Electrolyte Basics

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Principles that will help you know when and how to supplement horses with electrolytes.

One topic that horse owners repeatedly wonder about is that of electrolytes and specifically how and when they should be used. In general, horses participating in most equestrian sports don't need electrolyte supplementation. A horse that sweats during a short training ride or competition might lose some body water and salts, but these losses are usually replenished quickly upon eating hay, drinking, or visiting the salt block. However, there are other situations, involving horses that compete in distance riding pursuits (endurance, competitive trail, or the cross-country phases of eventing or combined driving), for example, when electrolyte supplementation is important to the horse's safekeeping and welfare. Electrolytes are salts--notably potassium, chloride, sodium, calcium, and magnesium--and are essential to proper body function.

Research conducted at endurance and competitive trail rides has demonstrated that many horses experience the greatest loss of fluids and electrolytes within the first 20 miles of exercise. Long-distance transport to an event adds to dehydration and electrolyte losses before the horse even begins to perform, so this, too, must be factored in. A horse that participates in protracted exercise, such as a distance trail horse, is working for many hours and, at times, for multiple consecutive days. Staying ahead of salt and fluid losses is instrumental in maintaining hydration, efficient muscle function, and the ability of the horse to perform to a safe standard and with enthusiasm for his work.

So, let's look at some principles that will help you decide when it is appropriate to provide electrolyte supplementation.

Energy into Locomotion

For muscles to obtain energy for locomotion, food substrates must be converted into energy fuel. In the horse, approximately 70-80% of this metabolic conversion to energy is liberated as heat. In the best situation, heat is dissipated from the inner recesses of the horse's body as sweat, which cools by evaporation of "water" from the skin. Even with moderate exertion during hot weather, a horse sweats. Think about what happens when you exert yourself even slightly on a hot day: Whether you are walking out to the pasture to retrieve your horse, are grooming your horse, or are riding at trot or canter, you sweat. This is a normal physiologic response of man or horse to muscular movement, particularly when the ambient conditions are hot and/or humid, or when the exertion is significant. The inherent problem in some equestrian pursuits is the persistence and duration of your horse's sweating process.

While a person might shed two liters of sweat in an hour, a horse has the potential to evaporate or drip away 15 liters in an hour. High humidity conditions make it hard for sweat to evaporate and cool the horse, so to compensate, the horse sweats more and for a longer time. In addition, there is a great difference between the salt content of horse sweat and human sweat--horse sweat tends to be a more concentrated salt solution. These salts are brought to the skin surface through the sweat pores along with body fluid. In contrast, human sweat has more water in it than salt. The longer a horse exercises, the hotter and more humid the climate, the less fit the horse, or the harder the effort--the more he sweats. And more sweat means more body salts (electrolytes) are lost along with evaporated fluid.

Fluid "Compartments"

Mammals are composed largely of salt and water, with this body "water" present in a few predominant body compartments. The areas that contain most of this mixture are the extracellular fluid that surrounds the cells and includes the bloodstream; the intracellular fluid within the cells and tissues; and the intestinal compartment that provides fluid to the bloodstream (extracellular fluid) from intestinal circulation. Body water moves along a concentration gradient to maintain hydration of all fluid compartments when possible.

Electrolytes also follow an ionic (based on atomic charge) concentration gradient, diffusing across permeable cell membranes--salts at a higher concentration diffuse into an area with lesser concentration. Each fluid compartment contains electrolytes that can be lost in sweat. Electrolyte balance in the horse has a direct relationship to neuromuscular function and fatigue. Nerves and muscles interact through electrical impulses,

which are controlled by the distribution of electrolytes within and outside each cell. In addition, electrolytes regulate the distribution of body water within the various fluid compartments. Peak performance relies on efficiency and synchrony of these functions; dehydration and electrolyte depletion causes a horse to fatigue.

So, in an exercising horse, how do sweat losses of electrolytes and changing proportions of salt cause imbalances between tissue compartments? Let's look at one example of a changing situation.

Normally, the extracellular fluid compartment contains a higher concentration of sodium, while the intracellular fluid compartment contains a higher concentration of potassium. Sweat losses reduce the concentration of these salts in their respective fluid compartments. Each salt possesses a specific negative or positive charge, and the system must remain in balanced electrical neutrality. Continued sweat loss of sodium ions (positive charge) from the extracellular fluid compartment stimulates potassium ions (positive charge) to diffuse from the intracellular fluid compartment into the extracellular fluid compartment. With continued sweating, potassium is subsequently lost from the circulation. This simple example demonstrates that as sodium is lost, potassium moves to fill the void, then it is lost, with a net deficit in whole-body sodium and potassium.

Each salt has many important roles: loss of sodium and potassium reduce neuromuscular irritability (abnormal responsiveness to stimuli), while losses of calcium and magnesium amplify this irritability. Sodium is necessary to drive the thirst reflex. Potassium dilates blood vessels to oxygenate working muscle tissues. The acid-base (pH) status of the horse is dependent on equilibration of electrolytes, particularly chloride, and the pH of the blood determines how much calcium is available for muscle contractility. This is an interactive system, dependent on relative salt concentrations.

Signs of Electrolyte Derangements

An elevated heart rate, delayed heart rate recovery, depressed gut sounds, altered muscular tone, and incoordination are important parameters used to evaluate if a horse is "fit to continue" while engaged in distance ride competitions. Myositis (inflammation of voluntary muscles) can develop from potassium (and other electrolyte) depletion, heat stress, and acid-base changes. Calcium and/or magnesium imbalances might elicit synchronous diaphragmatic flutter, also called "thumps." Some of the horse's nerves associated with the diaphragm--called phrenic nerves--cross the heart on their path to the diaphragm. Thumps occurs when an

irritable phrenic nerve causes the diaphragm to contract in synchrony with the heartbeat. Other signs of calcium and magnesium "deficiency" include tense facial expressions, twitching or tense muscles, a stiff gait, and prolapse of the third eyelid.

In speaking with a friend who set out to train on his bicycle one day in the summer heat, he described how he hit the wall at about 25 miles when he realized he hadn't brought any salt tablets and not enough water to sustain him through his anticipated 35-mile exertion. He felt nauseous, his muscles were exhausted, and he was barely able to get himself home, and he only did so after lying by the side of the road for an hour. This might give us an insight into how lousy a horse feels when dehydrated, salt-deficient, and muscle-fatigued.

It's All About Hydration

In every case, it is important that a horse engaged in aerobic exercise, such as a competitive trail horse, has access to as much water as he wishes to drink at any time. Of course, there is the old adage and irritating truth, "You can take a horse to water, but you can't make him drink." Some horses won't drink at every opportunity because they might be finicky about the taste, they might be nervous, or they might not yet have the need.

While electrolytes won't necessarily enhance performance, they will improve water intake, especially by maintaining sodium levels that drive the thirst center.

Hal Schott, DVM, PhD, Dipl. ACVIM, a professor at the Michigan State University veterinary school, has been interested in distance horse physiology for a long time. He reports on a study that evaluated hydration in the face of exercise with and without electrolyte supplementation: "When the horses competed without electrolyte supplementation, they lost about 50 pounds of fluid as sweat and replaced about half of this loss by drinking about 3 gallons (nearly 25 pounds) of water. However, when they ran with electrolyte supplementation dosed before and during the competition, the horses drank between 5 and 6 gallons (40-50 pounds of water), replacing nearly all of the fluid lost in sweat." He further comments that supplementation also stimulated horses to begin drinking earlier in the course of the endurance test.

A horse that is not drinking well might be best served by receiving a dose of electrolytes. A bucket of salt water (made by adding 5 ounces of salt to a 5-gallon bucket of water) can also be offered in addition to plain water. There is value in accustoming your horse to this taste at home so he will be more inclined to drink it at an

event.

Schott's studies stress the importance of salts in maintaining the horse's thirst drive. He says, "An initial drink of salt water improved recovery of sweat fluid losses because horses drank more water when it was offered a few minutes later. With that initial drink of salt water, the salt concentration in the blood remains elevated to activate the drinking centers of the brain. In contrast, horses that were offered plain water for their initial drink did not drink further during the initial hour of recovery, despite the fact that they remained partially dehydrated."

Schott also found that water temperature can make a difference in intake: "When we compared different temperatures of salt water, we found that horses seemed to drink the most when it was 68 degrees F (20 degrees C), near the temperature water comes out of the hose on a hot summer day."

Electrolyte Replenishment

You, as the rider, will learn the unique electrolyte requirements of your horse relative to each competition situation. The amount given and the frequency of administration are dependent on many factors, including ambient weather conditions, the fitness of your horse, the effort of the exercise demand based on terrain and speed, the duration of the event, the length of the course, the number of consecutive days ridden, how well the horse drinks, the number of rest stops allowed for eating and drinking, and the condition of the horse following transport to the event. Many horses arrive at the event site already in a mild state of fluid and electrolyte depletion from the muscular work of traveling. Some horses also don't drink or eat as well as usual while on the road. And in hot weather, a horse sweats for the duration of the transport, especially if the trailer is not well-insulated.

There are no hard and fast rules on the amount of electrolytes to administer, as each horse is an individual. Some horses need more; some need less. Suggestions here are guidelines for the average horse in an average situation and need to be fine-tuned to your horse, the demands of the event, the distance, the speed, and the climate. At distance rides, some horses might only need electrolytes once or twice along the trail and at the end of the day. On a cool, blustery, or wintry day, supplementation might only be necessary at the end of a 50-mile competition, or you might only need to place a pail of loose salt in front of your horse so he can eat salt as he

elects. Oversupplementation of electrolytes can irritate the intestinal tract, particularly in arid climates where a horse doesn't sweat as much or lose as many electrolytes as he would in a humid climate. In hot and humid climates, the hotter the temperature and the higher the humidity, the more electrolytes will be needed.

Schott points out just how much salt might be lost with exercise, noting, "Electrolytes lost during a typical hour of trotting and cantering on a hot, humid day measure about 75 g of NaCl (sodium chloride) and 30 g of KCl (potassium chloride) in 25 pounds of sweat. This is equivalent to about 1.5 ounces of table salt (NaCl) and 2 ounces of 'lite' salt (which is half NaCl and half KCl)."

Electrolytes don't immediately enter the bloodstream and find their way to the body tissues. It takes at least an hour or two for salts to be absorbed, then equilibrate in fluid compartments after administration. With that in mind, you might want to give a dose prior to the start of the ride, a dose or two along the course, and another at the end of the day.

Not all horses need the same amount or frequency of electrolyte supplementation. As a general rule, 1-2 ounces of salt can be administered periodically through an event. A common protocol suggests giving electrolytes every 10-15 miles during a competitive trail ride or while training, or every two to four hours. Ideally, electrolytes are supplemented at a time when a horse takes a good drink; it might be best to give smaller amounts at more frequent intervals, as, for example, at each active drinking spot.

The objective in supplementing a sweating horse with electrolytes is to replenish at least 30% of sodium and potassium losses. A horse that drinks plain water without any electrolyte supplementation further dilutes the concentration and balance of salts in the various tissue compartments. Sodium is essential to drive the thirst reflex, so a dehydrated horse that has lost excess sodium in the sweat or has diluted it by drinking plain water might not make the necessary effort to replenish his fluid losses.

What Kind of Electrolytes to Use?

"Electrolytes" is a vague term when it comes to deciding what and how much to give. Of all the salts one attempts to replace, sodium, chloride, and potassium are the most essential. According to Schott, losses of calcium and magnesium are 100-fold less than sodium, chloride, and potassium losses. He stresses that replacing the "essential three" improves the horse's acid-base status and facilitates better availability of calcium

in its ionized form.

Many commercial formulations are available, but some consist mostly of sugar with only a little bit of salt, while other brands are pure salt, specifically formulated with the distance horse in mind. The objective is to supplement salt, not sugar. An alternative homemade recipe delivers 100% of the "essential three" and is cheap to make by combining an equal mixture of table salt and lite salt. For horses that exercise in hot weather, but are not involved in protracted exercise, you might add 1-2 ounces of this preparation twice daily to a bit of grain to compensate for minor losses.

Eating is another valuable way for a horse to obtain electrolyte replenishment, but be aware that no food offers sodium or chloride replacement unless it has been commercially formulated with a salt supplement. The digestive tract serves as a hefty reservoir of fluids and electrolytes to be drawn on in times of need, so it is good to encourage hay consumption in horses engaged in aerobic exercise. Grass hay or alfalfa hay are both abundant in potassium, while legume or alfalfa products are rich in calcium and magnesium. Although a horse might stop for periodic breaks during protracted exercise, he could sweat more than he can consume and replace in a brief period of eating; for this reason, you should administer electrolytes with a syringe or mixed in with a mash.

Other Things to Watch For

When replenishing electrolytes in a horse that has been exercising aerobically for extended periods, be sure that no bicarbonate is present in the mixture, as this "basic" substance only worsens blood alkalosis (increased alkalinity from acid loss).

Some horses are acutely sensitive to oral electrolytes and might develop an irritable stomach or mouth, indicated by aversion to administration, excess salivation, and/or visible mouth ulcers. Experienced distance riders have indicated that it is helpful to buffer an electrolyte mixture with Maalox or Mylanta. Note: Again, be careful and don't use buffering products that contain calcium bicarbonate.

Veterinarians have also expressed concerns that electrolytes cause gastric ulcers, and recent research has indicated that competing endurance horses have a higher incidence of gastric ulcers (67%) compared to show horses (58%). Todd C. Holbrook, DVM, Dipl. ACVIM, of Oklahoma State University, reports, "Electrolyte

administration dose and frequency in this study was chosen to mimic common electrolyte replacement strategies used in distance competition during high heat and humidity conditions. Such electrolyte supplementation may induce gastric ulceration or worsen pre-existing gastric ulcers."

Gastric ulcers develop due to stress (from transport, training, competition, illness, herd dynamics, or nervous temperament), restriction of fiber and roughage in the diet, long intervals of fasting between meals, and diets that include high proportions of grain. If there is any concern that a horse has gastric ulcers, the best course of action is to have a veterinarian perform an endoscopic exam of the horse's stomach and to retire him from training and competition until ulcer treatment results in complete healing.

Take-Home Message

Depletion and disproportionate blood and tissue levels of salts, such as potassium, sodium, chloride, calcium, and magnesium, coupled with dehydration, might tilt the scales to a danger point, potentially leading to metabolic illnesses such as tying-up syndrome (myositis), thumps, heat stress, exhaustion, intestinal shutdown, colic, or laminitis. For horses engaged in protracted exercise, particularly in hot and humid climates, electrolyte supplementation has a valuable role in safeguarding them from metabolic distress. However, electrolyte supplementation is not the primary ingredient for performance success. Rather, it is an adjunctive tool to proper conditioning and preparation and an intelligent riding strategy. Knowing if and when to supplement with electrolytes requires constant vigilance as to how well a horse is coping with the demands of the day.
