NEWS LETTER #2

Clair Thunes, PhD
(916)248-8987 clair@summit-equine.com
www.summit-equine.com

Summer is squarely here and many on the East coast in particular have been facing record temperatures combined with high humidity. While high temperatures on their own are of concern, the addition of humidity can really cause problems for our equine partners. I frequently get asked at this time of year about feeding electrolytes to horses and whether they are necessary. In order to understand the importance of electrolytes we have to understand what they are, and what it is they do for the horse. But first let's take a look at what goes on during exercise.

COOLING MECHANISMS

About 70-80% of the energy the horse consumes is lost as heat. As exercise demands increase there is a greater utilization of energy, and therefore heat production increases. According to Lon Lewis author of Equine Clinical Nutrition Feeding and Care, even light work increases heat production 10-20 times that at rest, and when sprinting, this can be as high as 60 times greater. If this heat were not removed from the body, a horse working at 50% of maximal exertion would face an increase in body temperature of 0.6^{o}F per minute and reach critical levels within 10 minutes. However during exercise the heat is carried from the muscles in the blood to the skin where it is released. The horse utilizes sweating (evaporation) to remove about 55-70% of this heat with around 25% being removed through exhalation and the rest through convection. In humid weather the ability to remove heat through evaporation and the respiratory tract is reduced, and convection only works if the horse's body temperature is lower than the ambient temperature. So in hot weather, and especially when there is high humidity, the ability to dissipate body heat is reduced and overall body temperature will rise, sometimes to critical levels resulting in heat stress.

Unlike human sweat, horse sweat contains high levels of the electrolyte molecules; 2.8g sodium, 1.4g potassium, 5.3 g chloride, 0.12 g calcium, 0.05 g magnesium per liter of sweat, and is isotonic, meaning that the balance of electrolytes in sweat mirrors that found in blood. The amount of sweat produced by a horse is determined by several factors including how hard the horse is working, the ambient temperature and how fit the horse is (less fit horses sweat more, especially early in the ride) and can range from 4 to 10 liters (1-2.5 gallons) an hour. Total body water is about 65% of body weight, so the 1100lb horse's body contains about 325 liters (87 gallons) of water of which about two thirds is intracellular (inside cells) and the rest extracellular fluid. Four to 10 liters per hour is therefore a loss of between 1-3% of total body water per hour. Dr David Marlin a specialist equine exercise physiologist stated in a recent article in Britain's Horse & Hound magazine that a 1% loss of hydration can lead to a 4% fall in performance. This is not only due to the water loss but because of the large quantity of electrolytes (especially sodium and chloride) that are lost in horse sweat.

The above picture clearly shows large amount of fluid loss through sweating as this horse cools itself post-workout

THE PURPOSE OF ELECTROLYTES

So what exactly do electrolytes do? Electrolyte comes from the Greek word lytos meaning that "which may be dissolved" and are substances that will dissolve in solution and once dissolved and in their free ionized form, are

able to conduct electricity. These are typically salts containing the macrominerals sodium, chloride, potassium, calcium, phosphorous, and magnesium. Because of their ability to conduct electricity, the body uses electrolytes to regulate nerve and muscle function. Movement of sodium across the nerve cell membrane is necessary for transmission of nerve impulses along nerve fibers. This in turn causes the release of calcium ions that are necessary for muscle contraction and then later, magnesium is needed for muscles to relax. During the contraction phase, potassium leaks out of the muscle cell and is one reason that if blood is drawn from horses recently suffering from severe tying-up high blood potassium levels may be found. Skeletal muscle performance is therefore impacted by electrolyte status but also there are a number of other vital muscle contractions that are impacted including the heart and the smooth muscles of the digestive tract.
Additionally electrolytes impact the following functions;

- Production of secretions, saliva, sweat, urine, mucus, digestive fluids
- Absorption of nutrients across the digestive tract
- Maintenance of normal hydration

The concentration of sodium within and between cells determines the movement of fluid in the body. There are 3 main compartments within the body where fluid is found, within cells (intracellular fluid), between cells and in the blood (both extracellular fluid). If the electrolyte levels inside a cell are more concentrated than outside, fluid will pass into the cell to help reduce the concentration and visa versa. Moving electrolytes in and out of these compartments helps to regulate the amount of fluid they contain. Electrolyte levels are maintained by the kidneys which will recycle them if there are not enough and excrete them if too many.

SCENARIOS OF ELECTRLYTE LOSS
As discussed earlier, horses lose a lot more of these electrolytes in their sweat than we do. This creates a real challenge especially for horses working for extended periods. For example endurance horses and fox hunters. In fact even though most fox hunters are exerting themselves in times of cooler weather, they still need to get rid of the body heat they are generating and it is estimated that in 3 hours of fox hunting 24-100lbs of body weight may be lost, of which 90% will be water. Table 1 provides a comparison for sweat fluid loss and electrolyte loss for horses participating in different disciplines.

Table 1. Estimated sweat and electrolyte losses in horses participating in various disciplines.

Exertion	Sweat Loss (liters)	Sodium loss (g)	Potasium (g)	Chloride (g)
Thoroughbred galloping[a]	4-66	11-185	5.5-92	21-350
Field hunter 3hrs hunting[a]	10-40.5	28-113	14-57	53-215
10 hr trailer ride[b]	18	50	25	95
3-day endurance traditional format[c]	18.4	52	26	98
At rest		10	25	40

Sweat losses are from the following sources and electrolyte amounts calculated based on NRC guidelines for electrolytes in sweat. [a] Lon Lewis Equine Clinical Nutrition Feeding and Care 1995. [b] Dr Davis Marlin Horse & Hound June 3rd 2010. [c] Dr Joe Pagan Electrolytes and the Performance Horse. [d] National Research Council 2007.

Our 1100lb horse will typically consume about 5-8 gallons of water a day and in hot weather this can more than double to approximately 13-16 gallons. Problems really start to occur when their water loss is greater than the amount being consumed. If you have ever experienced a hangover after too much alcohol consumption which is the result of dehydration then you can appreciate how your horse feels when dehydrated, and why performance is impacted. Other signs of dehydration include dry mucous membranes (check the gums), sunken eyes, high heart rate and respiratory rates that do not return to normal as expected, and colic. An easy test for dehydration is to check capillary refill time. If you push on the horse's gums with your finger, this is the time it takes for the color to return to the gum once you remove your finger and it should take no longer than 2 seconds in a normal horse.

Because there are such high levels of sodium and chloride in horse sweat, over time the horse can reach a point where nerve and muscle function are impacted showing signs of fatigue, muscle tremors, nervousness and stiffness. This may present as tying-up. In fact I believe that a large number of tying-up cases are due to poor electrolyte balance. Research carried out by the Animal Health Trust in England to evaluate 144 horses that repeatedly tied up showed that 100 of them had poor electrolyte balance.

YOU CAN LEAD A HORSE TO WATER BUT YOU CAN'T MAKE HIM DRINK

High concentrations of sodium in the blood act to trigger thirst and so you would think that the horse who has lost a lot of fluid from sweating would have high blood sodium levels and high thirst. Yet this is not the case because of the large amounts of sodium lost in sweat. This is a key reason why your horse may not drink, even when dehydrated, and why sodium status is so important for hydration.

A horse can look perfectly normal but the hormones that act to replenish sodium levels are still active the day after exercise, showing that sodium levels take time to return to normal. With this understanding, it becomes clear that work in hot climates, especially over multiple days, can slowly lead a horse into a critical situation. The same situation can arise in horses living in hot climates that are sweating just standing in their stalls all week who are then asked to work on the weekend. This is not an uncommon scenario for an episode of tying-up. It should be remembered that transportation is also a common cause of dehydration. Dr Marlin states in his article that during a 10 hour trailer ride a horse may lose 44lbs of weight from fluid loss leaving it dehydrated. For a horse being transported to a competition with no rest day after transport this creates a real possibility for poor performance or worse.

ELECTROLTYE REQUIREMENTS

Horses all have a baseline need for the electrolyte minerals even if they are not working and the weather is cool. The National Research Council bases this requirement on the horse's body weight as follows;
Sodium = 0.02 grams per kg body weight
Potassium = 0.05 grams per kg body weight
Chloride = 0.08 grams per kg body weight

The 1100lb (500kg) horse therefore requires 10g sodium, 25g potassium and 40g chloride per day. Forage is the basis of the horse's diet and is an excellent source of potassium containing roughly 1.75-2.5%. However, it is very low (0.05-0.5%) in sodium and chloride (0.5-0.75%). Therefore even when our 1100lb horse is eating 2% of its body weight per day as forage, he will only be consuming 5g of sodium. This is why even just to meet maintenance sodium requirements horses must have access to a source of supplemental salt. 1oz (2 tablespoons) of table salt is required everyday to provide 10g of sodium. Many owners rely on salt blocks for this purpose however many horses do not use a salt block. If your 1100lb horse does not consume a 2lb salt block ever 30 days then they are very likely not consuming enough salt to meet their base sodium needs. My preference is always to add salt to their feed to insure their needs are being met.

When the demand increases above this, whether due to exercise lasting more than about an hour, weather or both, additional levels are needed to replace sweat losses. If the weather is causing the horse to sweat just standing around or he is working moderately hard then increasing the table salt to 2 oz should be adequate. While horses in higher levels of work are often fed fortified grains and while these contain some salt it is not enough to meet the higher demands of the exercising horse. For those horses working hard and/or for prolonged periods such that they sweat a lot, and electrolyte supplementation made to replace sweat losses is needed.

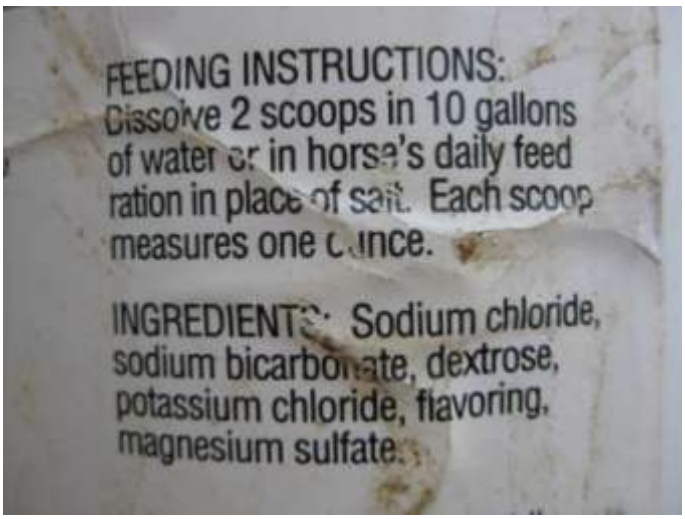
EFFECTIVE ELECTROLYTE SUPPLEMENTATION

The key to a good electrolyte supplementation program is to first provide enough salt to meet the horse's base sodium and chloride needs (at least 1oz or 1tbsp a day) and to then select a product whose electrolyte composition mimics that of sweat. For example Restore by Kentucky Equine Research, or Perfect Balance Electrolyte by Peak Performance Nutrients. It is vitally important that in selecting a commercial electrolyte that the ingredients be

Balanced – Independent – Personalized

checked. The first ingredient in many commercial products is dextrose or sugar and sometimes in amounts greater than 15%. When this is the case there will not be enough chloride provided to meet the horse's needs. Ideally the product should be at least 45% chloride and the sodium:potassium:chloride ratio should be similar to sweat at 2:1:3.8. Some will also contain magnesium and calcium and also a tiny amount of copper and zinc as these are also lost in sweat, but they are of lesser concern than sodium, potassium and chloride. Directions for feeding are frequently based on the level of work. One serving typically being suggested per hour of work or for light work, further increasing up to 2 sometimes 3 servings for those at the highest work levels. Minor sweat losses may be replaced using a simple homemade mix of equal parts table salt and lite salt fed at a rate of 1-2 ounces per day. This will replace sodium, chloride and potassium.

Products are available as pastes or powders and each have their pros and cons. Providing a paste soon after work may help to more readily stimulate thirst however there can be concerns over irritation of the mouth and stomach if used frequently. Powders added to water may deter some horses from drinking and plain water should always be available. My preference is to offer 0.9% saline solution to horses immediately following exercise on hot and humid days and to add electrolytes to feed. The saline solution is easily made by adding 1tbsp of table salt per gallon of water. There is research from Dr Harold Schott of Michican State University that when given 0.9% saline solution horses are "tricked" into drinking more plain water in the subsequent hour of recovery, versus those given plain water straight after exercise. This is due to the plain water further diluting blood sodium levels. Horse's that do not drink the saline should always be offered plain water. Horses were also found to prefer (drink more) water when it was a temperature of 68 ^{o}F (20^{o}C).



The above image shows the feeding instructions and ingredients for a commercially available electrolyte. Sadly the product does not state how much of each of the electrolytes are provided in a serving. It also states that it should be fed in place of salt when ideally an electrolyte is fed in addition to daily salt intake.

As with most things too much is not necessarily better. Overzealous use of salt pastes may result in gastric ulcers and when electrolytes are given without adequate water hyper concentrations of sodium and chloride in the blood can result. Pay careful attention to your horse's water intake when administering electrolytes.

IN SUMMARY

All horses must have access to plain white salt and be consuming approximately 1oz per day year round to meet their base sodium needs. Any time your horse sweats, additional salt should be provided and when you are working your horse hard, for prolonged periods, or in very hot weather an additional isotonic electrolyte should be given.

3053 Freeport Blvd.,
PO Box 246,
Sacramento, CA 95818
Phone: (916)248-8987
clair@summit-equine.com
www.summit-equine.com