Nutrition

Electrolytes and the Exercising Horse

Submitted by Donna Stokell

I chose this topic as the summer was very hot and humid, which created many challenges for me as I attempted to care for my Belgian mare that became quite ill. The veterinarian indicated that she was having problems with dehydration and that the condition was occurring due to the lack of sweat evaporating, lactation, heat, humidity and the loss of electrolytes. I wanted to continue riding and working my horse but I felt that I must further educate myself on electrolytes and dehydration, identifying the clinical signs and the proper way to prevent such a condition from recurring.

Electrolytes are simple inorganic salts that act as charged particles in water solutions. (UC Davis, 1996) The horse produces sweat (may lose 10 to 15 litres of water per hour) that is high in electrolytes: sodium, chloride, potassium, bicarbonate and lower, yet still significant amounts of calcium and magnesium. Water and electrolytes function together in the body fluids. Fluids are lost in manure (75% water), urine (which also contains electrolytes), the respiratory tract and skin; however, these last two areas contain no electrolytes. Electrolytes are integral to nerve and muscle function as well as to almost every other physiological function in the body.

Clinical Signs

A horse competing at aerobic speeds over long distances can generate a tremendous amount of heat, which is primarily lost in extensive sweating. This could routinely result in a loss of 5 – 10% of their body weight, which corresponds to a water loss of 20 – 40 litres in a 1000-pound (lb.) horse. Dehydration is a result of the loss of both water and electrolytes. Clinical signs that would indicate an imbalance of electrolytes and dehydration could include any or all of the following symptoms:

Skin Tenting – When the skin is pinched on the horse's shoulder, it should return quickly to the normal position. However, in a dehydrated horse, the skin will return slowly after 2 seconds. At 10 – 12% dehydration it could take the skin fold 20 – 45 seconds to return to its normal state.

Dry Mucus Membranes- The gums above the teeth should be shiny, pink and moist.

Capillary Refill – upon release of the pressure on the horse's gums, the blood should return within 2 seconds.

Jugular Refill – Once the jugular vein is emptied, it should refill within two seconds.

*Urination –T*he horse will urinate less frequently or not at all.

Heart Rate/Respiratory Rate - After strenuous exercise and cool-down, the heart rate should be less than 68 beats per minutes within ten minutes.

Elevated Temperature- Rectal temperatures above 39.4 Celsius (C) should be rechecked in 15 minutes as the exhausted horse will often demonstrate rising body core temperature with rest, because of the preferential shunting of blood to the skin with overheating. At 41C, oxygen use exceeds supply and tissue destruction occurs (heat stroke). (P Dowling 1997).

Exhaustion- Performance will deteriorate and with severe dehydration the horse will no longer be able to perform and may collapse.

Gastrointestinal System- The system may not work properly and colic may result from lack of fluid in the intestines.

*Metabolic Myopathie*s- Muscle cramps, tremors or stiffness may occur.

*Appearance- T*he horse will be very sweaty, could have sunken eyes, and show signs of nervousness, depression and an increase in respiratory rate.

How Electrolytes Affect the Body (causes and conditions)

A horse's sweat contains chloride, sodium, potassium, bicarbonate, calcium and magnesium, which are inorganic salts also known as electrolytes. An electrolyte is " a substance that associates into ions (individually charged particles) in a solution, thereby becoming electrically conductive. (Ball M, 1997). Electrolytes have many functions and an imbalance can cause many serious health problems for the horse. Imbalances can cause disturbances of the acid-base balance in the body fluids, nerve and muscle function problems (large losses can result in neuromuscular and system disturbances) including muscle cramping, exhaustion, tying up, synchronous diaphragmatic flutter and systemic alkalosis. In horses, sweat is quite high in electrolytes and as a result sodium is lost in a proportional amount to water. Therefore, on the heavily sweating horse, plasma sodium concentrations may not increase and the "signal" for dinking is not produced (Lawrence L., 1996).

A horse's body is about 65% water, with most of the water being contained in cells (intracellular water). Extracellular water contained in blood plasma, spinal fluid, joint fluid, fluid inside the eye etc.. Blood plasma, which constitutes a large portion of the horse's blood volume, is an important component of the extracellular water pool. When horses sweat, some of the water in sweat is obtained from the plasma volume. A reduction in plasma volume and thus total blood volume may affect the ability of the horse to maintain adequate blood flow to muscles during work (Lawrence L., 1996).

Electrical activity of the body is highly dependent on normal electrolyte concentrations. The normal contraction of a muscle, including the heart, and transmission of nerve signals are dependent on the electrical activity in part created by the electrolytes. It is the rapid changing of electrolyte concentrations across the cell membrane that depolarizes a cell and creates electrical activity. The electrolyte concentrations between the intracellular and extracellular fluid differ as many structures are imbedded in the cell membranes that act as pumps (requiring energy) that move potassium into the cell and sodium out of the cell. In addition, there are channels imbedded in the cell membranes that when signalled to open, allow a flood of sodium or calcium into the cell, which will subsequently be moved back out of the cell (Ball M., 1997).

Synchronous diaphragmatic flutter or "thumps" are indicative of an electrolyte imbalance. The condition is usually seen after the heavily sweating horse drinks plain water without electrolyte replacement. Absorption of plain water into the plasma further dilutes the decreased plasma electrolytes. Calcium, potassium and magnesium are required for normal conduction of nerve impulses and a deficiency of these electrolytes causes increased nerve irritability in the horse's phrenic nerve, which controls the contractions of the diaphragm, passing over the heart. As the heart beats, its movement is sufficient to cause the hyperirritable phrenic nerve to fire and cause a contraction of the diaphragm (Dowling P., 1997).

Electrolytes are distributed throughout the body in a highly ordered way and any disruption of this order may result in severe bodily dysfunction. (Mazan, M.).

Changes Necessary to Correct the Condition

Electrolyte availability can become a problem when the rate of loss exceeds the rate of replacement. To minimize losses of electrolytes and fluids, the horse should receive a high quality diet, adding electrolytes only if the horse has been working at intensities and durations causing moderate to high sweat losses (Ecker G.1994). Feeding wet hay or soaked beet pulp four to five hours before the event may also increase the water in the gut which would be available to the horse when required during exercise. One wet-down flake of hay can absorb 1-2 gallons of water. (Cummings School of Veterinary).

After exercise, provide water that is not extremely cold and in graded amounts so that the horse can begin to replace it's fluid deficit without causing digestive disturbances. Post-exercise restoration of fluids and electrolytes should be treated as separate issues (Marlin, D.).

Horses should have continual access to water on a regular basis. A horse allowed to drink while training will more likely be willing to drink when eventing. Flavour the horse's water at home and bring the flavour to events. This will encourage the horse to drink water that may have a different taste.

Free choice salt blocks with trace minerals should always be available to horses. Commercial grains only contain from 0.5% to 1% added salt, in addition to potassium and calcium. Because horses eat considerable more hay and other forage than grain, the horse's total ingested salt will be less than 1%. This is not enough for heavily exercising horses. Horses can generally be supplemented from 1-2 ounces of salt per day (Cummings School of Veterinary). If the horse will not drink, try a tablespoon of salt on the tongue or into the lip of the horse. A salty taste sometimes causes the horse to start drinking.

Cooling the overheated horse aggressively with ice-cold water (0-5C) over the whole body surface is the single factor most likely to reduce the risk of heat stroke or heat exhaustion and other heat related disorders

Nutritionists have long observed that water intake is correlated with dry feed intake. That is, the more dry feed a horse eats, the more water it consumes.

Effect of amount of feed intake on water intake in horses:

	TOTAL KG FEED Evening meal	Water Intake (L) overnight
Diet A (2.1 kg hay + 2.5 kg grain)	4.6	11.0
Diet B (6.1kg hay + 1 kg grain)	7.1	16.4

(Danielsen et al, 1995).

Electrolyte supplements are most often used when a horse is worked very hard several days in a row and the intake of electrolytes from a salt block and regular diet may not be able to match the losses in sweat. When considering the use of an electrolyte supplement, it should be remembered that horses do not "store" sodium, potassium or chloride from one day to the next. Therefore a high level of daily electrolyte supplement is necessary only when horses sustain high sweat losses every day. Adding electrolytes when not required will probably only increase water intake, urine losses and the owner's

sweat losses when cleaning the stall (Lawrence L., 1996).

Do not use electrolyte preparations with glucose as the first ingredient or other sugars listed as one of the first ingredients. The high sugar can cause a surge of glucose in the bloodstream, which in turn causes a surge of insulin. Also avoid high fat supplements as this may slow down the absorption of electrolytes in the gut (Ecker G.1994).

Electrolytes should be provided in paste or feed rather than in the water to eliminate any possible negative effects on water intake. Electrolyte administration is most effective if the horse is actively drinking and should be given under supervision of a veterinarian if the horse is very dehydrated or experiencing metabolic problems. The veterinarian may decide to add water intravenously or through a stomach tube if the horse cannot or will not drink. The severely dehydrated horse may require 20 to 50 litres of fluids and they must be administered intravenously to prevent possible cardiovascular collapse. Intravenous fluids are given as rapidly as possible (5-10 litres per hour) until the horse responds by decreasing its heart rate, urinating, increasing gut sounds and decreasing the capillary refill time.

Fluid loading by nasogastirc tube is commonly used. This can reduce the degree of dehydration experienced during exercise, may speed up post-exercise recovery, and may reduce the risk of other exercise related conditions (e.g. synchronous diaphragmatic flutter). The efficiency of fluid loading depends primarily on the sodium concentration. Isotonic, plasma like solution is least likely to cause acid-base disturbances. Volumes of around 6 litres may be administered as a bolus by nasogastic tube around 60 minutes prior to exercise (Marlin D).

The factors that determine the thermal stress imposed on the horse are air temperature (measured in the shade), moisture content of the air (often measured as relative humidity), thermal radiation (directly from the sun but also reflected from the ground) and the presence or absence of wind (Marlin D.) To further assist the horse, competitions should be moved to early mornings and the horse should exercise for 10-14 days daily (Marlin D.) in the hot and humid conditions to acclimatize.

The primary reason why it is more difficult to exercise in high humidity is that the sweat is still generated, but it doesn't evaporate, and thus doesn't cool effectively; so even more sweating is stimulated ((Mazan M.)

Electrolytes and Dehydration in Horses (quick pointers)

A sweating horse may lose 10 to 15 litres of water per hour causing dehydration and a loss of electrolytes. Sweat that horses produce is high in electrolytes, which are simple inorganic salts containing levels of sodium, chloride, potassium and lower, yet still significant amounts of calcium and magnesium. The electrolytes are integral to nerve and muscle function as well as to almost every other physiological function in the body; therefore, the water and electrolytes work together in the bodies' fluids.

Prevention and Management:

Acclimatization- Horses cope much better with hot or hot and humid conditions after 10-14 days of daily exercise in such conditions. This will increase exercise tolerance and help reduce the risk of heat related disorders.

Salt- Have a salt block available at all times for the horse to lick. For exercising horses, supplement 1 – 2 ounces daily in a commercial grain. If the horse will not drink, try a tablespoon of salt on the tongue or into the lip of the horse. A salty taste sometimes

causes the horse to start drinking.
Higher Fluid Intake – Prior to heavy exercise, soak the forage or a beet pulp to increase fluids to the horse. This will assist in further hydration of the hindgut, reducing possible colic.
Time of exercise- Early morning is the best time to exercise, when heat and humidity are at the lowest levels.
Dehydration -Know the early signs and appearance of the horse before dehydration occurs; skin tenting, dry mucus membranes, capillary refill time, jugular refill time, frequency or lack of urination, heart rate/respiratory rate, elevated temperature, exhaustion, muscle cramps, tremors or stiffness.
*Appearance-T*he horse will be very sweaty, could have sunken eyes, and show signs of nervousness, depression, fatigue and an increase in respiratory rate.
Warm-Up- Provide the horse with shade where possible and reduce the warm-up time, giving breaks every 10-15 minutes.
Water- During breaks; give horses access to small volumes of water (4-5 litres).
Level of Exercise - Reduction of distances or speeds with increased monitoring of horses.
High Quality Diet- Always feed the highest available quality of feed.
Cooling- Cool the overheated horse aggressively with ice-cold water (0-5C) over the whole body surface. This the single factor most likely to reduce the risk of heat stroke or heat exhaustion and other heat related disorders.
Electrolytes- Never give electrolyte preparations to a horse that is already dehydrated. This will pull more fluid into the gut, and take more water out of the blood causing further dehydration..
Veterinarian – Dehydration and loss of electrolytes in the horse is a serious condition, which may even cause death. If your horse is in distress, showing symptoms and appearing overall unwell, be certain to seek the advice of your veterinarian.

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