EIPH Research: Past and Present

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Since the early 17th century, scientists have recognized that many horses that exercise strenuously bleed from their nostrils during or shortly after a workout, a phenomenon known to horsemen as "bleeding." For many years, people thought this blood originated from the nose. However, 20 years ago, an energetic young graduate student from the UC Davis School of Veterinary Medicine, Dr. John Pascoe (now Executive Associate Dean of the school), used a fiberoptic bronchoscope to examine the airways of horses following racing. He demonstrated that the blood originates in the lungs and he coined the technical term for the disease—exercise-induced pulmonary hemorrhage or EIPH. Dr. Pascoe found that the majority of racehorses eventually experience EIPH and more recent studies suggest that anywhere from 70 to 100 percent of horses in racing and training experience EIPH. This problem is not only limited to racehorses; horses engaged in any activity that involves strenuous effort are susceptible, including draft horses pulling heavy loads.

Bleeding from the lungs during exercise is rarely reported in other mammals, yet nearly all horses experience this bleeding—why? Research has shown that during exercise, horses have unusually high blood pressures in the vessels that lead from the heart to the lungs—two to three times higher than in almost all other species—and scientists have hypothesized that high blood pressures in the lungs' small vessels could lead to their breaking and releasing blood into the airways. Research has focused on why the blood pressure in the pulmonary blood vessels is high during exercise in horses, and particularly on whether the high pressures are required to push the blood through

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Drs. John Pasco (second from left) and Jim Jones (second from right) with members of the Japan Racing Association at the International Conference on Equine Exercise Physiology in Japan during September 1998. They were presenting collaborative research on equine athletic performance.

the smaller blood vessels in the lungs because they are too small and have high resistance.

In an effort to reduce this blood pressure in the lungs, the diuretic furosemide (Lasix) has been administered to horses prior to a race. Horsemen use Lasix to make the horse urinate, thereby slightly reducing the volume of fluid in its circulatory system and hence, the degree to which the blood vessels are stretched and generate pressure. Although studies have shown that Lasix does lower blood pressure slightly, it has never been definitively demonstrated that Lasix reduces the frequency or severity of bleeding. Furthermore, Lasix has numerous undesirable effects, e.g., dehydrating a horse just prior to engaging in heavy exercise, diluting the urine and making it more difficult to detect illegal drugs, and a number of other direct and indirect physiological consequences for different body systems. Evidence also suggests that the sum of these effects is a slight, but measurable, enhancement of racing performance in horses receiving Lasix.

Nearly 10 years ago, Drs. Jim Jones and John Pascoe of the UC Davis School of Veterinary Medicine evaluated this question from a different approach. If the blood pressures in the vessels leading to the lungs were due to the high pressure needed to push blood through the lungs themselves, the pressure would be used up as the blood went through the lungs. Instead, what if the high blood pressure was due to the blood pressure being high on the far side of the lungs (downstream)? These blood vessels simply collect the blood from the lungs and return it to the heart, where it is pumped to the rest of the body. If the pressure in these vessels were high, then in order for blood to flow from the lungs to these vessels, the blood pressure in the lung vessels would have to be even higher. Unfortunately, it is very difficult to evaluate this hypothesis because the vessels that connect the downstream side of the lung to the heart are inaccessible—they are deep within the horse's chest.

Drs. Jones and Pascoe began a series of studies in which they surgically implanted catheters into the hearts of horses to directly measure blood pressures. These were very difficult studies because they required horses to recover from major chest surgery, then return to maximum performance on the treadmill. The results showed that the pressures in the heart are unusually high, thus raising the blood pressure throughout the lung and setting up conditions in which EIPH might occur. These studies were funded by CEH and Grayson-Jockey Club. Concurrent studies have been funded by the CEH, Japan Racing Association, and the Southern California Equine Foundation/Dolly Green Research Foundation.

In extensive collaborative studies with the Japan Racing Association

EIPH Facts vs. Fiction

FICTION: If you can't see any blood in the nose after exercising, there was no bleeding (EIPH)

FACT: Most cases of EIPH occur internally with no external sign of bleeding. In Japan, researchers analyzed 250,000 racing starts and found that bleeding from the nose occurred in less than 0.2 percent of the racing starts. However, in studies using an endoscope, in which a tube is passed via the nose and the veterinarian looks into the airways, researchers found that 50-70 percent of all horses that race experience EIPH at some time. In studies that evaluated airway cellular debris, results suggest that perhaps 100 percent of racehorses experience EIPH.

FICTION: Only Thoroughbreds running flat races experience EIPH.

FACT: Bleeding can occur with almost any type of severe exercise in horses, even with draft animals pulling heavy loads. Some horses pull-up and show evidence of bleeding immediately after sudden exercise (e.g., the start of a Quarterhorse spring). Some evidence suggests that bleeding might be more frequent in shorter, tougher intensity events. At UC Davis, horses on the treadmill have bled severely when simply changing from a trot to a canter.

FICTION: Lasix will prevent a horse from bleeding.

FACT: The diuretic Lasix can be legally administered four hours before a race to horses that have been documented with a history of bleeding. Although Lasix does lower blood pressures slightly there is no proof that it reduces the incidence or severity of bleeding. Several studies have found evidence indicating that Lasix measurably improves racing performance, however, it dehydrates the horse prior to the race, as well as dilutes any drug residues that might be in the urine. Recent evidence indicates that Lasix causes only a slight improvement in racing performance.

How do I tell if my horse is bleeding?

In rare cases, a horse may spray blood from its nose while exercising or after abruptly pulling up. In other unusual cases, there may be a thin trickle of blood showing from one or both nostrils up to two hours after a workout. The most common way to diagnose EIPH is by passing a flexible endoscope into the horse's airways to view the blood that is being cleared from areas of the lungs where bleeding occurred. This is usually done one to two hours following exercise. Over time, repeated EIPH incidences will lead to changes in lung structure as a reaction to the blood in the airways. In extreme cases, large areas of the lung's upper rear portion may consolidate to become unusually solid which may be detectable with radiographic imaging.

Dr. Jones holding a newborn pronghorn antelope, one of the animal athletes he has compared to horses in his research. The antelope was hand-raised and taught to run on the treadmill.

(JRA), researchers utilized surgically implanted catheters in conjunction with ultrasound crystals surgically affixed to the surface of the heart to directly measure the mechanics of the heart during exercise. These excruciatingly difficult experiments showed that the fundamental cause of the high pressures in the heart, and hence the lungs, appears to be the heart's inability to relax quickly enough between beats during extreme exercise. When the heart is not relaxed and thus too stiff, it takes higher pressure upstream (in the lungs) to fill the heart between beats. This finding led to current studies that evaluate possible methods to enhance the rate at which the heart relaxes during heavy exercise.

To understand why the horse's heart relaxes too slowly at maximum exercise, Dr. Jones compared horses with another mammalian athlete, the pronghorn antelope. Among mammals, pronghorn antelope have one of the highest abilities to utilize oxygen (they are highly aerobic). They have a maximum rate of oxygen consumption during exercise that is nearly twice that of a horse (per unit of body weight). They also are capable of sprinting at speeds approaching 60 mph and running fully aerobically for an extended period of time at a speed (45 mph) that the fastest Quarter Horse can only reach in a sprint for 20 seconds. However, pronghorn are exceptionally skittish animals. To study them on a treadmill was a challenge.

Dr. Jones and his colleagues spent a month camped in the sagebrush of northern Colorado to capture newborn pronghorn fawns. The fawns were then bottle fed and hand-raised for two years until they were mature, and had grown up trained to run on a treadmill. These studies showed that although the pronghorn is more highly aerobic and its heart pumps relatively more blood than the horse's, it accomplishes this without the high blood pressures that occur in the horse. This suggests that body (and heart) size may be an important factor in understanding why horses have such high blood pressures and why their lungs bleed.

Our current knowledge of the mechanisms responsible for causing EIPH is not sufficient to provide a cure or method to prevent it from occurring. However, we have made great advances in just the past few years in understanding the physiological factors that seem to be involved. These advances hold great promise for providing the tools necessary to develop a method to prevent or reduce the severity of EIPH in the near future. Much of this information, particularly that related to the heart's role in predisposing the horse to this problem, has resulted from the collaborative research studies between UC Davis and the JRA. Experiments are currently being conducted to evaluate physiological strategies on which a future therapy might be based.

A cutaway of an equine lung showing the airways. The narrow region at the top right is the area where bleeding occurs.