Recent research has shown that 45% of barrel racing horses suffer from lower grades of EIPH.

Respiratory Disease and the Equine Athlete

These presentations from the 2017 AAEP Convention discuss various aspects of equine respiratory health.

By Nancy S. Loving, DVM

Many horse owners and equine practitioners ascribe lameness as one of the limiting factors in horse performance; however, they also know that respiratory disease takes a significant toll. An in-depth look at the effects of respiratory disease on the performance of equine athletes was presented at the AAEP 2017 Convention and is summarized here.

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Pulmonary Disease and its Impact on the Athletic Horse

The equine athlete is reliant on a number of essential factors for optimal performance: energy sources, the cardiovascular system, muscle strength, the ability to adapt to exercise and training, specific biomechanics integral

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to a horse's conformation, the ability to excrete by-products (carbon dioxide, water, and lactate) of metabolism, and a will to win.

At the AAEP 2017 Convention, Laurent Couëtil, DVM, PhD, of Purdue University's College of Veterinary Medicine, emphasized the importance of aerobic metabolism in just about every equine athletic endeavor. Even a sprinting Quarter Horse uses 40% aerobic energy sources in a race. A horse racing a mile relies 80% on aerobic fuel sources; an event horse relies on 90% aerobic fuel sources; and an endurance horse works 95% of the time through aerobic metabolic pathways, particularly relying on fat as an energy source.

He explained that with the onset of exercise, a horse's ventilation ramps up, achieving as much as 30-fold increase at peak exercise. Heart rate can increase eight-fold from 30 bpm to 240 bpm in a racehorse. With an eight-fold increase in cardiac output, stroke volume increases to achieve a 10-fold higher cardiac output than the horse experiences at rest. To add to all these physiologic changes, the spleen contracts to release an extra 50% supply of red blood cells into the system, potentially driving the packed cell volume up to 70%. Hemoglobin concentration increases 15%, which improves the oxygen-carrying capacity of the blood.

Couëtil explaind that, in general, strenuous exercise increases oxygen intake (VO2) in a linear relationship with speed: 5 ml/minute at rest increases to 150 ml/minute at race speed. Horses cannot take in more oxygen than this amount, so once a horse reaches 80% VO2max, there is a need to rely on glycolysis for energy production.

The amount of blood oxygen available is limited by diffusion and by insufficient ventilation to provide for metabolic needs. Once anaerobic metabolism becomes a more prominent energy source, lactate builds up in the blood. When lactate reaches 4 millimoles (mmols, which is the anaerobic threshold), lactate increases exponentially and is known to contribute to fatigue.

With airway disease, blood lactate levels increase more quickly in the strenuously exercising horse.

Training elicits many changes in all organ systems, said Couëtil.

- Bone remodels in response to loading, with increased bone thickening along the dorsal cortex of the cannon bone.
- The maximum heart rate does not increase with training, but will with age.
- Heart muscle mass increases, which helps to increase stroke volume.
- Muscle fibers enlarge with hypertrophy.
- Capillary density increases to improve delivery of blood to muscles.
- Mitochondria increase to provide energy for muscle contraction.
- There is no change in the maximum ventilation possible.
- A fit horse is able to exercise at lower heart rates at a given speed than an unfit horse.
- Adaptations over 6-10 weeks occur with training to increase VO2 max by 10-25%.
- Training enables a horse to go faster before there is increased blood lactate.

Because horses are obligate nose breathers, they encounter resistance through the upper respiratory tract: 50% due to nasal passages, 30% due to larynx, and 20% due to lower airway resistance.

Ventilation is measured by the partial pressure of carbon dioxide in the blood, and while ventilation increases with exercise, the horse develops relative hypoventilation due to the limitations mentioned above, resulting in 25% decrease in partial pressure of oxygen during exercise.

A fit horse's muscles have an improved ability to take up oxygen so that more oxygen is pumped out of the blood. Because there isn't sufficient time to fully saturate the pulmonary capillaries with oxygen, the horse can experience relative hypoxemia.

Overlaying respiratory disease on top of the native physiologic idiosyncrasies of a horse's respiratory capacity can have profound effects on performance, said Couëtil.

Respiratory disease includes:

- Equine asthma encompassing: a) recurrent airway obstruction (RAO or heaves); b) inflammatory airway disease (IAD); c) summer pasture RAO; and d) infectious bronchitis;
- Exercise-induced pulmonary hemorrhage (EIPH);
- Interstitial lung disease; pneumonia.

Equine asthma, and in particular RAO or heaves, has the most severe effect. Couëtil described dietary changes that have the potential to improve performance in horses with respiratory disease. Horses were fed a pelleted complete senior feed with an omega-3 (DHA) supplement (Aleira by Arenus). The low-dust pelleted diet improved horses by Day 60, but those fed the omega-3 DHA supplement demonstrated a greater magnitude of improvement.

Horses with mild asthma experience deficits in performance. Endoscopy can identify excess mucus in the trachea. He advises that the optimal time to scope is about an hour following exercise. Tracheal mucous scores of ≥ 2 are associated with decreased performance in racehorses; scores of ≥ 3 affect performance of sport horses.

Bronchoalveolar lavage cytology is informative. Poor performance is associated with neutrophilia in BAL fluid samples taken an hour following exercise. A study in Thoroughbred racehorses identified 1.4% reduction in speed with each percentage increase in-neutrophils; with each percent increase of mast cells, speed decreased by 3%.

Performance of horses with exercise-induced pulmonary hemorrhage

(EIPH) depends on grade of blood in the airways: As grade increases, distance behind the winner increases.

In summary, Couëtil made the following observations:

- Oxygen diffusion already reaches its limit in a healthy horse; therefore, any physiologic problem exacerbates the limit of oxygen availability.
- Any degree of inflammation or bleeding in the airways leads to a dramatic drop in oxygen tension.
- Healthy horses can develop good expiratory flow rate but with airway obstruction, there is increased resistance.
- Airway hyper-responsiveness develops in those with increased mast cells and eosinophils. Therefore, there is an increased risk of airway shutdown when exposed to irritants.
- Racehorses need 100% of airway capacity, so any degree of compromise of oxygen carrying capacity reduces delivery of oxygen to the muscles. In contrast, low-intensity exercise (Western pleasure, trail) needs less than 50% VO2max, and moderate intensity exercise (endurance, dressage) needs 50-80% VO2max.

Diagnostic Testing of the Equine Respiratory Tract

Poor performance in equine athletes is often attributable to disorders of the respiratory system. Even a small decrease in lung capacity or airflow has dramatic effects on a horse's performance. Disruption in training routines or schedules is another consequence of airway issues.

At the 2017 AAEP, Renaud Lëguillette, DVM, MSc, PhD, DACVIM, DACVSMR, pointed out that there is a high prevalence of upper and lower airway inflammation in equine athletes with 66% of lower airways affected by moderate inflammation and 17% affected with severe lung inflammation. Since all equine athletes rely to some extent on aerobic capacity to fuel performance, a horse's lung capacity and ability to obtain oxygen has a huge impact on performance.

Airway obstruction in horses can cause increased resistance in air flow rates.

Initial methods for diagnosis rely on evaluation of clinical signs. Upper airways might exhibit abnormal respiratory noise, especially during exercise. Or, a horse might be exercise intolerant.

Upper airway problems are associated with coughing, said Lëguillette. Lower airway pathology also elicits coughing and might be accompanied by bilateral, mucoid nasal discharge, progressive exercise intolerance, and signs of heaves, such as labored breathing at rest.

He pointed out that coughing and nasal discharge might be independent clinical signs, not necessarily occurring together.

Lëguillette emphasized that there is a strong association between coughing and lung inflammation as well as the presence of neutrophilia, tracheal mucus, and abnormal sounds with auscultation. Sometimes, he cautioned, it takes an hour of observation to identify a cough in a resting horse. Use of a stiff rebreathing bag with auscultation provides additional information about airway health.

Imaging methods are other important diagnostic tools. Endoscopy using a 1.1–1.4-meter long endoscope is informative and enables scoring of inflammation, mucus, blood, lymphoid folliculitis, and tracheal septum thickness.

Upper airway restrictions on airflow have huge impacts on performance. Lëguillette pointed out that if even one-quarter of the throat or trachea is obstructed, there would have to be considerable compromise to the lung field to approach a comparable obstruction in the lower airways.

EIPH has a large negative impact on racehorses. Recent findings also have identified that barrel racing horses experience a 45% rate of EIPH, usually at the lower grades 1 and 2. Nearly 74% of barrel racing horses demonstrated tracheal mucus scores of greater than 2. High mucous scores are associated with high neutrophilic inflammation in the lungs.

Ultrasound of the lung also yields definitive information about the lung periphery, such as the presence of "comet tails" often associated with EIPH in caudal lung fields. Radiography is particularly useful for infectious pneumonia as it is effective at viewing deeper lung structures. Lëguillette said it is of limited benefit for diffuse inflammatory lung disease.

Other diagnostic tests mentioned by Lëguillette included cytology via bronchoalveolar lavage (BAL), and culture and sensitivity of tracheal aspirates or washes. He emphasized the importance of targeting the appropriate area of the lungs for obtaining relevant samples, especially when using bronchoalveolar lavage. BAL is also a good technique for monitoring response to therapy after at least six weeks. EM