

Understanding Exercise-Induced Pulmonary Hemorrhage (EIPH) & How to Manage It

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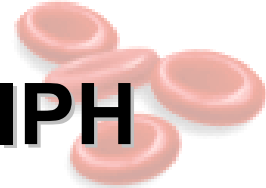
Flair, LLC

3 Day

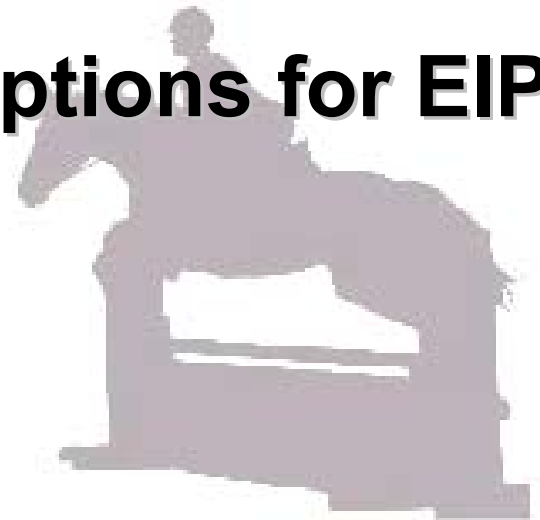
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This talk will cover....

- **Definition and background on EIPH**
- **Causes of EIPH**
- **Diagnosis of EIPH**
- **Management and treatment options for EIPH**
- **Conclusions**



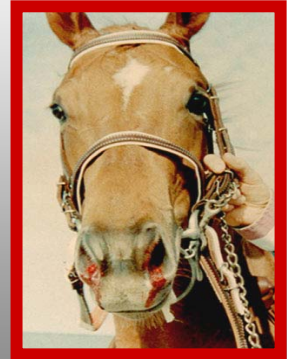
3 Day



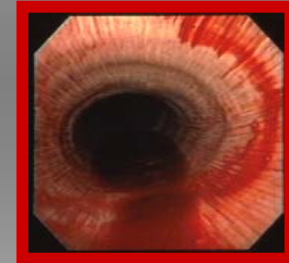
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What is Exercise-induced Pulmonary Hemorrhage (EIPH)?

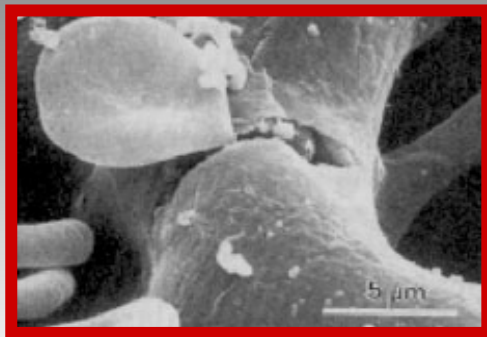
- The presence of blood in the airways during or following exercise



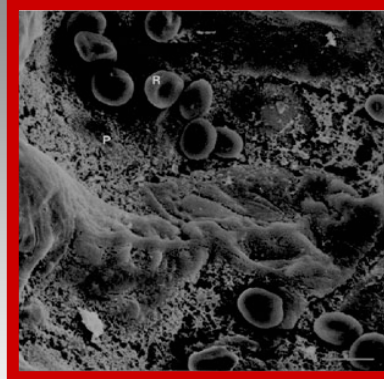
± Bleeding from nose



± Blood in Windpipe



RBC escaping from a tiny blood vessel within the lung into the air spaces



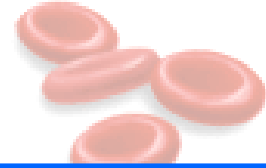
Always RBCs in air spaces of lung

Lay Terms for EIPH

- “Bleeders”

- “Broken blood vessels”

- “Nosebleeds”



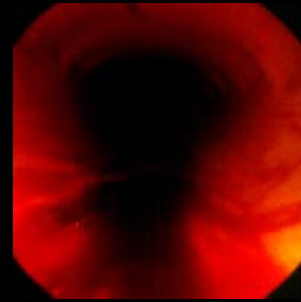
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Importance of Understanding EIPH



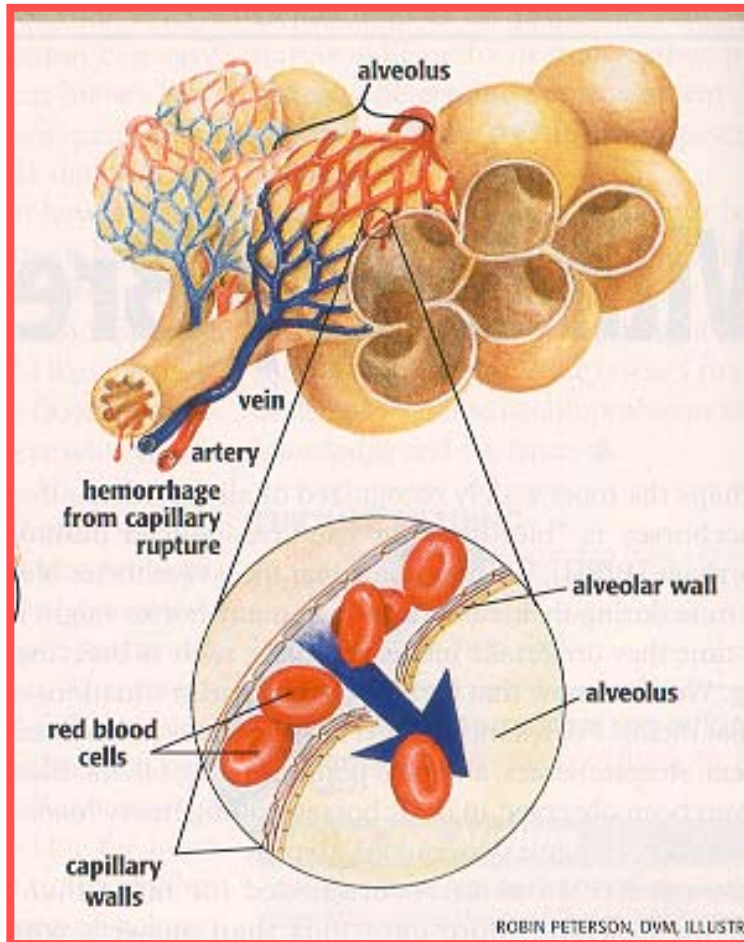
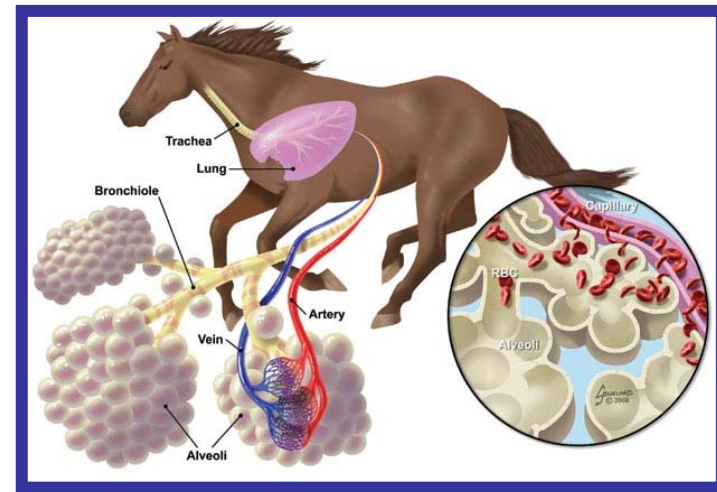
- Affects all exercising horses to some degree
- It is not good as it permanently damages the lungs
- Impacts performance
- Worsens with continued exercise, ↑ training time, and with more events
- Can result in extended time out of training/competition
- May require additional veterinary care if associated with inflammation or infection
- May result in premature athletic career termination due to cumulative damage
- Can result in death, in rare, but severe cases
- Owners pay large sums of money for unproven and ineffective treatments
- Costs industry, especially racehorse industry > \$100,000,000/year in diagnosis and treatment



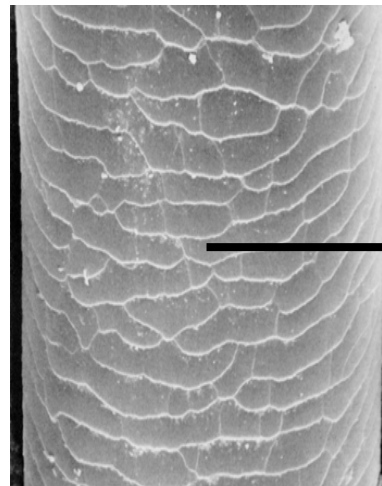
- All horses bleed to some varying degree, even during lower intensity level exercise
- Severity of bleeding ↑ with more intense exercise

Review of Anatomy

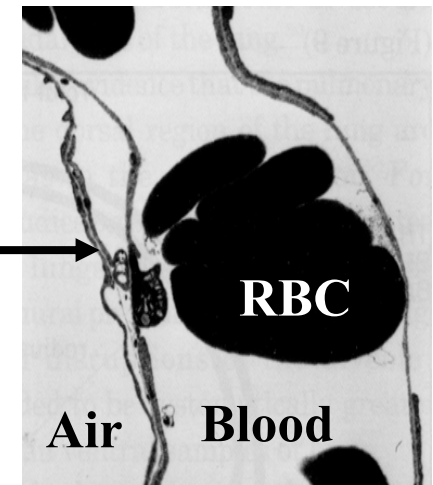
Smallest airways within lungs are completely surrounded by a network of very small blood vessels



Human Hair

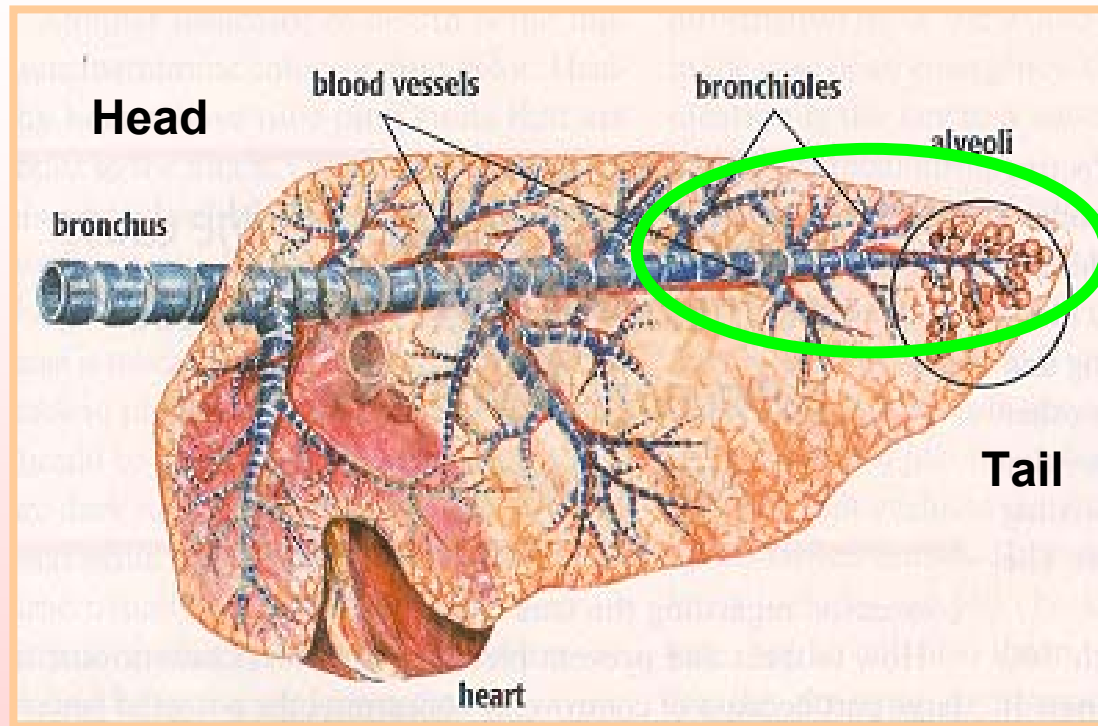


Blood-Gas Barrier



Tissue where oxygen in the air is transferred into the circulating blood (Blood-Gas Barrier) is 1/100th of the thickness of a human hair

Location of EIPH in the Lungs



- Dorsocaudal region of lung (region directly under back of saddle) is predominant site of EIPH. As horse continues to event and train, damage progresses in a forward and downward direction

Site of Initiation & Progression of EIPH

caudal



dorsal



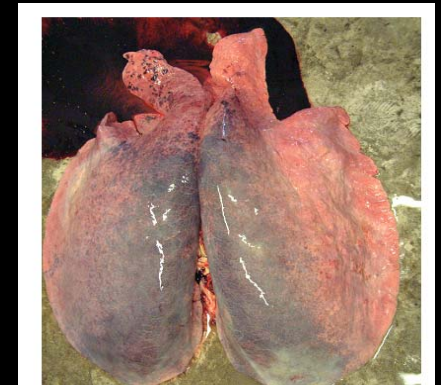
cranial

cranial

ventral

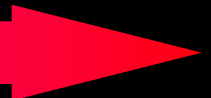


Head

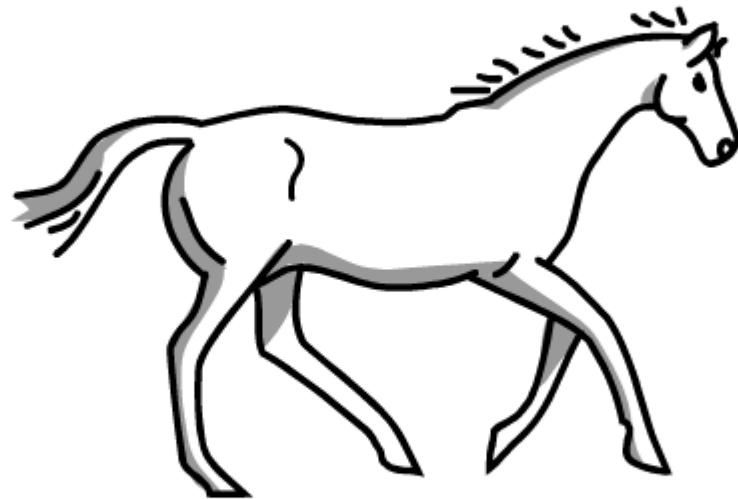


Tail

Increasing damage



EIPH



Which Phases of 3-Day Eventing may result in EIPH?

- During conditioning and training
 - significant level of EIPH present in lungs of horses during trot and canter
- Cross-Country
- Stadium Jumping
- Bleeding may be less severe during Stadium Jumping due to ↑ intensity of Cross-Country phase



Factors affecting the risk for increased severity and occurrence of EIPH

- **↑ time in training and competition (therefore ↑ age)**
- **Hard ground (firm going)**
- **↑ distance, speed, and weight carried**
- **Females tend to have ↑ severity**
- **Season – spring, winter**
- **Jumping/Steeplechase**
- **Intense training schedule (↑ damage may actually occur during training as more time spent here vs competition)**
- **Pollution (ozone)**
- **Allergy, inflammation, infection**



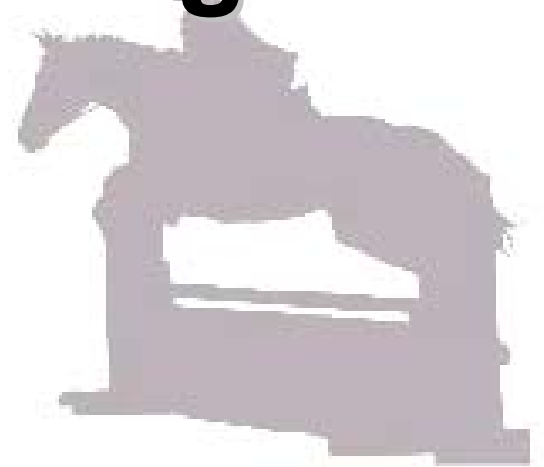
EIPH Negatively Impacts Performance

- Racehorses with mild EIPH (i.e. Endoscopic Grade \leq I/V) are much more likely to be in the top 10% of money earned (less lung damage)
- Racehorses with moderate levels of EIPH (i.e. \geq Endoscopic Grade II/V) have only a 20% chance to win a race & are less likely to finish in the top 3 places
- The more severely a horse bleeds, the further behind the winner it will finish
- Mechanism – severe EIPH fills tiny air spaces and interferes with oxygen transfer into the circulating blood

Factors Responsible for Causing EIPH and Affecting the Severity of Bleeding



3 Day

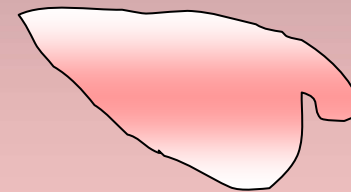
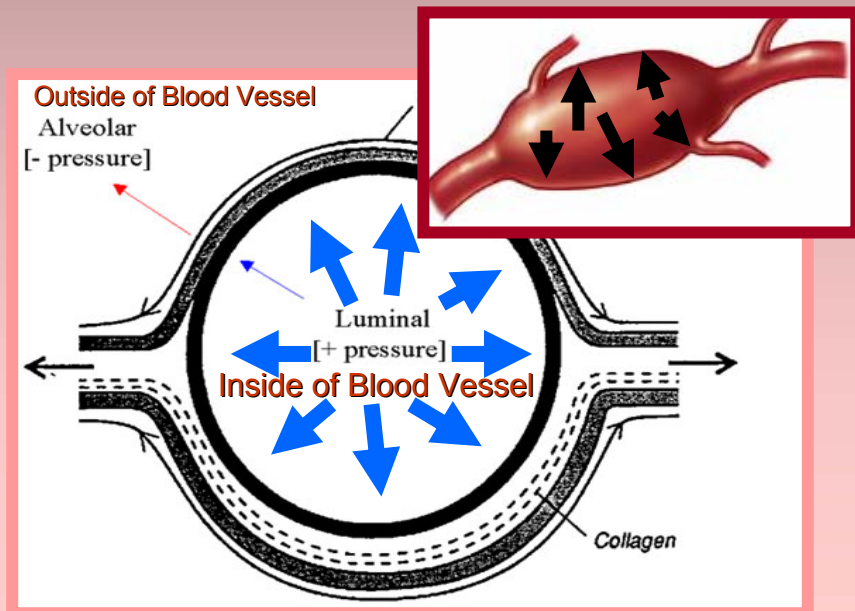


Event

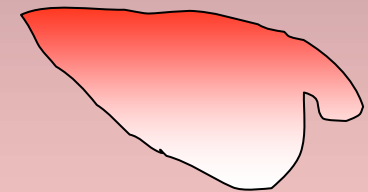
Extremely High Blood Pressure inside the tiny blood vessels coursing through the lung

Result of:

- Extraordinary \uparrow in the amount of blood pumped by the heart per minute in exercising horses
- \uparrow thickness of blood during exercise due to $> 12\text{L}$ of RBC released into the bloodstream at the start of exercise from storage in the spleen
- \uparrow blood flow to the area of the lung that is located directly below the back part of the saddle during exercise



Rest

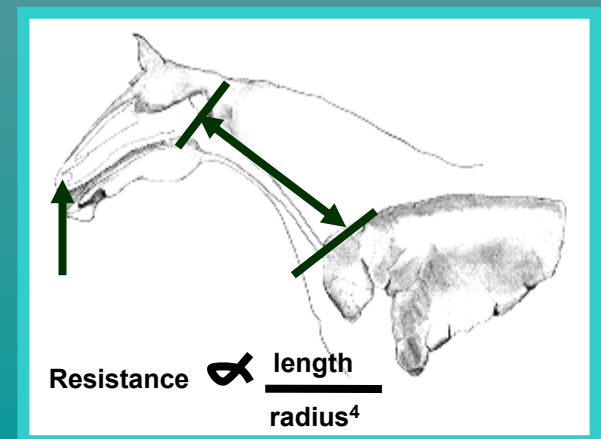
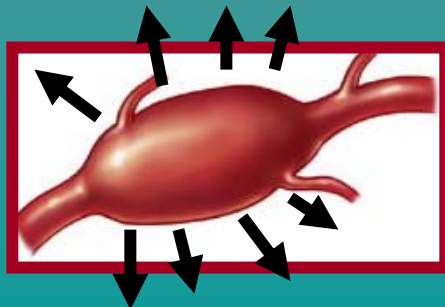


Exercise

- Low blood flow
- Moderate blood flow
- High blood flow

Role of the lungs: Unique Breathing Characteristics Of Exercising Horses

- Horses can only breathe through their nose and 80-90% of the resistance to getting air into lungs occurs here during exercise
- Horses have an extremely long windpipe that is responsible for an additional 25-40% of the resistance to breathing
- Horses must take a breath with each stride (120-140 per minute) during galloping which leaves only a short time available for inhalation and exhalation
 - Therefore, when a horse breathes in, huge suction-like forces are generated by the lungs that ↑ the outward pressure produced by the blood inside the tiny blood vessels deep within the lungs



High blood pressure combined with suction forces generated during breathing result in tearing of millions of small blood vessels and bleeding into the airways of the lungs



RBCs (blood coming out of the blood vessels into the airways)

Upper Airway Obstruction

Abnormal noises heard during exercise

“Gurgling”

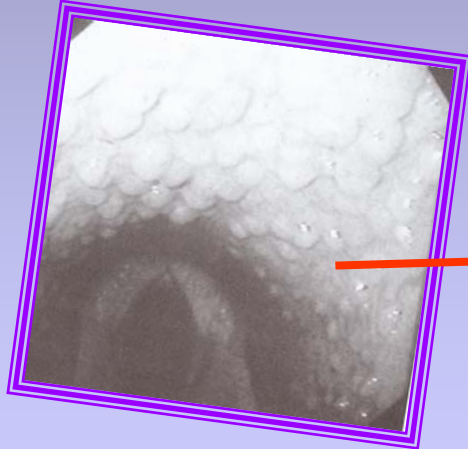
(dorsal displacement
of the soft palate)



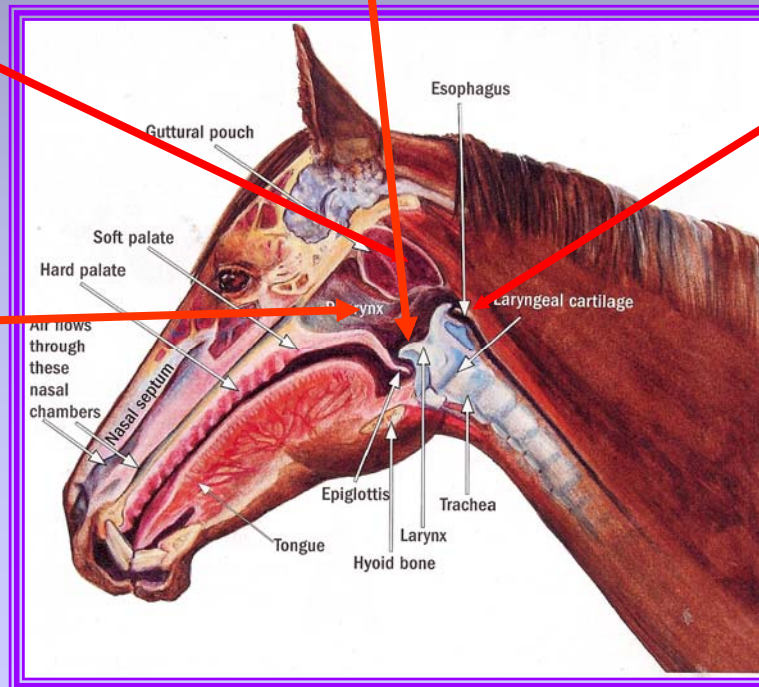
Epiglottic Entrapment



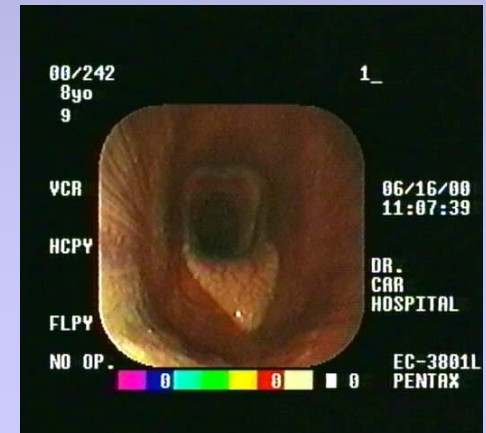
“Roaring/Flappers” (laryngeal hemiplegia)

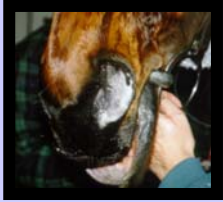


Pharyngeal
Lymphoid
Hyperplasia

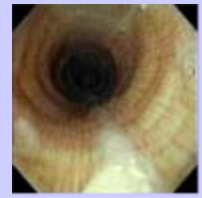


Normal

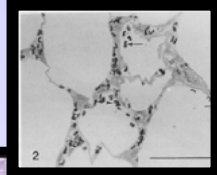
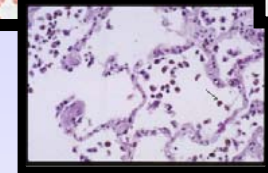
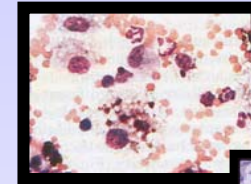




Inflammatory Airway Disease

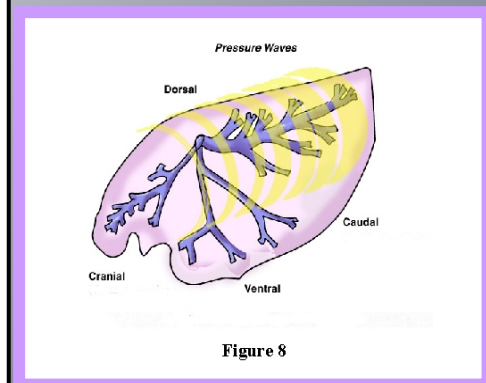
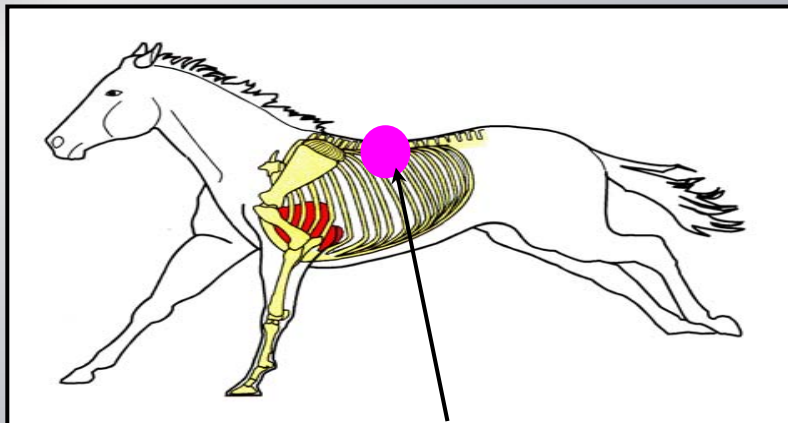


- Airways are inflamed (thickened), narrower than normal due to smooth muscle spasm, and lined with a thicker layer of mucus and WBCs than a normal airway which can result in a decrease in movement of air to and from the lungs
- Causes
 - Viruses (e.g. influenza, herpes virus, rhinovirus)
 - Bacteria (e.g. Strangles “Shipping fever”)
 - Allergens (e.g. mould, pollen > “broken wind”)
 - Irritants (e.g. pollution, cold air, inhaled dirt)
 - long-distance travel (head position)
 - Management (e.g. barn ventilation (air quality), dust in bedding & feed)
 - Trauma associated with blood vessel tearing and presence of blood in lung from EIPH
- Clinical signs: \pm nasal discharge, \pm cough
- Diagnosed by endoscopy or BAL
- Severity varies between horses and shown to affect performance
- Prolonged inflammation in the lungs causes scarring and uneven lung expansion due to \downarrow elasticity of lung tissue
 - Results in \uparrow likelihood of tearing & \uparrow severity and susceptibility to bleeding episodes in the future



Locomotory (Impact)-Induced Lung Trauma

- Upon each contact of the hoof with the ground during running, vibration and pressure waves travel up the leg, across the scapula, and terminate over the lungs in the area of the greatest bleeding directly under the back of the saddle
- These pressure waves cause stress on the lung tissue leading to rupture of the tiny blood vessels within the lungs
- Worse during jumping and exercise on hard ground due to exaggerated impact forces upon landing



Genetic Contributions

Thoroughbred Foundation Sires



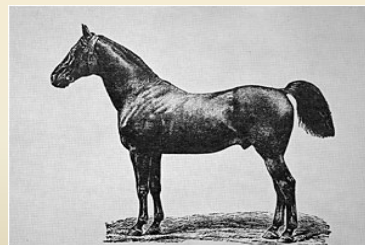
**Darley Arabian
(1700-1733)**



**Godolphin Arabian
(1724-1753)**



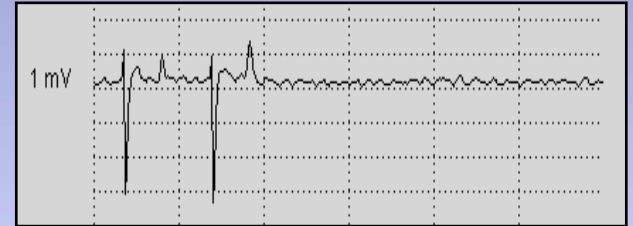
**The Byerly Turk
(1680-1696)**



Bartlet's "Bleeding" Childers (1716)

Additional Factors Influencing the Severity of EIPH

- Scarring of some of the blood vessels within the lung due to repeated exposure to high blood pressures
- Disorders of the heart
 - stiffness of the walls of the heart
 - back-flow of blood through the heart valves
 - abnormal heart rhythms (i.e. atrial fibrillation)
- Compression of the chest during the gallop when the trailing leg is on the ground
- In a horse with marked bleeding from one nostril, endoscopy may be helpful as other disease conditions can cause this type of bleeding
 - (i.e. fungal infections of the guttural pouch, ethmoid hematomas, cysts below the epiglottis, etc.)





Diagnosis of Bleeders

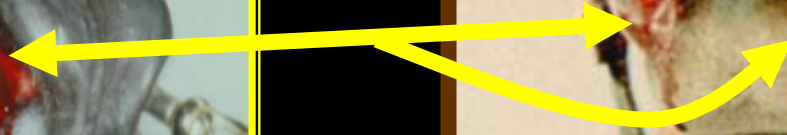
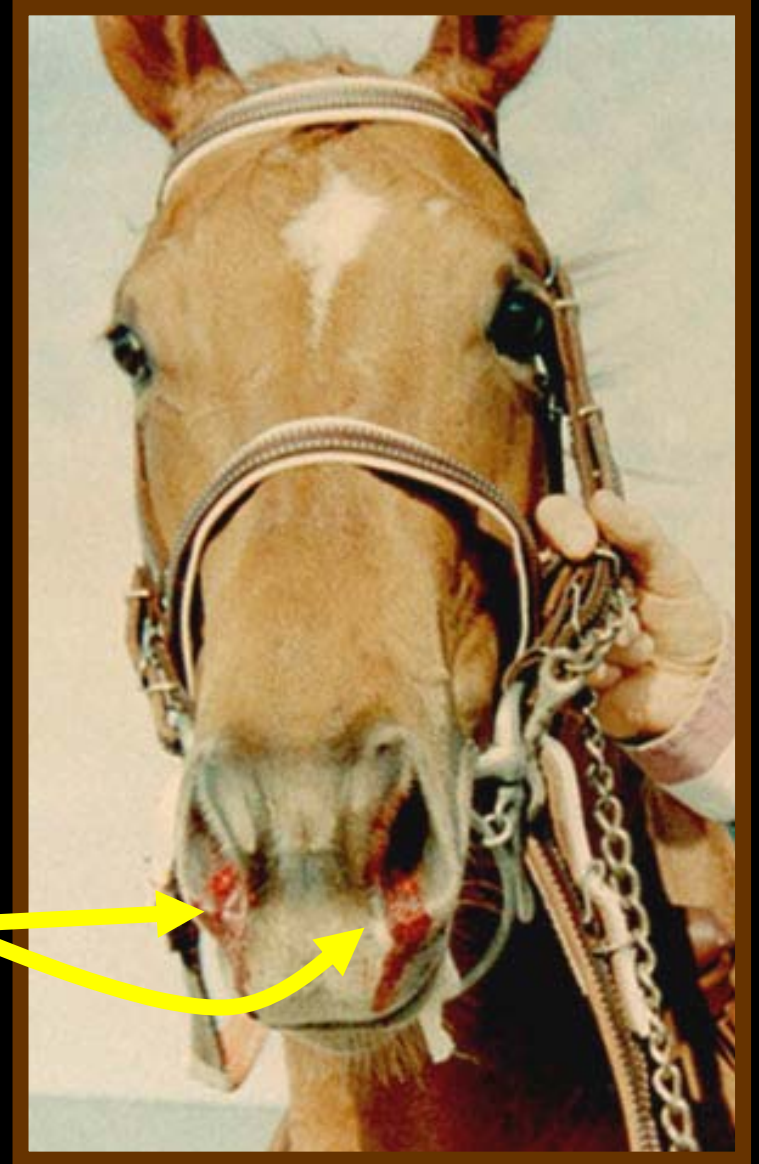


3 Day



Event

- **EIPH first diagnosed by visualization of bleeding at the nose “epistaxis” (0.25 to 13%)**
- **Lung: confirmed as source of hemorrhage (Cook 1974)**

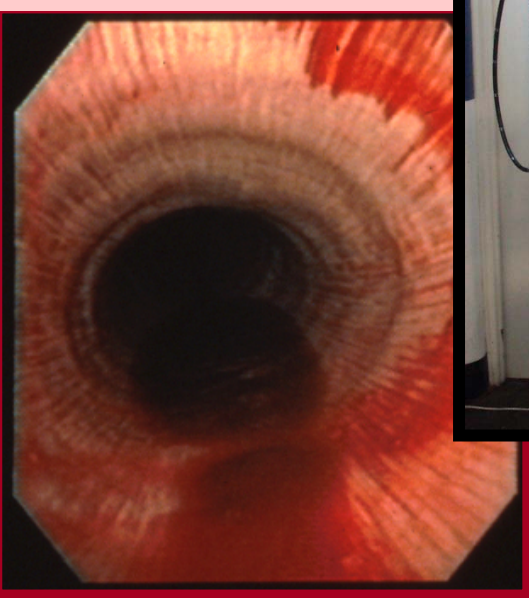


Signs Indicating That Your Horse May Be a “Bleeder” Or Have Inflammatory Airway Disease

- **Clear or white nasal discharge**
- **Blood coming from the nose after exercise**
- **Cough (after exercise)**
- **Disappointing performance**
- **Blowing for a long time after exercise (poor recovery)**
- **Frequent swallowing during cool-out**

Endoscopy

- Detection of EIPH + horses ↑ with repeated number of scopings/horse due to missed diagnoses resulting from limited reach of camera & visualization of airways in the area where bleeding is most common



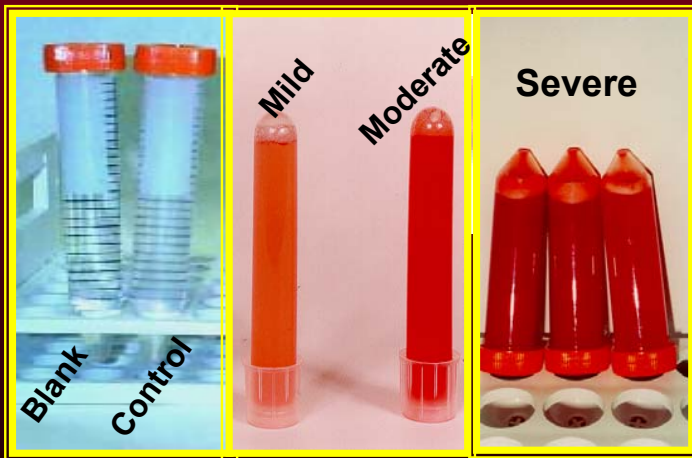
- 40-75% + after single scoping
- 85% + after 2 scopings
- > 95% + after 3 scopings (most all horses have blood in trachea in at least 1 of 3 scopings)

Bronchoalveolar Lavage (BAL) – “Lung Wash”

- Extremely sensitive technique with ability to detect EIPH in all exercising horses



- Can detect lung scavengers called hemosiderophages that contain broken-down RBCs in the lungs of a horse not recently exercised indicating past hemorrhage



- Can detect varying levels of RBCs (red colored fluid) in the lungs of a horse 30-60 minutes post-exercise indicate bleeding during that bout of exercise

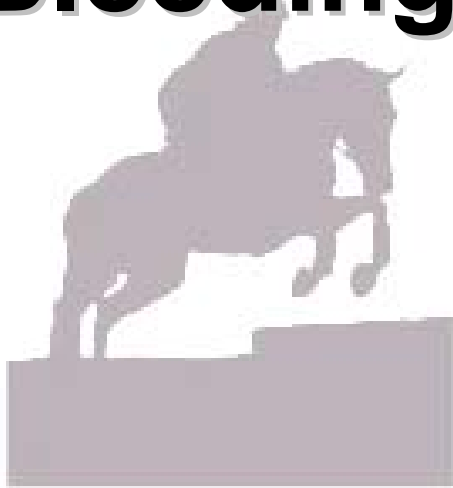
Volume Equivalent of Blood Associated with Visible Blood in Windpipe

- Blood could be seen endoscopically (Grade 1) in the windpipe when the color of the lavage fluid was very red (> 2 mls of blood in lavage fluid)





Treatments to Help Reduce Bleeding Associated with EIPH



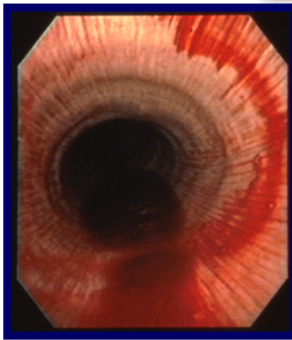
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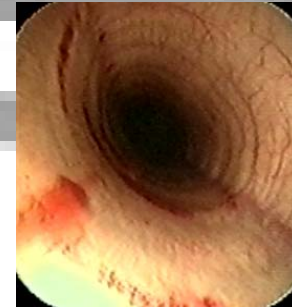
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Goals in Management of EIPH

- ↓ level of bleeding
- ↓ pulmonary damage (improve health of horse)
- Improve performance
- Complete prevention is not a realistic goal due to the multiple factors involved in causing bleeding into the lungs



Before Treatment



After Treatment

Management Factors that are Critical in Promoting a More Healthy Respiratory System

- **Vaccination**
- **Regular endoscopy**
- **Turnout as much as possible**
- **Rubber matting (good quality)**
- **Minimal bedding or that with low dust (paper, cardboard or paper shavings)**
- **Improve air quality (i.e. good stable ventilation)**
- **Never muck-stall with horse inside**
- **Haylage or soaked hay**
- **Low dust feed/grain**
- **Minimize transportation stress**
- **Rest (2-4 weeks in between events)**

Gold Standard Treatment for EIPH



Furosemide/Lasix/Salix™

- Decreases EIPH 50-90%
 - ↓ blood pressure within lungs
 - ↓ amount of blood flow to major area of bleeding
 - May ↑ diameter of airways, making air flow into lungs easier
 - Greater ↓ in bleeding noted at lower intensity exercise

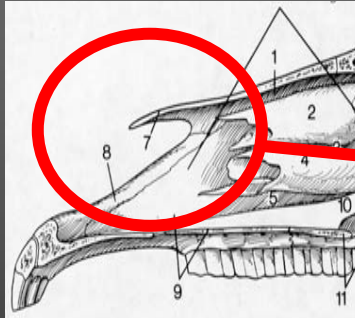
Disadvantages

- Horses may run faster due to weight lost from ↑ urination
- Results in ↑ ability to handle lactic acid, tricking body into running longer
- Potential for making illegal drugs harder to detect by diluted urine
- Greatest effect seen in first couple of uses and effectiveness seems to ↓ with continued use
- May be illegal for use in some competitions

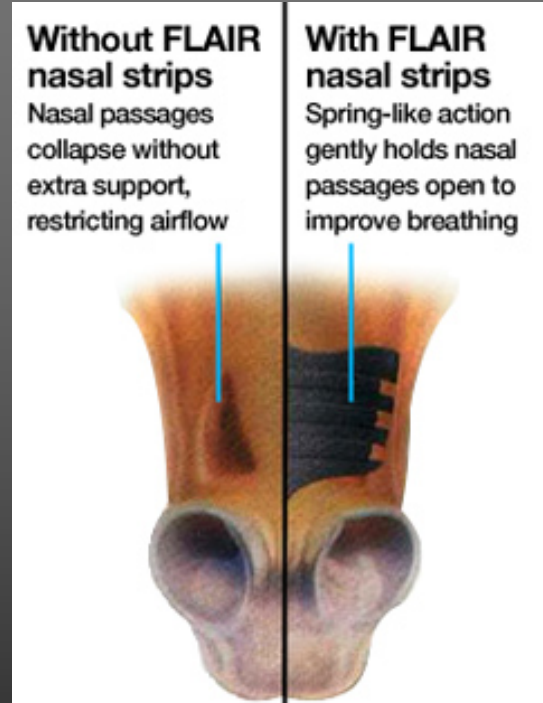


FLAIR® Equine Nasal Strips

- ↓ resistance to breathing and work of breathing by maintaining the size of the nostril and nasal cavity



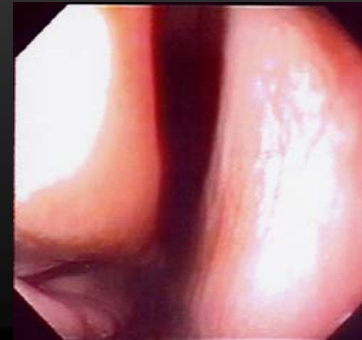
FLAIR strips prevent the collapse of the nasal passages during heavy exercise.



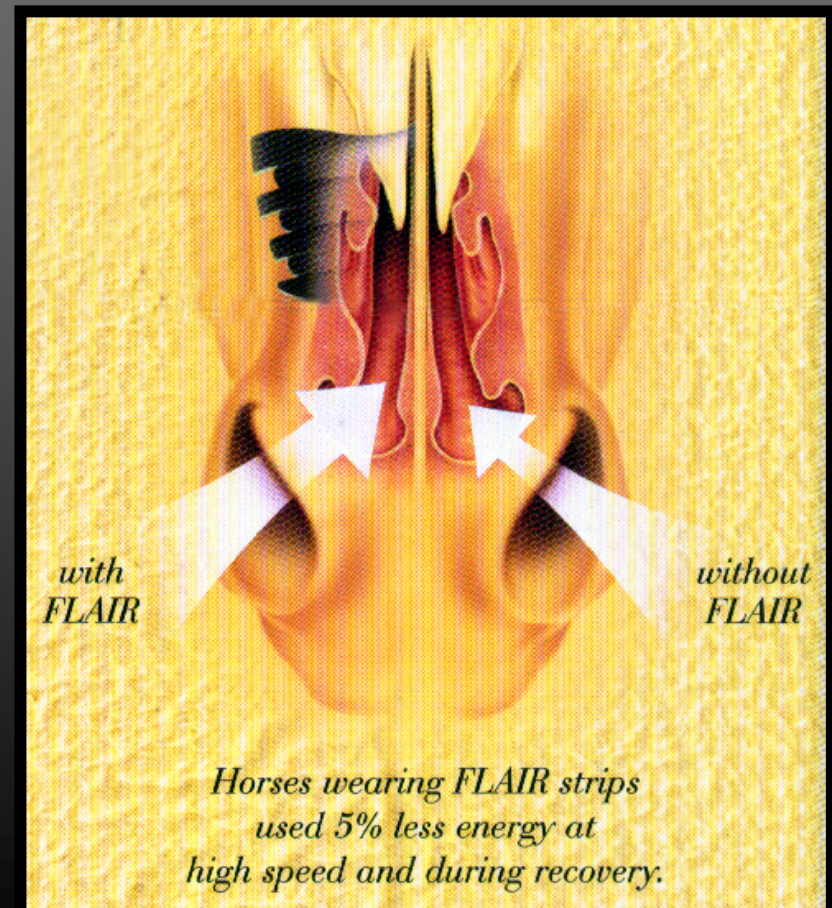
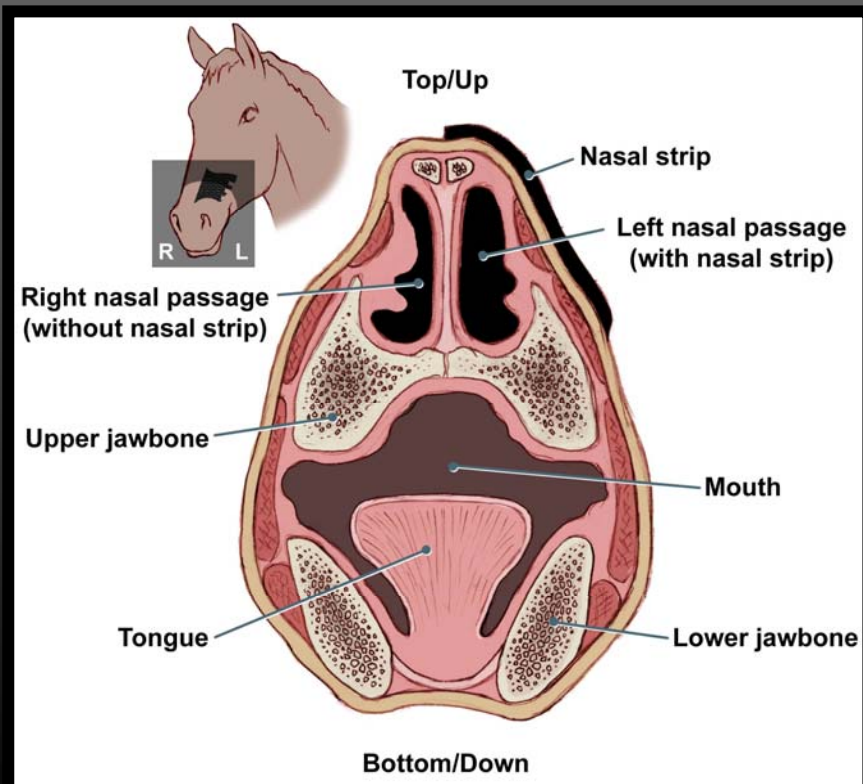
without



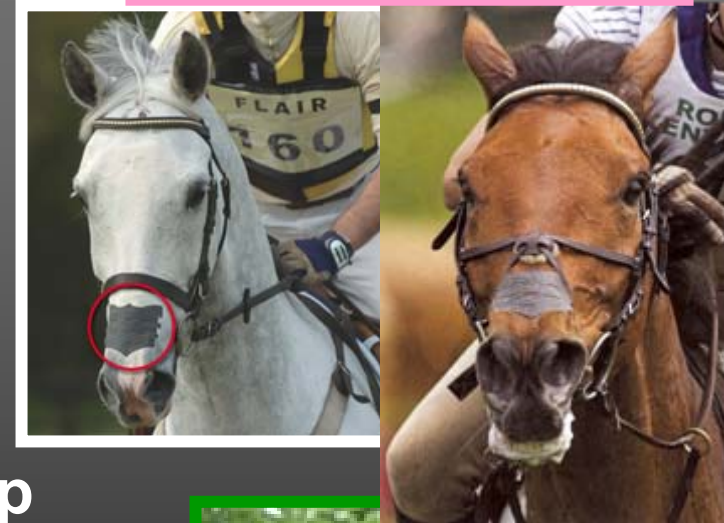
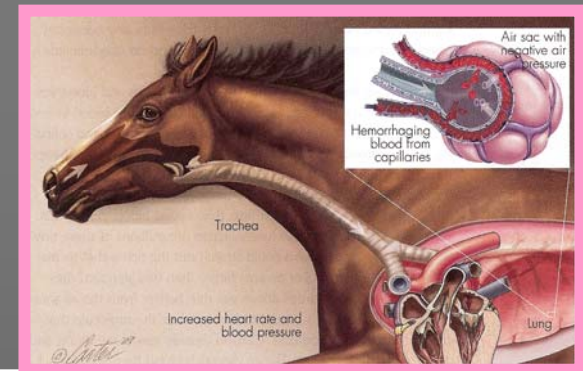
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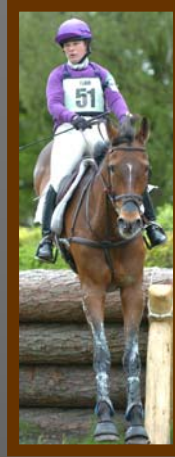
- Less work required to breathe, and therefore, less blood flow and oxygen required by the muscles of breathing so that more is available to exercising muscles (i.e. those used for jumping)
- Horses can run farther and faster without fatiguing (performance enhancement)
- Horses recover faster



- ↓ suction pressure on blood vessels within the lung that ↓ likelihood of tearing
- ↓ EIPH 30% during lower-intensity exercise and 50% during maximal exercise
- Equivalent to lasix at maximal exercise
- Potential benefit of using nasal strip + lasix together
- KSU and racetrack studies indicate:
 - nasal strip affords greatest benefit to worst bleeders
 - Results in 3.4% greater win %
 - 15% ↓ in race interval when wearing the strip vs not

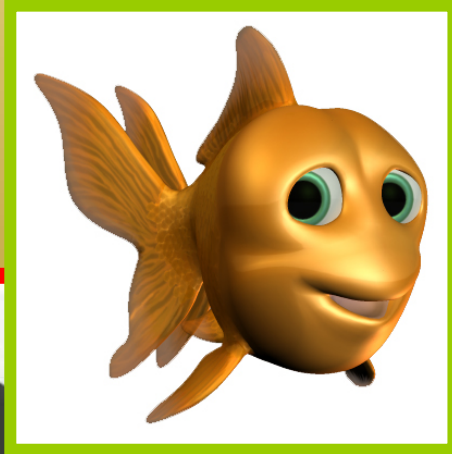


Specific Benefits for All Stages of Eventing



- During Dressage, horses are asked to perform difficult maneuvers requiring aerobic metabolism and the delivery of adequate oxygen to working muscles
 - When horses are collected, neck is bent, reducing diameter of windpipe and increasing resistance to breathing, which can impact airflow and concentration of horse
- Horses hold their breath while going over jumps
 - FLAIR strips make it easier to move air into the lungs more efficiently in between jumps to improve concentration, slow onset of fatigue (i.e. clipping rails) for optimal performance
- Cross-Country Phase is intense exercise
 - FLAIR strips reduce resistance of airflow into lungs and the work of breathing so that working muscles get more oxygen, slows onset of fatigue, reduces EIPH, improves recovery

Omega-3 Fatty Acids and EIPH



- Treated horses did not show \uparrow in EIPH seen with non-treated horses
- Likely due to:
 - \downarrow inflammation
 - \uparrow deformability and flexibility allowing RBCs to move more easily through vessels
 - \uparrow elasticity of blood vessels and airways when exposed to large pressures, lessening chances of tearing

Concentrated Equine Serum (CES)

- Currently USDA licensed for failure of passive transfer “Seramune”
- ↓ EIPH 54% and ↓ lung inflammation 30%
- Administered via concurrent intravenous injections and injections into the trachea
- Requires time for treatment to take effect, not prophylactic like nasal strip and lasix
- Thought to stimulate immune system to clear blood from lung more rapidly in order to avoid inflammation and scarring



Treatments That Have Scientifically Been Proven To Be Ineffective

- **Blood Pressure Treatments**
 - Nitric Oxide – ↓ blood pressure in the lungs, but ↑ EIPH
 - Endothelin-1 Receptor Antagonists – do not ↓ blood pressure within the lungs nor level of EIPH
- **Anti-Inflammatory Treatments**
 - Citrus Bioflavonoids – do not ↓ EIPH
 - Heated Water Vapor Therapy – do not ↓ EIPH
- **Coagulation Enhancing Treatments**
 - Herbal Formulations (Yunnan Paiyao and Single)- enhance coagulation, but not problem in EIPH so not change level of EIPH
 - Premarin (Conjugated Estrogens) – not affect coagulation nor level of EIPH; anti-inflammatory effects take time, may have potential to strengthen vessel and airway walls by altering strength of collagen
 - Aminocaproic Acid – do not affect coagulation nor level of EIPH and ↓ performance



Additional Therapies for EIPH

Many anecdotal therapies on market without the backing of scientifically controlled studies!

- **Blood Pressure Treatments:**
 - Phosphodiesterase-5 Inhibitors (i.e. Sildenafil)
 - EIPH-NOx (Phosphodiesterase-5 Inhibitor + inhaled NO)
- **Reduction of Inflammation:**
 - Leukocyte Elastase-Protease Inhibitor
- **Miscellaneous**
 - Equiwinner™ - EIPH patch
 - Hyperbaric Oxygen Therapy
 - Carbazochrome (Kentucky Red)
 - Corticosteroids and Bronchodilators
- **Swimming – blood pressures still high and big breaths? May help by removing effects of locomotory-impact trauma**



Treatment Reality



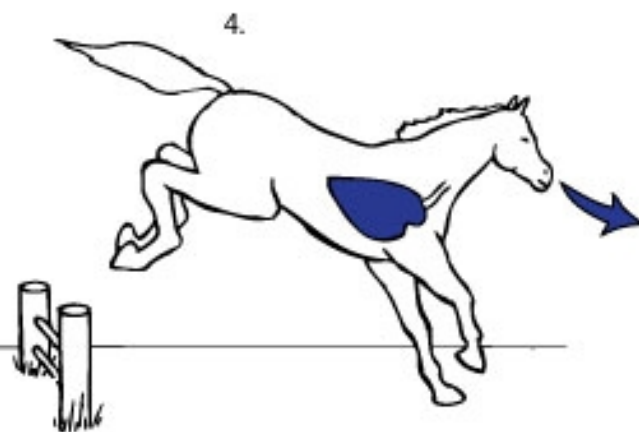
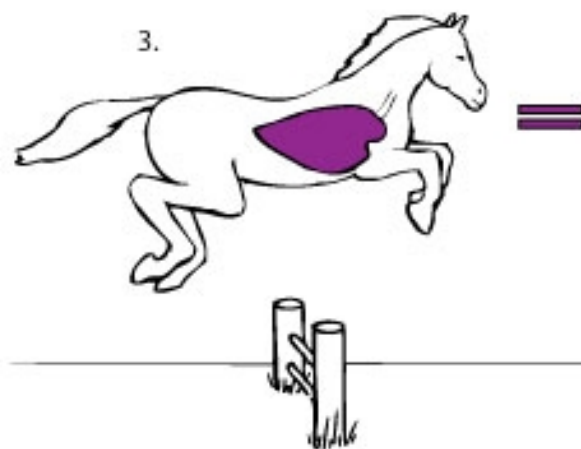
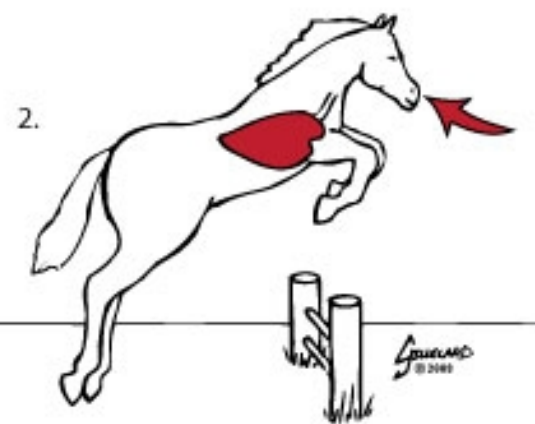
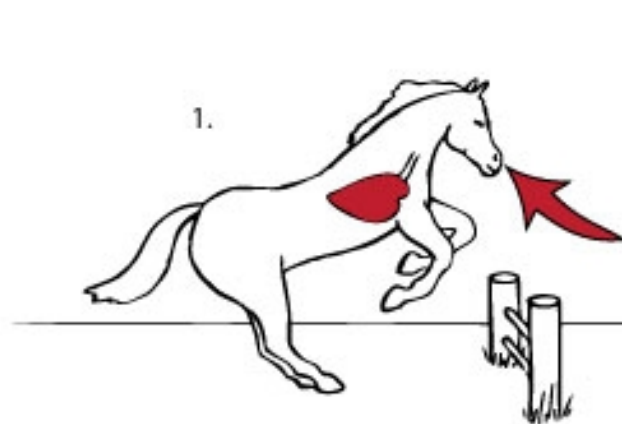
- Due to the involvement of multiple factors in causing EIPH and affecting the severity, it may be necessary to combine treatments for maximal EIPH reduction
- Anecdotal evidence supports this line of thinking!

What have we learned?

- EIPH is a large scale problem in athletic horses of all levels
- Multiple factors affect initiation and severity of bleeding
- Methods of differing sensitivities exist to diagnose bleeding
- Only 4 treatments have shown effectiveness scientifically
- No single treatment is able to completely prevent or eliminate bleeding
- Combination treatments may be necessary and the most effective for reducing EIPH
- A lot of information and research is still needed in order to better control this problem and to make the horse's respiratory system healthier and able to perform optimally

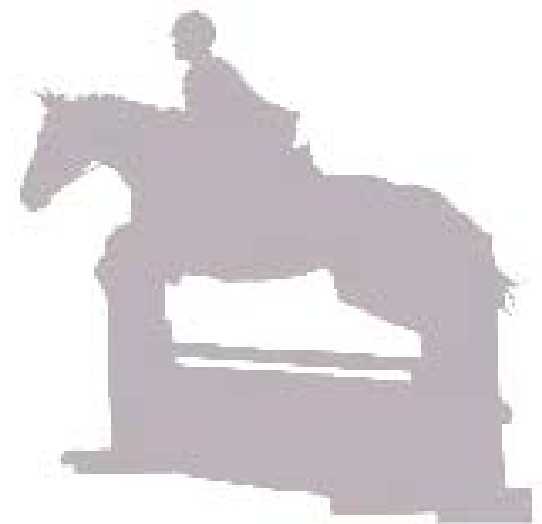
Questions?



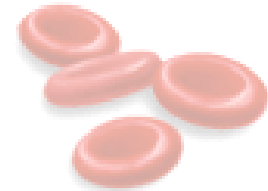




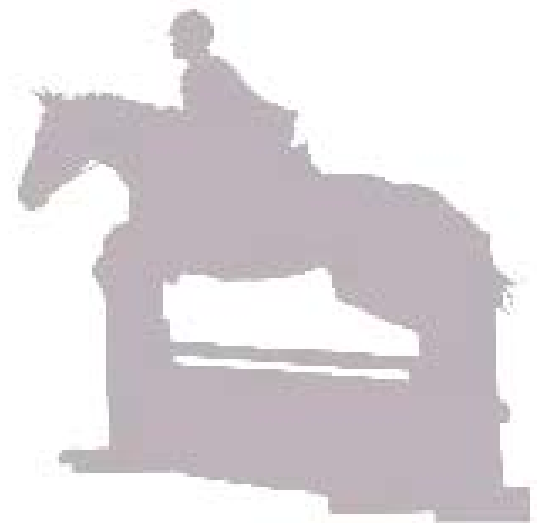
3 Day



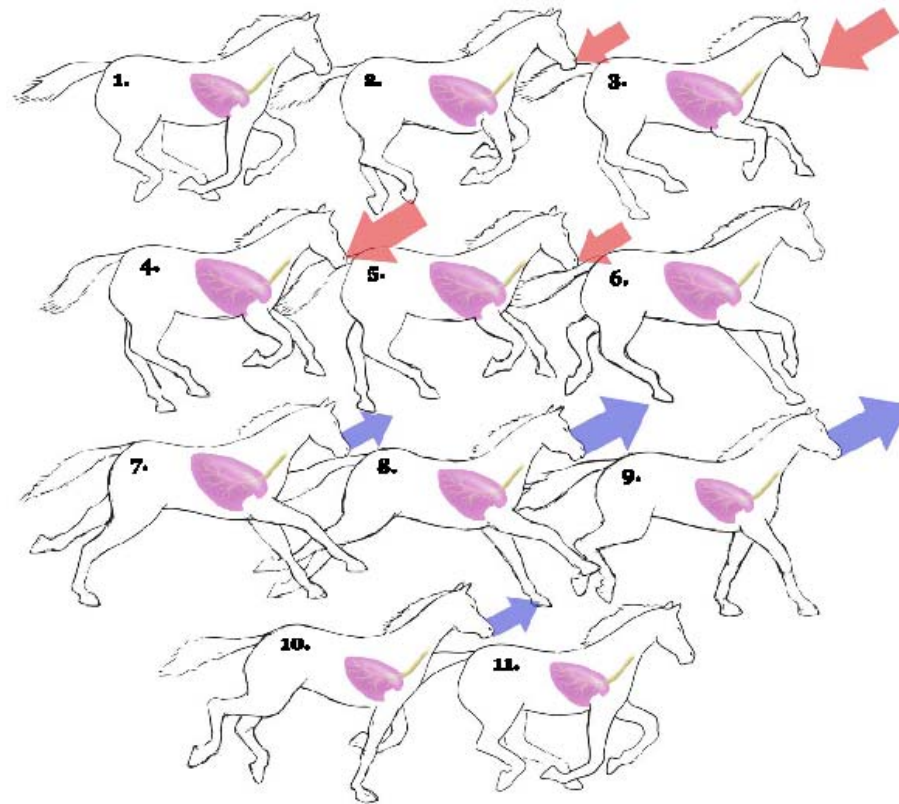
Event

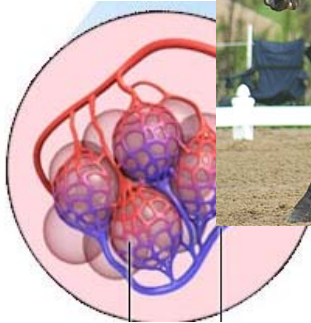


3 Day



Event





- Commonly encountered problems in eventing horses
 - Roaring, problem with dressage and jumping, DDSP, EE
 - Lower respir tract problems, lots of transport, age
 - Pneumonia, pleuropneumonia related to transport stress, particularly >500 miles
 - EIPH
 - IAD, RAO
 - 48-72 hr medication withdrawal