Heat Stress

Beneath your helmet, your head feels hot and sweat drips off your face as you ride. Your horse's neck is soaked, your reins slippery and lathered. The more you call for an effort from your horse, the more torpid he seems. Despite moving across firm ground, it is as if his legs suddenly mired in deep footing, the ground holding him down. In fact, your horse has run out of steam, or more correctly speaking, his body is boiling over with too much heat. He has reached a dangerous state of exhaustion. You pull him up yet his muscles remain quivering, his breaths come quickly, nostrils are flared. Could you have foreseen this development? Could you have prevented your horse from pushing the red line into the danger zone? Let's examine how heat stress develops, what signs you can monitor, and what you can do to prevent it.

The Build-Up of Heat

With each stride, muscles of an exercising horse flex and strain from the effort. Vast amounts of heat accumulate from the metabolism of working muscles: Over half of the energy used for muscular activity and locomotion in a horse is converted to heat. At higher temperatures, muscles (and all body tissue) demand more oxygen. Unchecked, continued heat build-up stimulates a decline towards exhaustion. If increased metabolic demands cannot be met, muscles fatigue. Loss of muscular control and strength can lead to serious accidents; an exhausted horse may stumble and fall, placing both horse and rider in jeopardy.

Hours of protracted moderate exercise or high intensity exercise for short periods are both conditions that particularly tax the ability of a horse to move heat out of the body as quickly as possible. To remove muscular heat, your horse sweats, pulling heat from the interior of his body in a process known as *evaporative cooling*. Around 70 percent of the heat of locomotion is normally dissipated from the body using this process of evaporative cooling.

The inherent problem in prolonged exertions is the persistence and duration of your horse's sweating process. Of particular note is the fact that a horse suffers body fluid losses and electrolyte imbalances with sweat. A horse that sweats during a mile long track race loses lots of body water and some small degree of electrolytes, but then the exertion is quickly over; in a short time he easily replenishes what was lost. But a horse that is exercising for protracted periods continues to dehydrate as heat from the continually working muscles is eliminated as sweat.

Heart and Respiratory Rates

As internal body temperature rises, sweat is not the only means to dissipate heat. Another, but far less-effective mechanism can eliminate up to 15 percent of the heat load. Just as your panting dog moves air across his hanging tongue, your horse breathes rapidly to cool his body. Warmed blood flowing from heated skeletal muscles circulates to the heart and through the lungs. With each in-coming breath, cool air (and oxygen) is exchanged for warm, exhaled air.

Fitness and good circulation are essential for efficient heat dissipation. Cardiovascular recovery is only one of many parameters used to evaluate metabolic well-being. It provides a useful tool to monitor how efficiently your horse responds to athletic demands. If your horse has difficulty in recovering his heart rate and respiratory rate following an intense effort, respiration may remain elevated, with nostrils flared as your horse gulps the air. His flanks move rapidly in and

out with each breath, giving the impression that he is "panting." When the number of your horse's respirations is faster than his heart rate, this is called an *inversion*.
Hot weather, particularly if it is humid, compromises a horse's ability to shed heat from his body. He sweats, but it is not always enough to stay ahead of the heat build-up. Heart rate and respiratory rate may remain elevated for a short period once exercise stops; blood flow coursing through his body flushes the bulk of heat to the skin, while respiration serves a minor role in cooling. A fit horse that is performing aerobic exercise returns to a heart rate below 64 bpm (beats per minute) within 10 minutes. No matter the intensity of an exercise effort, both heart and respiratory rates should recover to 64/64 within 30 minutes following cessation of exercise, and preferably respiration should return to less than 20 breaths per minutes. Dehydration notably slows heart rate recovery. Persistent elevation of heart rate indicates that the horse is not coping well with the demands of the effort, and may be in metabolic distress. Poor recovery often signals an impending metabolic collapse due to the combined effects of dehydration, energy depletion, electrolyte losses, and heat build-up in the muscles.

Conditioning for the Task at Hand

Many of us spend time strengthening our own bodies for the athletic demands of riding. Whether we accomplish this foundation through aerobic sports, jogging, biking, or through time in the saddle, we take pride in our stamina and fitness. Our horses deserve no less of a conditioning program, and may even require a more tailored approach. Training often concentrates on skills essential to your intended discipline. Yet, another training ingredient is essential to the success and well-being of any athletic horse: Fitness of the cardiovascular system. As the muscles train to better efficiency, less work is needed to achieve a certain level of athletics, with less heat generated by the body.
Extenuating Factors

Hot weather is not the only factor contributing to developing inversions, dehydration, or signs of heat stress. A horse ridden at too fast a speed for his level of condition generates excess body heat. A horse being asked to climb a particularly intense hill or mountain, or to put forth an extraordinary work effort in jumping or galloping will tend to over-heat. A horse that is ridden for too long without a rest may also build up an excess heat load in the muscles. A horse sporting a full fur coat is at risk of over-heating since the hair coat that keeps him warm in cold climates serves as an insulator to heat dissipation. Hairy horses should be clipped to accommodate taxing weather conditions. Heavily muscled horses, such as Warmblood breeds and Quarter Horses, are at greater risk of retaining heat in the working muscles than leaner breed horses such as Arabians or Thoroughbreds.

An overweight horse with abundant fat layers beneath its skin cannot dissipate heat effectively. Not only does excess body weight interfere with normal cooling processes, but it also reflects a lack of fitness. Adequate preparation and training develop a horse into a sleek physique, building muscle where once there was fat. Conditioning expands capillary beds and blood flow within skin and muscles to improve circulation of oxygen in the tissues and flushing of heat to the skin surface.

Transport of a horse in an enclosed van in hot weather can also contribute to dehydration and heat stress. A horse that has shipped from a distance away and has not been acclimated specifically to exercise in hot and humid conditions is ill prepared to deal with the added stress of the environment no matter how fit the athlete. Most horses need at least three weeks in a warmer climate to allow their bodies to learn to dissipate heat more efficiently.

Monitoring the Cardiovascular System of an Exercising Horse

Some basic physical parameters can be examined to monitor how well your horse is coping with the stress of exercise. Heart rate recovery is an important parameter to gauge. In addition, a peek at mucous membrane color and capillary refill time of the gums provides an impression of blood perfusion throughout the body. The gums should be a healthy pink color. After blanching the gums with a fingertip, this color should return within two seconds. A normal pink color with a normal capillary refill time indicates an adequate cardiovascular state, confirming pumping of blood throughout the body tissues. With poor circulatory perfusion, gum color appears congested and capillary refill time slows.

A rough estimate of dehydration is obtained by grabbing a fold of skin on the point of the shoulder or an eyelid, and noting how quickly it snaps back into position. It is considered normal for the skin to snap back immediately. Skin that remains tented and refuses to return to its normal position represents serious dehydration of seven to 10 percent. There are many levels in between. Mild dehydration of two to three percent may be ascertained by evidence of a dry mouth and dry mucous membranes. At about five percent dehydration, the eye sockets appear sunken in, skin elasticity is markedly reduced, and the horse is weak with a dull or listless attitude and posture.
The moistness of the gums and a skin pinch test are but crude assessments of hydration status. It is easy to be fooled that all is well simply by measuring capillary perfusion time, gum color, or skin tenting. You may not be able to obtain a clear picture of mild clinical dehydration using only these physical inspections. Mild dehydration of as little as two to three percent is associated with a decrease in performance. Your horse may not be in direct danger of metabolic collapse, but his ability to compensate for further dehydration, electrolyte losses, or heat build-up becomes taxed as exercise continues.

Rectal Temperature – Evaluation and Significance

Rectal temperature provides another valuable parameter to monitor a horse's well-being. As a mammal, an internal set point is regulated in a horse's midbrain to maintain body temperature within a very narrow range. Part of the body temperature control process relies on losing heat generated by working muscles and normal digestive metabolism. A racehorse running one mile in two minutes can lose as much as two-and-a-half gallons of sweat as he "cools" his body. Consider, then, the dramatic fluid loss in an unfit horse that is in sustained work under adverse climatic conditions. Even a well-conditioned horse loses as much as two to three gallons per hour with exertional demands in the face of high heat and humidity conditions.

An exercising horse typically works within a rectal temperature range of 101 - 103 degrees Fahrenheit. Should rectal temperature surpass 103.5 degrees Fahrenheit, the horse is overheating. Once a horse has been pulled up to rest, rectal temperature should decline steadily over 20 minutes. Cooling strategies can hasten the return of internal temperature towards normal. Initially, as internal temperatures rise, the bulk of blood from cardiac output is diverted to the skin away from the working muscles to facilitate heat dissipation. Internal heat continues to rise if surface evaporation (sweating) is no longer able to keep pace with the heat build-up. As muscle temperature elevates, contractile function of the muscle fibers is impaired, further contributing to fatigue and exhaustion. Loss of vital fluids through the skin causes a steady state of dehydration unless this "water" is replenished. Blood flow diminishes to the subcutaneous layers of the skin, further limiting sweating action in an effort to conserve body water. Heat continues to build within the horse with no outlet.

A rectal temperature exceeding 105 degrees Fahrenheit is abnormal in any horse and poses a dangerous situation; rapid cooling measures should be initiated at once. The higher the internal temperature, the more metabolic demands placed on the system; this metabolism needs to be fueled by oxygen. If body temperature exceeds 106 degrees Fahrenheit, the body's demand for oxygen may surpass the amount that can be supplied by the respiratory system. An oxygen deficit occurs in the tissues (*hypoxia*), potentially leading to kidney, liver, and brain damage. At temperatures greater than 107 degrees Fahrenheit, a horse in severe heat stress may go into convulsions or coma, and die. The objective is to avoid these scenarios.

What to Do: Cooling Techniques

Under any exercise conditions, following some simple strategies will assist your horse in cooling out. As you finish a work, bring your horse immediately to a walk. Hop off, and spend a minute or two walking him so blood flow continues to flush metabolic waste products and heat from his muscles. If an over-heated horse abruptly ceases working, blood pools in the muscles and compromises his circulating blood volume, contributing to relative dehydration. A fatigued horse may refuse to move. Provided he is not tied-up with muscles spasms, you can assist circulation in the muscles by massaging major muscle groups in rhythm with the heartbeat.

If the heart rate returns to 64 bpm (beats per minute) or below within 10 minutes, but the respiratory rate remains elevated, such an inversion does not necessarily imply your horse is in trouble. It means he needs help in ridding his body of the extra heat. Both the respiratory rate and heart rate should return more towards resting rates within ten minutes of stopping exercise. You can assist your horse in cooling in a couple of ways.
Heat stress generally develops due overexertion leading to overheating rather than to the external heating by the sun's rays. A bright sun-shiny day contributes to high ambient temperatures. Warm air temperature and high humidity prevent a horse from adequately dissipating internal heat from his body. Help your horse cool down by copiously bathing his head, neck, and legs with cool water. Large blood vessels in these locations flush heat to the skin surface. Rapid evaporative cooling is achieved by continual sponging of these areas. Draping wet towels over the head and neck may be counter-productive to cooling as the towels serve to insulate, particularly if the water on them remains warm. Continuously apply and scrape water away until the horse's skin feels cool to touch. His respiratory rate should settle down as his internal body temperature is brought back within a normal range. All horses will need some assistance with cooling in the summer months even if the respiratory rate is not inverted or elevated.

Ideally, the body temperature of an over-heated horse should be decreased by one degree Fahrenheit every 30 to 40 minutes by bathing head and neck areas with water. Cooling down too rapidly can cause him to chill. In hot and humid climates, cold or ice water may be applied to the entire body with less risk of muscle cramping. The danger in cooling these large muscle groups too rapidly lies in the tendency of blood vessels to constrict away from the surface while retaining metabolic by-products that need to be carried out from deep muscle tissues. Diminished blood flow to the skin surface further allows heat to persist within deep muscles, causing heart and respiratory rates to remain elevated. Besides exhibiting poor metabolic recoveries, the horse might develop "tying up" syndrome, with sudden cramping and muscle spasms. Such an affected horse refuses to move, and may exhibit signs of "colic" due to pain akin to a severe "charlie-horse". Heart and respiratory rates further climb in response to pain. As muscle fibers spasm and contract, more heat is generated in already over-heated muscles. Continue to monitor rectal temperature and muscle tone as you cool out your horse. Once the rectal temperature reaches 101 degrees Fahrenheit, you can stop and see if he stabilizes without further cooling assistance.

Offer a bucket of water to your horse following exercise. If the horse has been galloping, initially only offer small, frequent drinks until he has cooled down a little bit. If the horse has been working aerobically for protracted periods, he should be encouraged to drink as much as he desires.

Find an area of shade for the over-heated horse. Find an area where there is decent air circulation, preferably with a light breeze. An enclosed space with stagnant air adds to heat retention. Fans are helpful for convective cooling – as air flows across the horse's body, it pulls heat off the skin. Periodic, short walks help the muscles pump heat out of deeper tissues. A dangerously over-heated horse may need to be dunked into an available pond, or soaked entirely by hose or with buckets of water. Intravenous fluids are often necessary for treatment of a horse suffering from severe heat stress not only to treat dehydration and shock to maintain circulatory health, but also to cool the internal organs and muscles.

Anhydrosis

Some horses living in hot, humid climates lose the ability to sweat, a syndrome known as *anhydrosis.* It is thought that over-worked sweat glands exhaust their ability to produce sweat. During exercise, such a horse loses the ability to cool himself. In addition to reduced tolerance to exercise, you might notice that your horse's skin feels dry and hot to the touch. There may be a damp area of sweat beneath the mane and saddle or in the groin region, but no moisture is felt elsewhere on his body. He pants with the slightest effort, and seems fatigued. Rectal temperature will rise. Exercise must be stopped immediately, and the horse moved to a cool location and aggressive cooling techniques implemented immediately. Such horses are in great danger of heat stroke. Early recognition is important to restrain the horse from further physical exertion and so appropriate medical attention can be initiated.

Seek More Knowledge

By following these guidelines, you can help your horse stay out of trouble. Pay close attention to your conditioning program, using cardiac and respiratory recoveries to guide your advances in speed and intensity. If your horse is laboring under the effort you ask, rethink your training strategy and back off your demands. Take the time to learn more about cardiovascular conditioning of your horse, and to apply appropriate cool-down techniques during training and competition.