Electrolytes - Managing Heat Scientifically - Cooling

By Abby Bloxsom, courtesy of Eastern Competitive Trail Ride Association, www.ectra.org

A Little Background… no matter where you ride or what distance you ride at, no matter what your experience or how fit your horse is, heat and humidity make distance riding harder. The horse is an arctic adapted species – in a summer coat, its body is temperature-neutral between about 30 and 60 degrees Fahrenheit, meaning that it will not have to expend energy to either cool off or heat up within that temperature range. Humans are not set up that way. Our small, flat, mostly hairless bodies with blood vessels close to the surface evolved in tropical climates (until we learned to dress ourselves, at which point our territory expanded gradually over the globe). Naked, we get cold quite easily.

This means that while we prefer to ride and compete in the summer, the heat and humidity of that season places a strain on the horse's system that we as humans may not feel. In addition to the heat of the human-preferred climate, the horse is constantly producing heat of his own. When he's exercising, he produces it at an alarming rate. Your job as Heat Manager is to get the excess heat out of the horse's body as quickly as possible. (On borderline coolish days – or even on a dry, breezy day when the temperature might still be fairly high – it's also important to know when not to cool the horse. A minimum amount of heat is necessary in order to maintain the horse's normal body temperature, but that's a subject for another time.)

How It Works …before I talk about how you can help your horse to keep his cool in the summer heat, I want to review a little chapter from our high school science textbooks about heat in general. There are three basic heat transfer processes: conduction, convection, and radiation. Conduction is the way that heat travels through an opaque solid, as when the handle of a frying pan gets hot during cooking (I always forget about that). The speed of transfer – the amount of heat moved over time – depends on the difference in temperature between the warmer part and the cooler part of the solid. This is called the temperature gradient.

Convection is when heat is transferred from one solid, liquid, or gas to another, such as when a warm plate on a countertop warms up the surface of the counter, or when you put your jello in the refrigerator to chill it. Again, the speed of transfer depends on the temperature gradient.

Radiation is the process involved when a material transfers heat by electromagnetic energy. This process is unique in that objects need not be in contact with each other. All objects in our everyday world radiate heat because they are warmer than absolute zero, but the amount of heat given off depends solely on the temperature of the object. A glass of lemonade in the sun will warm up because it is absorbing more radiant heat (from the sun) than it emits (by virtue of its inherent "heat").

The problem with using any one of these processes to cool the body of a horse is that – especially on a hot, sunny day – they are way too slow compared to the amount of heat that his powerful engine is producing inside his body. The horse has a large body mass, especially compared to its surface area, so the transfer of heat from the muscles (where the horse is burning fuel and creating heat) outward to the surface by conduction is inefficient. He moves a little more heat by convection, as his blood is heated and then pumped through his blood vessels to the skin. The air around a dry horse is also heated by convection, which removes heat from the horse as long as it's cooler than the horse itself (remember the temperature gradient?) This effect is reduced to nil, however, as the ambient temperature approaches the horse's body temperature.

The warm body of the horse also radiates heat, in increasing amounts as he heats up. Still though, if he's standing in the sun, he's like my glass of lemonade in that he's soaking up a lot more infrared radiation from the sun than he's emitting. A dark horse – like a black rubber bucket – will soak up more solar radiation than a white horse, but he also radiates more, and he's still going to be producing many times that amount of heat by virtue of the work that he's doing. So keep him out of the sun when you can – but you should do that with any horse anyway.

Rest assured, though, that Mother Nature has also given us a supercharger to jack up the speed at which we can transfer heat, and that is the phase change. As water changes from solid (ice) to liquid (water) to gas (water vapor), it absorbs huge amounts of thermal energy. Firefighters take advantage of this when they cool a fire by spraying a fine mist of water over it. As the water vaporizes rapidly, it sucks the heat out of the fire, cooling it instantly. The speed of evaporation is limited by the ambient relative humidity– the amount of water vapor contained in the air relative to the maximum amount of vapor that it can possibly contain at that temperature. In the case of the fire, the relative humidity is effectively zero right before the hose comes on. Because the air is superheated from the fire, the maximum amount of vapor that can be contained is very high, so the cooling potential is very high. In the bathroom after a shower, the humidity approaches 100%, so evaporation and cooling potential are very low. This cooling supercharger – evaporation – is the best tool that we have for removing heat from a hot body. That's why we sweat.

Putting It Together… *Dry Weather:* In a dry climate (or even in the humid Northeastern U.S. on a dry day, say below 40 or 50% relative humidity) the sweat produced by the glands on both equine and human skin will evaporate rapidly, sucking the heat out of the skin and the blood vessels just below it. The heart can then pump this cooled blood around through the body to cool the tissues in the core of the body. The evaporative process also occurs in the passages of the horse's airway. He breathes in dry air, and the moist tissues in the nostrils, sinuses, trachea, and lungs are cooled by evaporation (and a little bit by convection).

Remember, though, that the horse's sweat and the moisture in his airway contain water, electrolyte salts, and some proteins that come from inside him, from the tissues of his body. You can help preserve an enormous amount of your distance horse's vital body fluids by putting plain old water on the outside of him. That's the first reason that we sponge. On a day that will likely be warm at the outset, it doesn't hurt to start right out in the morning by sponging a horse before starting a ride, and preventing those early fluid losses. Continued sponging during a ride will spare even more sweat, especially if you concentrate on the areas with the most blood vessels under the skin – the chest, neck, shoulders, belly, and upper legs.

When the humidity is very low, say below 25 or 30%, evaporation can happen so fast that you might think you and the horse are not even sweating – but you are. The more water you keep on the horse's body the less he will have to replace from the inside (a notoriously slow process). Your horse will stay cooler, his pulse will be lower, and his recovery will be faster. SO just because it's a dry day and the horse feels fairly dry and cool, don't stop sponging! In this type of weather, the water used for sponging can be fairly warm, since the goal is for it to evaporate (it will feel cool anyway). In fact, if the water is too cold it might actually chill the horse by removing heat too quickly. If I were competing in very dry weather (which, face it, in New England I'm not!) I'd probably refrain from clipping my horse during the competitive season. I'd want to keep the water on the horse so that it will be able to cool him by evaporation. It can't do that if it runs off onto the ground.

Hot Weather: As the ambient temperature approaches that of the horse (100-103 degrees F), remember that the effects of conduction through the body and convection to the air are both reduced (because they depend on the temperature gradient, right?). This means first that we must rely on a new principle: convection to water. The water that goes onto the horse must be cool, so that heat will be transferred from the body to the water. As the air becomes hotter, the water needs to be cooler so that the cooling process will be faster (remember the temperature gradient). Water sponged onto the horse must be scraped off immediately (it will feel warm) and replaced with more cool water.

High air temperatures also mean that radiation and evaporation (the supercharger) become more important. It's essential to keep the horse in the shade to minimize the heating effect of solar radiation and maximize the effect of convection to the air (cooler air means a greater difference in temperature, hence faster cooling). Standing in a breezy spot or walking the horse about slowly will increase both the evaporation and the convection rates as the air passes over the horse's heated body. In high heat with low humidity, this may be all that's needed.

Humid Weather: As the ambient relative humidity approaches 100% and temperatures are in the "very hot day" range, however, we have an entirely different situation. Very humid air cannot absorb water from evaporation (the steamy bathroom effect), which means that the supercharger is now out of gas. The weakling coolers of conduction, convection and radiation can do the job, but not without a lot of effort on your part. As on the hundred-degree day, you will need to get a jump on the cooling by laying on the water heavy and early.

In oppressive weather, we depend on relatively slow heat transfer processes, but they are all notorious for being painfully slow for a horse with a chunky body. A loaf of bread fresh from the oven stays warm much longer than a pancake, even a stack of pancakes, because heat has to travel much farther from the core of the bread to the outside than it does in the flat pancake. This is why my riding partner's chunky little horse – faster and fitter than my lanky mare – inverts and has trouble recovering in muggy weather. On a cool, dry day he can trot circles around her for 25 miles!

Clipping a horse before a ride can help with cooling in humid weather – it allows the convection heating of air and water over the body to happen faster, since even the summer coat is a decent insulator. It also allows the evaporative cooling to draw more heat because it takes place closer to the blood vessels below the surface. Keeping pads, ear nets, and hanging mane to a minimum will of course also help your horse keep his cool on a muggy day.

A horse with a fast, efficient gait can sometimes manage to cool himself out on the trail by using speed to his advantage: a convection oven cooks faster by virtue of the fact that circulating the air rapidly speeds up the convection process. My husband likes a fan in the summer for the same reason. If a horse is very fit (it would be counter-productive to try this with a horse who was not up to it) moving him along the trail at a good clip (in the shade, over easy going) can speed up both convection and evaporation, even if the temperature gradient and relative humidity are not in your favor.

When the rider dismounts at a hold or the end of a ride in hot, humid weather, the saddle should be pulled immediately. Huge amounts of the coldest water need to go on the horse's body – everywhere, but especially on those big veins of the chest, neck, head, ears, belly, and upper legs. The water must be scraped off as quickly as possible and replaced with more cold water. In effect, you're speeding up the convection to water by circulating the water over the horse's body. You need to keep this up as long as it takes to make the water run cool off the horse's body.

When the water does run off cool, you're not done. Walking the horse slowly will maintain blood circulation from the core of his body until he's both cool and dry. You may find though, especially in a horse with a blocky body type, that he seems to heat back up again later because the body core was not as cool as the surface was. The cooling/walking cycle needs to be repeated until the horse stays cool if allowed to rest after the walk.

In An Emergency

If all else fails, and the horse really does overheat (a temperature over 103 degrees that isn't coming down) it's essential for the horse's health to get the heat out as fast as possible. At this point, a horse will have been withdrawn from an ECTRA ride, so the ride rules go out the window. To take advantage of the temperature gradient, you need ice – and lots of it – in your water bucket, and you need to get the very cold water onto the entire horse as quickly as possible. Again, as long as the water comes off warmer than it went on, keep scraping it off and putting more on. Use the shade, the breeze, and walking to your advantage, and use as many people as you can get to help cool the horse before he suffers medical complications.

The Human Factor… Of course, it does no good to discuss caring for the horse if I don't also throw in two bits about caring for the rider. On an ECTRA ride, you have no crew available to look after the horse while you go off and lie down, sponge yourself, or eat and drink. DO NOT put the horse's welfare in front of your own at all costs, since an under-fueled or dehydrated rider can quickly become weak, disoriented, and careless. By forgetting to care for him or herself, a rider can easily jeopardize the welfare and safety of the entire team. You can use the same physics to cool your own body that you use on your horse in extreme weather conditions. Now go out and ride.

Courtesy of Eastern Competitive Trail Ride Association, www.ectra.org and www.endurance.net