Zweig Memorial Fund News Capsule

A Report on Equine Research at the College of Veterinary Medicine at Cornell Sponsored by the Harry M. Zweig Memorial Fund

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Horses That Bleed During Racing: Bronchial Artery Could Be The Culprit

Up to 75 percent of Thoroughbreds, standardbreds, and other athletic horses, bleed into their lungs and airways during or after heavy exercise. The bleeding not only impairs the horses' performance but can end their racing careers, thereby putting a significant economic burden on horse trainers and owners. "The bleeding from exercise-induced pulmonary hemorrhage (EIPH) is sometimes so profuse that the jockeys get covered in blood and the horses pull up or completely stop in the middle of the race," says Dr. Robin Gleed, associate professor of veterinary anesthesiology at the College of Veterinary Medicine at Cornell University. "It's a major economic problem worldwide because it affects some very good horses."

There is strong evidence that the bronchial artery may be the source of EIPH. Until recently, the role of the bronchial artery in mammals was a complete mystery but now researchers have discovered that the bronchial artery is enlarged and pathologically different in horses with EIPH. "The bronchial artery is the only vessel in the lungs where blood pressure is high," says Gleed. "So it occurred to us that if a blood vessel is going to rupture during exercise, it would make sense for it to be the bronchial artery."

A horse is exercised on the treadmill of the Equine Performance Testing Center.

With a grant from the Harry M. Zweig Memorial Fund for Equine Research, Gleed and his colleagues , Dr. Alan Dobson, professor of veterinary physiology, and Dr. Richard Hackett, associate professor of veterinary surgery, set out to determine exactly what happens to bronchial-artery blood flow when horses exercise.

By surgically implanting a real-time flow probe (which was developed in the College's Department of Physiology) around the bronchial artery of standardbred horses the researchers have been able to measure and record the blood-flow signal from the artery. They have successfully monitored the bronchial artery in standing horses and in exercising horses. The exercising horses have been tested both on a track (with all the equipment on a jog cart behind the horse) and on a specially designed treadmill at the new Equine Performance Testing Center. By using the treadmill, researchers can continue their work during the winter months.

"To the best of our knowledge, these are the first measurements of bronchial-artery blood flow in the horse as well as the first measurements of bronchial-artery blood flow during exercise in any species," Gleed points out.

The researchers have determined that bronchial-artery flow varies with the alertness,anticipation, and manipulation of the standing horse. When the horse is harnessed and apparently standing quietly before exercising, the bronchial flow has already doubled. Once steady exercise begins, the heart rate jumps rapidly to a plateau that is sustained until exercise stops. Bronchial-artery flow, however, decreases initially, then rises steadily during the exercise. "But this rise in flow is apparently not related to heart rate, and we have the impression that the hardest exercise depresses the otherwise steady rise in bronchial-artery flow," Gleed says.

More importantly the researchers have uncovered a perplexing phenomenon. Not only does blood flow through the bronchial artery increase severalfold during exercise, but it continues to climb even after exercise has slowed or stopped and after the pulse rate is well on its way back to normal.

To further explore the role of the autonomic nervous system in the control of bronchial-artery blood flow, Gleed and his colleagues are now using drugs that are known to affect blood flow. By mimicking how the body reacts during exercise or by blocking certain responses, the researchers hope to better understand the mechanisms that control bronchial-artery blood flow during exercise and to discover how it is different in horses with EIPH. Their immediate plans are to refine their techniques so that they can simultaneously record systemic (body) blood pressure and bronchial-artery blood flow in both standing and exercising horses.

They also plan to compare changes in bronchial blood flow in conscious horses that are standing with those in anesthetized horses that are in different positions, and to compare bronchial-artery blood flow changes in normal exercising horses with those in exercising horses afflicted with EIPH. "Confirmation of our findings in other normal horses and what we find in horses affected by EIPH will help define the etiology of this disease and in the long term, provide a rational approach to methods of preventing or curing the condition," Gleed concludes.

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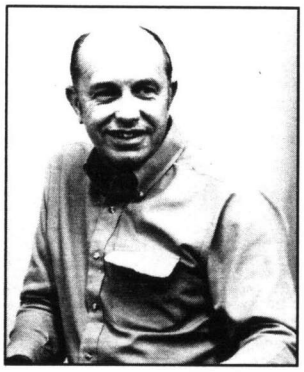
Vitamin E: How Much Does An Exercising Horse Need?

When horses, humans beings, and other mammals exercise hard, their bodies burn up nutrients faster than when they are at rest and produce highly reactive and potentially destructive chemicals known as free radicals. By damaging cell membranes and reprogramming genes, free radicals may be involved in more than sixty disorders from heart disease and cancer to Alzheimer's disease and Parkinson'sdisease.



Dr. H. Hintz

Vitamin E in the diet can protect cell membranes by attaching to those potentially damaging metabolites and deactivating them. Yet horses may not be getting enough vitamin E to prevent cell damage. Scandinavian equine researchers have recently suggested that the National Research Council's current dietary recommendation for horses of fifteen milligrams of vitamin E for every kilogram of feed is far too low and have recommended levels more than five times greater. Although too little vitamin E can result in tissue damage, too much is costly and wasteful.

To determine just how effective vitamin E is in protecting against tissue damage from free radicals produced during exercise and to establish the vitamin E requirements of exercising horses and sedentary horses, the Harry M. Zweig Memorial Fund for Equine Research has funded a study on twelve standardbred horses at Cornell's College of Veterinary Medicine.

Researchers suspect that when an animal exercises, vitamin E gets used up to neutralize or mop up the additional free radicals that are formed as a result of the activity. "Work with rats has shown that under endurance programs, the rats start depleting their vitamin E stores," says Katherine Petersson, a doctoral student in the Department of Animal Science in the College of Agriculture and Life Sciences. She is conducting a study of vitamin E requirements in horses under the supervision of Dr. Harold Hintz, professor of animal nutrition in the Department of Animal Science and in the College ofVeterinary Medicine.

"We hope to determine whether an increase in the current recommended level of vitamin E would better protect cells during exercise when there is increased oxidation of energy-supplying nutrients," says Hintz. "If we can determine just how much vitamin E an exercising horse needs and supply it in his feed, we hope the animal will be able to perform to the best of its innate ability, recover more quickly from rigorous activity, or have a longer running career than if the vitamin E level were insufficient."

Petersson will test the vitamin E requirements of exercising horses by physically training six of the twelve horses on the treadmill now available in the College of Veterinary Medicine's Equine Performance Testing Center. Petersson will work the horses' heart rates to 70 percent to 80 percent of their peak for thirty minutes, five days a week. The treadmill allows her to standardize the horses'workouts while adjusting for individual differences, to monitor the horses' heart rates, and to keep-factors such as footing constant.

After eight weeks of training followed by a stress test on the horses to establish a performance baseline, Petersson will begin to deplete the

vitamin E of all the horses by reducing the amount in theirdiet. She will continue to feed them a diet with insufficient vitamin E until she determines throughblood tests and muscle biopsies that the horses are significantly depleted and that some cellular membrane destruction has begun.

Petersson will then conduct another stress test to determine whether the endurance of the horses has diminished as a result of the vitamin E depletion. "Our hypothesis is that the horses will show decreased endurance when they are vitamin E depleted," Petersson says. "We also suspect that the depletion of vitamin E in exercised and nonexercised horses will occur at different rates."

Next, Petersson will increase the vitamin E intake of all the horses to the current recommended levels (fifteen milligrans per killogram of feed), to the proposed recommended levels (eighty milligrams per killogram of feed), and then to an even higher level (one-hundred milligrams per killogram of feed). At each new dietary vitamin E level, the horses' performance will be monitored through blood tests, muscle biopsies, and stress tests.

The results of Petersson and Hintz's study will be important to the racing industry because of the current trend toward supplementing horses' diets with high levels of vitamin E. So far the supplementation has not been founded upon scientifically controlled studies but rather on unconfirmed reports of a beneficial effect on horse performance. By determining the effect that vitamin E plays in protecting horses against oxidative tissue damage during rigorous exercise programs and by establishingthe level of vitamin E supplementation needed for performance, the reasearchers hope to learn just how much vitamin E. is needed to maximize health and without needless overdosing. The Cornell researchers also hope that their results will contribute to investigations of the role exercise plays in the production of free radicals in humans.

Nerve Transplants May Cure "Roaring" in Horses

Equine surgeons at Cornell University have identified a nerve that looks promising for repairing the paralyzed half of the larynx that causes "roaring" in horses, and are developing techniques to assess the success of nerve transplants.

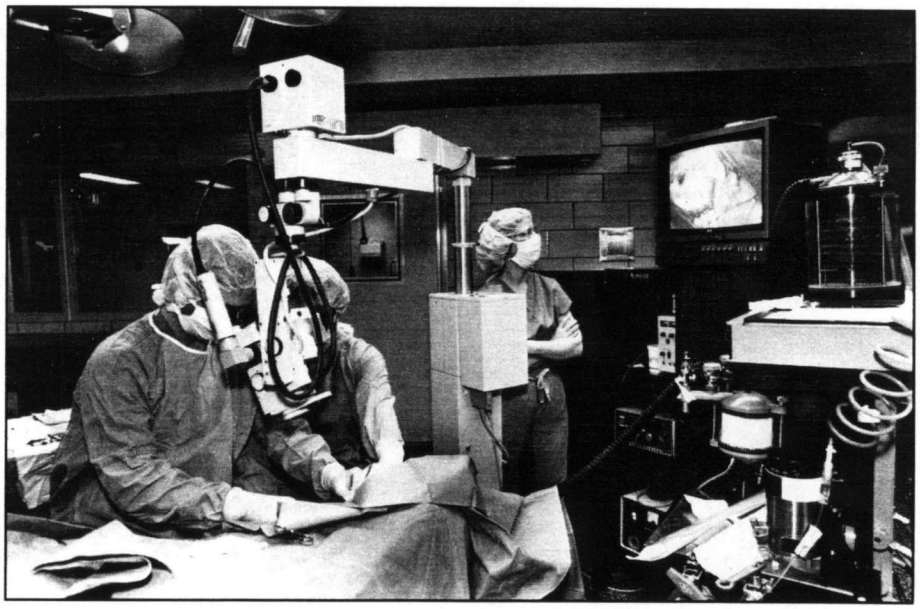
"Roaring," or laryngeal hemiplegia, is probably the most common upper respiratory disorder in performance horses. "Roaring affects approximately five percent of Thoroughbreds," says Dr.Normand Ducharme, assistant professor of clinical sciences at the College of Veterinary Medicine at Cornell University.

This common and costly disease is caused by the degeneration of the nerves that supply the larynx (windpipe opening). Although no one knows for sure what kills the nerves, experts suspect that infection, trauma, heredity, or congenital abnormality may be the culprits.

Whatever the cause, as the nerve degenerates, half the larynx becomes paralyzed and can't open properly. Sufficient air then fails to get through the laryngeal opening. The result is not only the characteristic roaring noise but also reduced air to the lungs, which translates into impaired racing performance.

According to Ducharme, "Roaring can reduce a horse's racing speed by five seconds to as much as thirty seconds, in which case, it means the horse is done with racing." Hunters and jumpers are also seriously impaired when they develop the condition.

To date, the most common procedure to restore sufficient larynx function for racing or running is the surgical insertion of a prosthesis. The prosthesis is a ligature placed on the outside of the larynx. Its placement mimics the attachments of the cricoarytenoideus dorsalis muscle,



Dr. Normand Ducharme and Dr. Richard Hackett use an operating microscope to pinpoint the phrenic nerve. Dr. Susan Hackett watches their progress on the monitor.

which fails to open the airway when the nerve is paralyzed. When the prosthetic ligature is pulled tight, it draws the paralyzed vocal fold out of the way and opens the larynx. Yet, only between thirty-five percent and sixty percent of horses who undergo the treatment improve in their racing, and the improvement may be only temporary. "There's also a high incidence of complications," explains Ducharme. "Some 40 percent of horses cough after the surgery and some horses cough for the rest of their lives. Other complications include infection, choking, prosthesis failure, and more rarely, pneumonia."

To improve the treatment of roaring in horses, and perhaps contribute to the research done on tracheostomies in human beings (holes through the neck to open the windpipe after surgery or cancer of the larynx or thyroid), researchers at Cornell are working on a technique to reinnervate, or restore, nerve functioning in the larynx. After minimal success in transplanting a throat nerve into the paralyzed portion of the larynx (which at best opened the larynx opening about twenty percent), Cornell researchers set out to find a better nerve to transplant.

With a grant from the Harry M. Zweig Fund for Equine Research, they are investigating the phrenic nerve, which looks like an ideal donor because it innervates the diaphragm and is therefore "fired" during breathing.

To locate the root, or nucleus, of the phrenic nerve, Ducharme and his colleague, Dr. Susan Hackett, a Ph.D. candidate in anatomy, adapted a dye "tracking system" that had not previously been used for equine motor nerves. By injecting the enzyme into individual nerves in and around the larynx, the Cornell veterinary surgeons were able to map the neural network of the larynx.

They found that the nucleus of the phrenic nerve is nowhere near the nucleus of the damaged nerve. "This was critical," Ducharme explains, "because if it were close to the damaged nerve, then whatever destroys the laryngeal nerves in roarers might also harm the phrenic nerve."

The Cornell equine surgeons also have collected evidence that when the larynx becomes diseased and produces roaring, the phrenic nerve remains unscathed. That information will allow the Cornell researchers to proceed with transplants of the phrenic nerve. "All this preliminary work is necessary because once we perfect this technique, roarers can be treated successfully," Ducharme explains. Significant headway has been made in experimenting with two techniques for transplanting the nerve, and the researchers hope to be successfully performing phrenic nerve transplants in the near future.

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