From Lecture 5 of NRC Plus – Electrolytes

....

Chloride

Chloride receives very little attention in the equine nutrition literatures, including the NRC Recommendations. The chloride content of the blood and extracellular fluids plays a key role in acid base balance, but chloride does much more than this. Chloride is secreted as stomach acid. Chloride channels ("pores") on cells are involved in a host of reactions that involve maintaining normal pH, fluid volume and electrical conductivity of cells. These anion channels are every bit as important as the cation channels and pumps (muscle contraction example above) that receive much more attention. For those interested in the details, see:

http://physrev.physiology.org/cgi/content/full/82/2/503

Estimates of chloride requirements based on balance studies, even when trying to include estimates of chloride loss in sweat, have consistently underestimated the amount needed to prevent low blood chloride (hypochloremia) and alterations in acid base balance (see box on anion gap). For this reason, for the first time the 2007 NRC has established a dietary requirement for chloride of 0.08 grams/kg of bodyweight for maintenance.

Anion Gap

This is a good place to introduce the **anion gap.** You will see a number for anion gap reported on most full blood chemistry screens.

Blood Anion Gap = [Sodium + Potassium] – [Chloride + bicarbonate as CO2]

[Na + K] – [Cl + CO2]

Bicarbonate can only be measured with a blood gas machine, so for practical purposes the content of CO2 in the blood is used as an indirect measurement of bicarbonate in this equation. At rest and in health, the anion gap is maintained in a very narrow range. The value considered normal will vary between laboratories, but a commonly used range in large laboratories using automated equipment is between 12 and 18 (units = mEq/L = milliequivalents/Liter).

The anion gap equation is a measure of electrical neutrality/pH of the blood. It will always be a positive number because the equation on the anion side does not measure organic acids like lactate and acetate and because albumin in the blood has a negative charge. The basic premise is simple. To maintain balance, the following will occur:

- ➔ If one of the cations (sodium and potassium) or one of the anions (chloride or bicarbonate/CO2) increases, the circulating concentration of the other will be reduced to maintain balance – and vice versa
- ➔ If the concentration of circulating organic acids increases, e.g. Lactate production during exercise, bicarbonate will decrease to compensate.

Profound shifts can occur before the anion gap changes, but the result is a change in blood pH because of shifts in bicarbonate. For a detailed discussion of anion gap and how electrolytes shift in a variety of conditions, see: http://www.ivis.org/proceedings/aaep/2001/91010100257.pdf

The chloride content of forages increases with maturity and ranges from a low of about 0.45% in immature cuttings to as high as 0.9%. A horse on a high forage diet can come close to, or meet, the chloride requirement from this source but no information is available on digestibility of chloride from the diet. In earlier feeding recommendations, chloride needs were assumed to be met when the horse is given salt to provide sodium. However, a horse receiving a maintenance supplement of 25 grams of salt would only be getting 15 grams of chloride from this source. Clearly the diet must be providing a significant amount of the chloride requirement. Grains, seed meals, hulls and brans contain significantly less chloride than forages, ranging from 0.08 to 0.16% chloride. **A horse on a high concentrate diet receiving limited amounts of an early cutting, immature hay could easily have a chloride deficiency, especially when being worked.**

The 1989 NRC did not even set a requirement for chloride. One has now been established, but the significance of chloride continues to be glossed over. While maintenance and light work requirements are likely met by a combination of chloride in the diet and chloride in salt, performance horses with high sweat losses and/or high concentrate diets may well not be having their needs met.

Because of the need to keep the anion gap equation in balance, inadequate chloride intake may explain why horses take so long to replete their electrolyte losses after exercise unless freely supplemented with chloride salts of sodium and potassium.

Also from Lecture 5:

Electrolyte Supplementation – Getting It Right

Most people are well aware that the horse requires additional electrolyte supplementation in the heat, more so when performing. However, the most common mistake made is failing to guarantee that the baseline maintenance needs are met first. As we saw above, the baseline requirements are substantial. They are also different from the composition of sweat.

Na : K : Cl Ratio

Maintenance Dietary Requirements: 1 : 2.5 : 4

Sweat Composition: 2 : 1 : 3.8

Sweat losses are important, but "electrolyte supplements", the good ones at least!, are formulated to meet sweat losses only, not provide maintenance needs. A typical electrolyte solution will be formulated to contain 2 to 2.5 grams of sodium per dose, with instructions to feed one dose for each hour of work. If the horse's baseline sodium requirement of 10 grams (500 kg horse) has not already been met, this amount won't come even close to meeting the horse's true total requirements. Remember too that maintenance requirements are tied to body weight, while sweat composition is not.

Effective electrolyte supplementation includes both sweat losses and maintenance needs.

It must begin with evaluation of the basic dietary intake first.