a race? Bad idea!

Courtesy of an article written by a registered dietician, one practice now being considered, and even adopted by many athletes, is to & increase sodium in the diet by pre-loading three to four grams of sodium about 12 to 24 hours before the race.

What is bothersome about this recommendation is that one would think that a registered dietician ought to be well-versed on the health consequences of a high-sodium diet (which the overwhelming majority of Americans consume). Yet this particular person advocates additional sodium in the diet prior to a race. The question is: Is this a Article continues here Limiting sodium is recommended since research supports that chronic consumption of more than 2,300 milligrams per day may contribute to congestive heart failure (CHF), hypertension, muscle stiffness, edema, irritability, osteoarthritis, osteoporosis, pre-menstrual syndrome (PMS), liver disorders, ulcers, and cataracts. - William Misner, Ph.D. - Director of Research & Product Development, Emeritus Thoughts on reducing sodium Sodium imbalance: what it causes and how to fix it, page 43 46 safe and healthy practice?

A number of references are provided in the article, apparently to solidify these recommendations: 1) Eichner, E.R. Genetic and Other Determinants of Sweat Sodium. Current Sports Medicine Reports 7.4 Supp 1(2008): 236-S40.

Comment: Our interpretation of Eichner's statements/conclusions is that the more sodium in the pre-event diet, the more plasma aldosterone level is suppressed, resulting in a higher rate of sodium loss in sweat during the event. Our position is that suppression of aldosterone prior to events by increasing sodium intake is counterproductive to keeping natural body homeostatic controls in the healthy norm range, which means consuming a low sodium diet of under 2,300 mg daily.

Bottom line: More sodium in the diet equals more sodium lost during exercise. 2) Murray, R. and L. Kenney, Sodium Balance and Exercise. Current Sports Medicine Reports 7.4 Supp. 1 (2008): S1-S2. **Comment**: Our position is that over 2,300 mg/day results in harmful consequences to health proportionate to predisposed individual sensitivity, while a large majority of the human population reacts negatively to >5,800 mg/day.

Bottom line: Keeping sodium intake levels between 1,500-2,300 mg/day will support sodium requirements without taxing the aldosterone pathway or the kidney organ's role in homeostasis.

3) Stachenfeld, N.S. Acute Effects of Sodium Ingestion on Thirst and Cardiovascular Function. Current Sports Medicine Reports 7.4 Supp. 1(2008): S7-S13.

Bottom line: Salty foods and/or salt tablets will not cut it when it comes to electrolyte replenishment. Instead, adopt a low-sodium approach that emphasizes a balance of essential minerals that cooperatively enhance the body's natural hormone and enzyme actions. You want a product that will provide comprehensive electrolyte support without compromising internal regulation.

Comment: The human body is constructed to be sensitive in monitoring homeostatic electrolyte balance. This suggests that a consistent intake of small amounts of fluids and electrolytes help to prevent severe deficits of fluids and loss of electrolytes.

How the body controls serum sodium

Aldosterone is a hormone that controls the rate of sodium circulated in the human body. When sodium levels dip too low, via loss in perspiration or urine, aldosterone is released, stimulating the kidney tubule cells to increase reabsorption of sodium back into the blood. In basic terms, the body has a very complex and effective way of monitoring, recirculating, and thus conserving its stores of sodium.

High sodium intake will suppress serum aldosterone, whereas low sodium intake will elevate serum aldosterone. In other words, too much sodium, be it via diet and/ or during exercise, will suppress and neutralize aldosterone's sodium recirculation (and thus sparing) effects, causing more sodium to be lost. Conversely, a low-sodium diet and a more conservative sodium intake,

in tandem with other depleting electrolytes, during a workout or race creates an environment where lower amounts of sodium are lost in sweat and urine.

This is also why sweat rate figures can be deceiving. You'll find many a coach or researcher stating something to the effect of I've seen athletes lose up to several grams of sodium during a onehour training session. That may very well be true for some athletes during such a short-duration bout of exercise, especially if it's under a controlled environment (such as riding a stationary bike in a warm room with no circulating air). However, that doesn't mean that those losses are sustainable hour after hour; again, the body's built-in chemical messengers and hormones (namely aldosterone) help prevent those losses from continuing down the same path. Yes, the body does need sodium replenishment but it has to be an amount that works in cooperation with aldosterone's sodium recirculation/conservation effects. A high-sodium diet and/or too-high sodium intake during a workout or race effectively negates aldosterone's desired effects, which means greater sodium losses.

Bottom line: Instead of adopting a recommendation that more and more sodium be added to the already too-high and unhealthy amounts in the diet, athletes should focus more on lowering their daily sodium intake. It is almost virtually guaranteed that each and every one of us consumes far more sodium than we need on a daily basis, and the harmful effects of oversupplying the body with sodium above its daily needs is a real and present danger which will compromise optimal health. Lowering your sodium intake in the diet, keeping it in the range of 2,300 mg or less, is not only a more appropriate recommendation/protocol for general health purposes, it will also benefit athletic performance as well. Definitely do not pre-load sodium in the days leading up to a race.

So what is the answer? How should I replenish electrolytes

Proper electrolyte replenishment during endurance exercise requires a gradual, consistent approach that incorporates all of the electrolytes in amounts that do not override normal body mechanisms. Remember, electrolyte intake needs to be below systemic detection, yet help alleviate systemic depression. This means that you need to consume enough to support body functions and prevent heat-related issues such as cramping without overwhelming your body; electrolyte intake must slip under the body's radar detection system while still providing optimal support.

Endurolytes, Endurolytes Fizz, and Endurolytes Powder are full-spectrum electrolyte products designed to fulfill the body's electrolyte requirements, countering the effects of hyperthermia, optimizing specific bodily functions, and enhancing endurance performance, especially beyond the two-hour mark. The electrolyte profile of the Endurolytes formula balances cations (positively charged ions) and anions (negatively charged ions) responsibly without emphasizing one electrolyte over others. This is a key note to remember: When a balance of electrolytes of cations to anions are managed in the energy producing cell, assuming the cell has adequate fuel and fluid, such a cell will produce energy at a higher rate than one overdosed by a single cation mixed with an irrational list of anions. That's a darn good reason to avoid going salt only or to use products, be they fuels or supplements, that contain high levels of sodium, especially at the expense of too-low amounts of other electrolytic minerals. Additionally, we do not formulate

Endurolytes, Endurolytes Fizz, and Endurolytes Powder to reflect the amounts of electrolyte loss in sweat because each person has a unique biological predisposition in terms of minerals lost via perspiration. Furthermore, the differences in an athlete's size and fitness, as well as the pace of exercise, and of course the humidity and heat, can mean up to a 1000% difference when one athlete's sweat rate is compared to another's. A one size fits all formula based merely on sweat rates cannot, and will not, adequately support your specific electrolyte requirements.

In the purest sense, the Endurolytes formula is not so much an electrolyte replacement product, but is better described as an electrolyte stress support formula. It helps the body perform better under the demands of exercise, especially in heat, by providing a full complement of minerals in the proper balance without interfering with normal body control systems.

Getting your fluid and caloric needs dialed in and nailed down is fairly easy to accomplish, but fulfilling your electrolyte needs requires more attention because you have much more variability to account for. Using Endurolytes, Endurolytes Fizz, or Endurolytes Powder in your training will resolve that challenge. They contain the right minerals in the right balance, and because they are independent of your caloric and hydration sources, they provide you with the necessary dosing flexibility. Regardless of your size, sport, training intensity, fitness level, or the weather, you can fulfill your electrolytic mineral needs accurately and precisely hour after hour with Endurolytes, Endurolytes Fizz, or Endurolytes Powder.

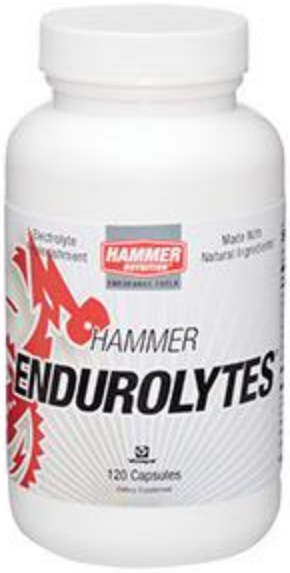
The Hammer Nutrition website has several detailed articles on sodium and electrolyte replenishment. We especially recommend:

The Endurolytes Rationale
(www.hammernutrition.com/za/HNT?PAGE=ARTICLE&ARTICLE.ID=770)

Does a High Sodium Diet Inhibit Endurance Performance and Health?
(www.hammernutrition.com/za/HNT?PAGE=ARTICLE&ARTICLE.ID=4892)

What is the Role of Sodium During Hyperthermic Endurance Events?
(www.hammernutrition.com/downloads/JOE/nov05.pdf)

The Endurolytes Formula



Endurolytes contains chelated minerals. Chelation is the process of bonding a mineral to another substance, ideally an amino acid, making the mineral more bioavailable. Chelated minerals are the form most often recommended because they provide greater absorption than their non-chelated counterparts. For example, magnesium is 87% absorbed when chelated, but only 16% when taken in an inorganic, non-chelated form. One nutritional scientist wrote, Estimates of normal mineral absorption average 10%; however, absorption of chelated minerals may be as high as 60%. Let's examine each mineral...

CALCIUM is the most abundant mineral in the human body (about 2.85 lbs/.8 kg in the average person). Normal heart rhythm, healthy nerve transmission, and strong muscle contractions require a constant blood calcium level. During exercise, calciumdependent enzymes produce energy from fatty and amino acid conversion. Because fatty acids are such an important fuel during endurance exercise, providing 60-65% of your energy needs when exercise goes beyond two hours in length, having adequate calcium available to efficiently convert them into energy is crucial. When blood calcium runs low, the body extracts it from the bones, but this process can't keep up with your exercise depletion rate. Serum calcium deficiency during endurance events may produce high blood pressure, muscle cramps, and weakness.

MAGNESIUM should accompany calcium at a ratio of 1:2. When calcium flows into working muscle cells, the muscle contracts; when calcium leaves and magnesium replaces it, the muscle relaxes. Many enzymatic reactions necessary for fuel conversion to muscular energy occur in the presence of adequate magnesium. Deficiency of magnesium contributes to muscle cramps, tremors, sleep disturbances, and in some cases, convulsive disorders.

POTASSIUM is the chief cation (positively charged ion) within all muscle cells. It is necessary for maintaining the optimal concentration and balance of sodium. Potassium deficiency symptoms are nausea, vomiting, muscle weakness, muscle spasms, cramping, and rapid heart rate. Even though 100-200 mg are lost in sweat alone (not counting internal muscle and cell use),

if we try to replace those amounts all at once, optimal sodium balance is altered. In addition, too much potassium is hard on the stomach and can cause severe stomach distress.

SODIUM is the chief cation (positively charged ion) outside the cell. The average American carries 8,000 mg of excess sodium in extracellular tissues. During endurance events, a minimum of three to four hours is necessary to deplete this mineral, which may result in symptoms of abnormal heartbeat, muscle twitching, and hypoventilation. However, if sodium is replaced at or near the same rate as depletion, it overrides the hormonal regulating mechanisms that enable the body to conserve electrolytes. Consumption of too much sodium will cause a variety of problems, the least of which is fluid retention. Therefore, we highly recommend a more moderate, body cooperative replenishment of sodium.

CHLORIDE is the relative anion (negatively charged ion) that accompanies sodium. This electrolyte is absolutely necessary in maintaining the osmotic tension in both blood and extracellular fluids. It's a somewhat complicated process, but to put it in the simplest terms, think of osmotic tension as being the proper balance and consistency of body fluids and electrolytes. An appropriate amount of chloride (as sodium chloride) supports, but does not override, the function of the hormone aldosterone in regulating and conserving proper electrolyte levels.

MANGANESE is included in Endurolytes as it is necessary in trace amounts for optimal muscle cell enzyme reactions for conversion of fatty acids and protein into energy. Again, fatty acids and protein are a crucial part of the endurance athlete's fuel supply, so while manganese is not technically an electrolyte, its importance cannot be overstated. Research also shows that manganese deficiency plays a key role in blood sugar fluctuation, free radical build-up from intense exercise, and nerve function disorders, especially in older athletes.

PYRIDOXINE HCL (vitamin B-6) is a coenzyme required in 60 enzymatic reactions involving metabolism of carbohydrates, fats, and protein. We include this water-soluble B vitamin in Endurolytes because of its active role in maintaining sodium-potassium balance.

L-TYROSINE is an amino acid added to the Endurolytes formula to protect thyroid and adrenal function. Blood plasma deficiency during extreme endurance events will lower thyroid and adrenal production, which hinders the proper rate of metabolism. Symptoms of l-tyrosine depletion first appear as depression, later anger, then despondency that degenerates into total despair. If any of these has ever happened to you during a long training session or race, it may be due to low thyroid and adrenal production; it can be easily avoided by the intake of supplemental l-tyrosine via any of the Endurolytes products.

GLYCINE is an amino acid added to Endurolytes Powder to help neutralize the naturally salty/bitter taste of the minerals.