A New Theory on Bleeders

A recent study indicates that bleeding from the lungs in horses occurs within the bronchial blood circulation and that low-grade inflammation is a factor.

by Peter D. Rossdale, England

Nosebleeds are familiar to all of us, and most people have personally experienced the problem at some time or other. During the last century, it was believed that a nosebleed was nature's way of relieving vessels which became to full. The favorite antidote was to throw cold water over the face or apply a cold compress or ice to the back of the neck. This was thought to produce a chill, which drove the blood from the bleeding surface.

In more recent times, nosebleeds are treated only if the individual suffers from them repeatedly. In these cases, the offending vessel is located and cauterized to seal it.

Because of people's familiarity with nosebleeds, they long assumed that the horse suffers in a similar manner, i.e., a broken vessel in the nose. In the early 1970s, however, Bob Cook, now a professor at Tufts University in the U.S., put forward the then original view that equine nosebleeds, following exercise, originated from the lungs. This theory has subsequently been confirmed by a number of independent workers.

For example, Dr. John Pascoe and Prof. J.D. Wheat with their colleagues at the University of California at Davis, observed blood in the windpipe of most horses with a few minutes of their completing strenuous exercise. The term exercise-induced pulmonary hemorrhage (EIPH) thus became an accepted term for equine nosebleeds.

When a horse bleeds from its nostrils, the event is obvious and can be seen by all observers. When a fiberoptic endoscope was used to search for the origin of the blood, many more horses had some evidence of blood in the windpipe (Fig. 1) than could be appreciated by external observation. This blood was traced to the lungs (Fig. 2).

Because of this discrepancy, the whole subject took on a different complexion. The complexity of bleeders continues to puzzle us today, despite some major advances in understanding achieved during the last decade.

If bleeding occurs from the lungs, why does blood issue from the nose only in a small percentage of cases? Is this because of the quantity of blood or the manner in which it escapes from the lungs? Where is the origin of the blood in the lungs? What is the cause of bleeding? If some blood escapes in small quantities in 80 or 90 percent of cases, can some blood in the windpipe be a normal sign? What is the cause of bleeding?

All these questions are to some extent interrelated. Answers to one alter our approach to others. Further, as newly discovered facts accumulate, further questions arise.

During the 1970's, investigators began to examine the lungs by radiography in addition to endoscopy. These studies were part of a collaborative effort between veterinarians at Davis and at Happy Valley Racecourse in Hong Kong.

An important feature of this collaboration was the discovery of evidence suggesting that bleeding occurred from the upper rather than the lower part of the lungs and from the hind rather than the front portion. These findings led to the supposition that bleeding was a result of mechanical forces related to the varying pressures operating throughout the lung as it expanded and contracted during breathing. This theory of mechanical causation has many supporters.

All the blood passes through the lungs in minute capillary vessels (Fig. 3) separated from the air by only the thickness of two cells (Fig. 4). It does not take a great deal of imagination to envi-

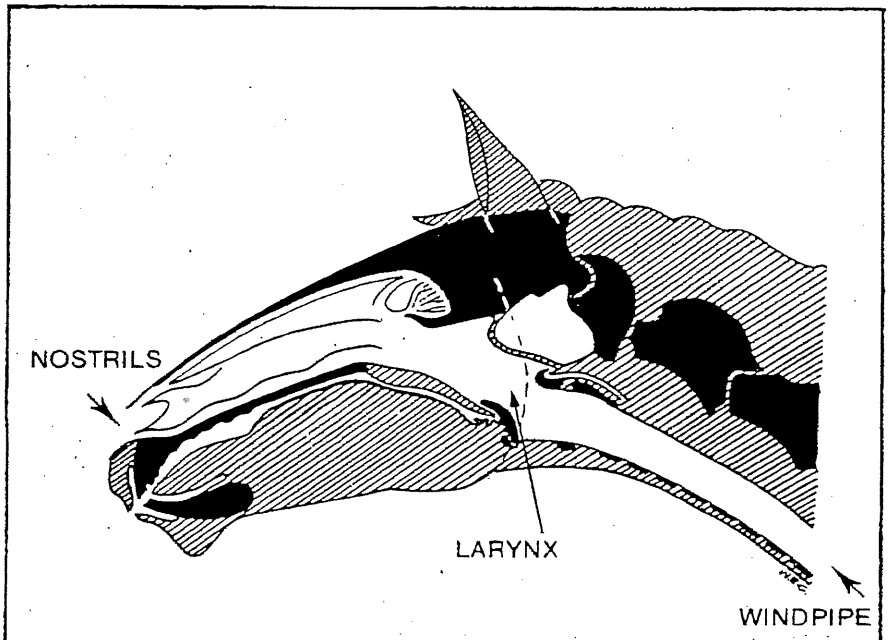


Figure 1: An equine nosebleed suggests blood issuing from the nostrils, though studies have shown the blood to come from the lungs.

sion leakage of blood in these circumstances, especially considering the system in light of the fact that hundreds of liters of blood pass through the lungs every minute of every day and the amount increases greatly with exercise. To achieve this increased flow, blood pressure must rise as the mechanical forces of expanding the lungs correspondingly increases in order to meet the needs of the extra air required to provide sufficient oxygen for the blood during maximum exercise.

A more recent step in the investigation of pulmonary bleeding has utilized the comparatively modern technique of nuclear imaging and scintigraphy. These techniques involve the injection of radioactive substances, which can be photographed or measured by cameras and other materials as they pass through, or become incorporated into, areas of the body such as the lungs. Measurements reveal the density and location of the substances.

Studies reported in the September special issue of the *Equine Veterinary Journal* include the details of the clinical, post mortem, and imaging of the lungs of 26 Thoroughbred horses retired from training in Hong Kong during the 1984-85 racing season. These studies are reported in a series of eight papers, the senior author in each case being Dr. Mike O'Callaghan, a New Zealand veterinarian now at Tufts University. His co-workers include Drs. John Pascoe, Walt Tyler, and David Mason.

This is the first such comprehensive study of the problem involving serial clinical examinations correlated with subsequent post mortem findings. Previous studies of post mortem findings have relied mainly on individuals that have died as a result of a hemorrhage and were cases that had not been extensively investigated clinically prior to death.

The results of this highly meritorious study are used to advance the hypothesis that bleeding in the lungs occurs from the bronchial rather than the pulmonary blood circulation.

In pulmonary circulation, blood is pumped from the *right* side of the heart (Fig. 5) through the minute blood vessels (capillaries) in the walls of the air sacs. The bloodstream passes through the walls of the air sacs, takes up oxygen, and flows to the *left* side of the heart from where it is pumped to the head,

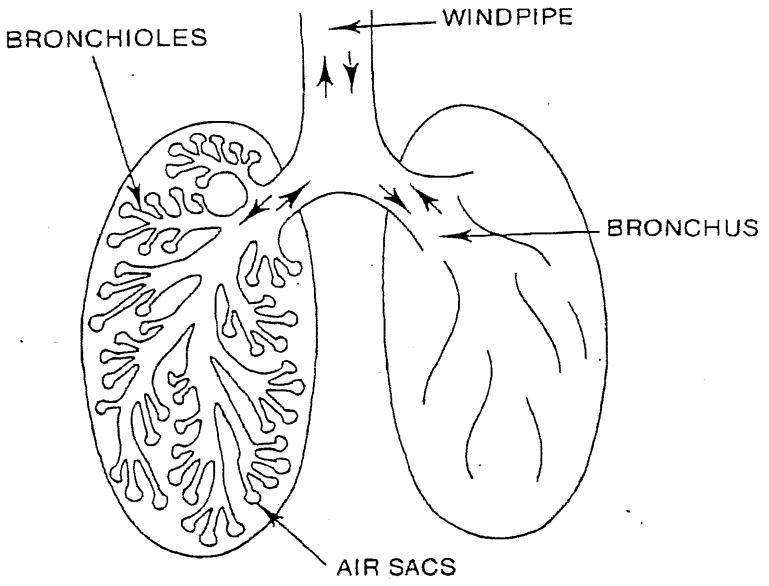
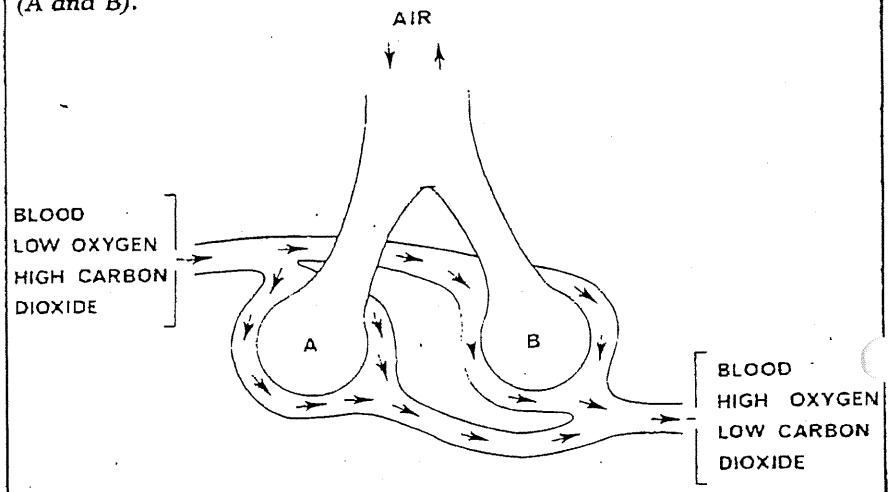


Figure 2: The equine lung. "A" indicates the entry on the left side of bronchial blood vessels, which supply the tissues of the lung and are separate from the pulmonary circulation (right side).

Figure 3: Blood flows, as illustrated, around each minute air sac of the lung (A and B).



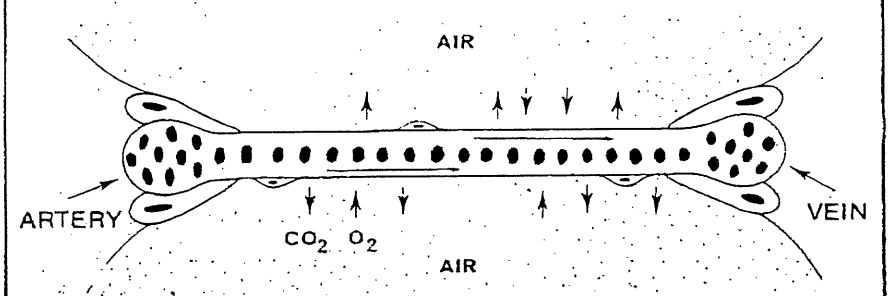


Figure 4: The blood in the lung is separated from air only by the thickness of two cells, and oxygen and carbon dioxide are exchanged between air and blood.

limbs, and body, including all of the organs.

The bronchial bloodstream, however, is derived from blood pumped from the *left* side of the heart. In other words, this is the blood supplied to nourish the lung itself, the lung being an organ in the same sense as the kidney, liver, pancreas, etc.

In this respect, the lung is like the heart, which, as a pump, acts as a driving force but is nourished by the coronary arteries. These coronary arteries may be likened to bronchial arteries in the sense that both are derived from the left rather than the right side of the circulation.

Blood flowing through the left side of the heart has a high oxygen content because it has been received from the lungs. Blood on the right side, however, has low oxygen content because it is received from organs and tissues that have taken up the oxygen for their own function. Thus, the bronchial and coronary circulations bring oxygen for the use of the tissue of the heart and lungs, respectively.

All of the O'Callaghan horses were geldings made available from approximately 730 horses in training at the Royal Hong Kong Jockey Club's Shatin Racecourse in Hong Kong. Nineteen of the horses had been retired from racing because of recurrent nosebleeds and/or poor performance, and seven because of lameness.

After the horses were destroyed, the bronchial and pulmonary circulations of each individual were injected with a cover of latex and the lungs subjected to special scanning techniques. The major damage was found to involve areas of inflammation accompanied by a proliferation of minute blood vessels extending from the bronchial blood vessels. In affected areas, the bronchial circulation had largely taken over the pulmonary circulation and there was evidence of previous hemorrhage from this bronchial circulation.

Dr. O'Callaghan and his colleagues concluded that, although the cause of equine nosebleeds was not determined by the study, the nature of the changes indicated that a low-grade bronchiolitis (inflammation of the small airways) was a factor. They envisaged a vicious cycle of increasing inflammation causing further bleeding, which resulted in further inflammatory effects.

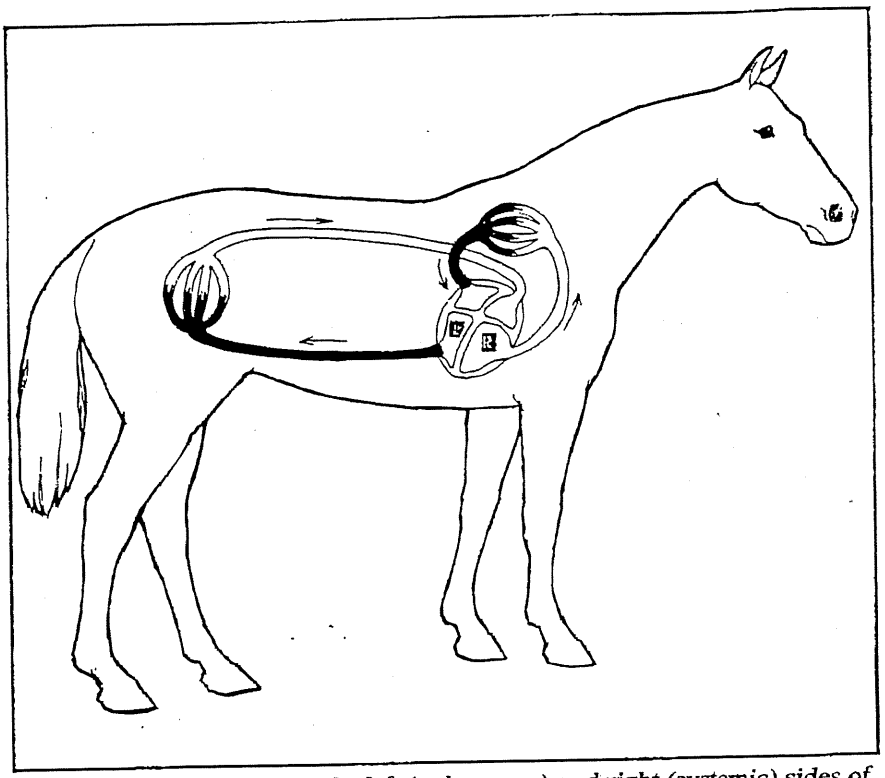


Figure 5: Blood passes on the left (pulmonary) and right (systemic) sides of the body, the arrows indicating the direction of blood flow (dark is arterial and light is venous blood). (A, blood flow of the lungs; L, left side of the heart; R, right side of the heart; B, blood flow of the body.)

A cardiovascular conditioning process, Interval Training reduces the incidence of stress induced bleeding in horses. Beginning with long distances at a slow rate of speed, a less stressful conditioning workout, a trainer gradually shortens distances and increases speed. Interval Training thereby creates a great expansion of the capillary bed in the heart-to-lung interface, and throughout the body. In bleeders, the effect of capillary expansion is a reduction of pressure as the system opens; an expanded capillary bed gives blood a systemic outlet which avoids rupture. As this occurs, Interval Training affords the race horse—whose heart rate jumps from 33 to 240 even as the thickness of his blood doubles—a level of fitness which makes racing less stressful.

For further information, refer to ***The Fit Race Horse*** *by Tom Ivers, published by Equine Racing Systems, Solvang, California.*

This cycle would be based on localized lack of oxygen (hypoxia); especially during periods of maximal exercise and coexisting with partial obstruction to the airways, thus introducing adnormal mechanical forces and lack of oxygen in the vicinity of original damage.

This vicious cycle of events is thought to result in a progressive deterioration and increased opportunity for bleeding as new blood vessels develop in the damaged area. They then leak at times of maximal exercise, when blood pressure and flow is markedly increased over resting levels while the lung itself is being subjected to maximal forces of breathing.

In this scenario, we can envision the start of the vicious circle as inflammation caused by infection with a virus and/or bacteria. In addition, the effect of air pollution (see the February 1988 issue of *The Thoroughbred of California*, page 106) must remain high on the list of factors that make the lungs more susceptible to infection and the type of inflammatory damage from which bleeding stems.

If we translate the facts as we know them about equine nosebleeds into the practical realities of attempts to prevent, minimize, or treat their happening, we can discern some hopeful progress from the findings of recent years.

We have certainly moved away from the concept of cold water or compresses applied to a horse's head. We now know that bleeding comes the from lungs. The debate about the diuretic drug Lasix and whether or not this is effective must now be sidelined because, at best, it can be only palliative. This is because the drug changes blood volume rather than acting directly to alleviate chronic inflammation and airway obstruction.

The real key to successful prevention must lie in the means of avoiding damage within the lungs. The search for this means must start at the point of air hygiene and proceed to ways of avoiding infection with virus by vaccination and, where practical, by segregating infected individuals to avoid spread of infection to others.

Treatment of individuals already affected has to include drugs that combat infection and reduce inflammation. Rest is probably the most important contributory benefit to healing, however, together with avoiding the ill effects of stress that exercise brings to levels of resistance and healing within the lung.

The nosebleed saga continues, and the jigsaw of our knowledge is far from complete. The O'Callaghan papers have undoubtedly advanced our understanding and, importantly, provided further impetus in the search for a solution.

Fundamental questions remain, though. For example, bleeding is but a symptom. We have no real knowledge of how a particular individual is affected by these symptoms, especially with regard to the quantity of blood we see issuing from the nose or lying in the windpipe.

Are these indicators of the effect of bleeding on the individual? It is possible that we see a small amount of blood because large amounts have been retained further in the lung and remain unseen. The effects on the individual may, in these circumstances, be extensive. Conversely, a large amount of blood may come from a very small area of damage and the consequences to the individual be much less.

In fact, the consequence of blood may be less than the consequence of the damage that causes the bleeding. It is only when we are able to pursue investigations under conditions that enable the study of function rather than post mortem consequences that the answers to these questions are likely to be determined.

The consequences of bleeders to breeders lies in the reduction of potential to the individuals this produces. By careful selection and diligent management, all their efforts may therefore be for naught by leaking blood vessels.

If damage to the lungs is the basis of bleeding and therefore poor performance, however, we should perhaps pay more attention to the infections suffered by foals and weanlings.

For many decades, the snotty-nosed foal and weanling was regarded in a similiar light to children suffering from colds. It was assumed that they were inevitable but helped to confer immunity and resistance against infections in later life.

There is a basic truth in this supposition. It does not, however, take into account the damage that this process of infection may cause, damage that may subsequently initiate the vicious cycle of events described above, leading to nosebleeds.

More effective and less risky means of vaccination for young stock are required. Current work on immunology is increasingly focusing attention on the need to develop vaccines that stimulate production of antibodies on the lining of the airways, in addition to those that stimulate such protective substances in the bloodstream.

The need for breeders, racehorse trainers, and owners to collaborate in the fight against disease is of paramount importance. There is always a dichotomy in the life of the racehorse between its farm and racetrack existence. This division is nowadays bridged with regard to parasites, and strict precautions are usually taken in the formative years to reduce the risk of damage caused by such parasites as *Strongylus vulgaris* (red worm).

We have yet to achieve a similar satisfactory situation on viral and bacterial infections. Further investigative work is therefore required to establish the age at which problems such as nosebleeds are initiated within the equine lung. □

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