IAD: Cough, Poor Performance, Mucus in the Airways—What Is So Important About That?

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1. Introduction

The lower respiratory tract responds to a variety of inhaled irritants in a stereotypical way by coughing, increasing mucus secretion, and bronchospasm. The purpose of such response is to limit further inhalation of irritants and to accelerate their removal from the respiratory tract. Additional defense mechanisms involve alveolar macrophages, airway-associated lymphoid tissue, and systemic immunity. Substances irritant to the airways may be infectious agents (viruses, bacteria, mycoplasma, fungi), parasites, endotoxins, molds, dust, noxious gases, or pollutants. Airway inflammation may result if exposure to the irritant is of sufficient magnitude.

Lower airway inflammatory diseases include infectious and parasitic diseases, interstitial pneumonia, recurrent airway obstruction (RAO) or heaves, and inflammatory airway disease (IAD). Inflammatory airway disease is an incompletely characterized pulmonary disorder that is most commonly observed in young, athletic horses. Contrary to other lower airway inflammatory diseases, clinical signs of IAD are subtle and include chronic cough, excess mucus in the trachea, and poor performance; otherwise, horses have a normal attitude and appetite, are not febrile, and do not exhibit increased respiratory effort at rest.

Recently, a panel of international experts recommended using the term IAD instead of small-airway inflammatory disease, small-airway disease, and bronchitis/bronchiolitis, which have been used in the past to describe the disease. In addition to terminology issues, confusion may result from horses with IAD being included in broader disease categories such as undifferentiated pulmonary disorders, chronic obstructive pulmonary disease, and lower airway disease.

The purpose of the following discussion is to clarify our current understanding of IAD focusing on clinical characteristics.

2. Historical Findings

RAO or “heaves” is an allergic disease characterized by cough, accumulation of mucopurulent secretions in the tracheobronchial tree, abnormal breath sounds, increased respiratory efforts, and exercise intolerance. Clinical signs result from small-airway obstruction secondary to airway inflammation, bronchospasm, mucus plugging of airways, and thickening of the airway wall. Cytologic examination of respiratory secretions usually reveals moderate to severe neutrophilia. Clinical signs resolve...
within a few days after implementation of environmental changes such as reducing organic dusts, conversely susceptible horses housed indoors and exposed to moldy hay develop clinical signs within a few hours to a few days. Horses with RAO tend to be mature to old animals with obvious clinical signs of respiratory disease and severe exercise intolerance during period of disease exacerbation.

A mild form of lower airway inflammatory disease commonly encountered in young athletic horses has been recognized recently as a separate entity from RAO and termed “inflammatory airway disease.” In the majority of cases, RAO and IAD may be differentiated based on clinical grounds (Table 1); however, some have argued that, over time, horses with IAD may progress into RAO. The incidence of IAD in racehorses may vary between 11% and 65% depending on the diagnostic criteria used (endoscopy, cytology) and the conditions of examination (i.e., pre- versus post-exercise). Horses with IAD usually have a history of decreased performance, mild exercise intolerance, cough, and increased respiratory secretions. Foals and older horses may also suffer from IAD. In these cases, the diagnosis is often reached by excluding infectious and other non-infectious causes of lower airway inflammation. The possibility of IAD should be considered in horses with signs of respiratory disease including tracheobronchial mucopurulent exudate that do not respond, or relapse, after antimicrobial therapy and further diagnostic tests should be pursued (e.g., bronchoalveolar lavage).

Duration of IAD is 7 wk on average with a range of 4–22 wk, which is longer than most infectious respiratory diseases. In a study involving 170 thoroughbred horses in training over a 2-yr-period, it was estimated that during 8 of the 24 mo, horses had some degree of IAD. IAD appears to be more common in young, athletic horses with the incidence decreasing with increasing age. IAD is particularly common in thoroughbreds and standardbred racehorses, but has been also reported in a variety of other breeds such as Quarter Horse, Warmblood, Appaloosa, and American Saddlebred. In fact, horses of any breed may be affected but racehorses are over-represented because of several factors. First, the major limiting factor to performance in a racehorse is pulmonary gas exchanges, therefore, even a mild degree of respiratory disease may have a profound negative impact on performance, whereas the same problem in a dressage horse would be considered clinically insignificant. Second, most racehorses are kept in an environment that is particularly challenging for the respiratory tract. They are often confined in stables with sub-optimal ventilation 24 h/d (except for the training session), exposed to high levels of respirable irritants (e.g., dust and endotoxins from straw and hay), and commingle in large population of horses originating from various locations. Third, racehorse training and racing schedule and frequent traveling are often stressful impairing body’s immune response and commonly resulting in lower airway disease.

The most common complaints reported by owners of athletic horses with IAD, other than racehorses, are chronic cough and prolonged recovery after exercise. These horses may be involved in a variety of activities such as barrel racing, three-day event, dressage, or simply trail riding. Owners often report a history of infectious respiratory disease in the months preceding the diagnosis of IAD with several horses in the barn being affected. The typical history is that all horses recovered except for the one with IAD, which continued to cough intermittently while in the stall and/or during riding.

### 3. Clinical Signs

The most common clinical signs associated with IAD are increased respiratory secretions, cough, and decreased performance. Estimation of the quantity of mucus present in the trachea by endoscopy reveals that horses free of respiratory disease have either no mucus or a few isolated flecks and horses with IAD have a pool of mucus at the thoracic inlet or a continuous stream of variable width (Fig. 1). In addition, the severity of IAD is related to the amount of mucus and the percentage of neutrophils in tracheal wash or in bronchoalveolar lavage (BAL) fluid. The incidence of tracheal exudate has been found to increase after strenuous exercise by some investigators but not by others. In healthy horses, the amount of tracheal mucus is not affected by age.

Cough is only present in 38% of horses with IAD, however 85% of coughing horses have IAD. Daily observation of horses in training showed that coughing is not noted 62% of the time during which they have IAD. Epidemiologic studies of thoroughbred racehorses in training found a strong association between coughing, the amount of mucus present in the upper airways, and pharyngeal lymphoid hyperplasia. Also, a strong association exists between coughing, isolation of bacteria, and

### Table 1. Summary Comparison Between Recurrent Airway Obstruction (RAO) and Inflammatory Airway Disease (IAD).

<table>
<thead>
<tr>
<th>Heaves/RAO</th>
<th>IAD</th>
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<tbody>
<tr>
<td>Older horses</td>
<td>Young performing horses</td>
</tr>
<tr>
<td>Chronic cough, mucopurulent exudate, abnormal lung sounds, increased respiratory efforts, marked exercise intolerance</td>
<td>Chronic cough, mucopurulent exudate, mild exercise intolerance</td>
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<tr>
<td>Chronic inflammation</td>
<td>Chronic inflammation</td>
</tr>
<tr>
<td>Allergic etiology</td>
<td>Multifactorial etiology</td>
</tr>
<tr>
<td>Moderate to severe airway obstruction</td>
<td>Mild airway obstruction</td>
</tr>
<tr>
<td>Recurrent disease</td>
<td>Not recurrent</td>
</tr>
<tr>
<td>Bronchitis/bronchiolitis</td>
<td>Bronchitis/bronchiolitis</td>
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the degree of inflammation in tracheal wash fluid. Nevertheless, bacteriological examination of tracheal wash samples reveals that 35–58% of horses with IAD do not contain significant amount of bacteria.

Other clinical signs of respiratory disease such as nasal discharge and fever do not appear to be associated with the disease. Thoracic auscultation is usually normal; however, some horses may exhibit increased breath sounds or wheezes. Horses with severe IAD may have a slightly increased respiratory rate and abdominal contraction on expiration. For the most part, IAD is subclinical and may go undetected unless coughing is present or tracheal exudate is detected by endoscopy.

Exercise intolerance and poor performance in racehorses have been associated with presence of mucopurulent exudate in the tracheobronchial tree and increased percentage of neutrophils in BAL fluid. Other signs associated with exercise intolerance are delayed recovery of normal respiratory rate after exercise and respiratory embarrassment. The latter signs are more likely to be recognized in athletic horses other than racehorses because most of their activities do not require exercising at or above maximal aerobic capacity.

Poor performance may result from a variety of causes such as lameness, exertional rhabdomyolysis, and cardiac and neurologic diseases. More importantly, it is common to diagnose several problems in the same horse. In a retrospective study performed on 163 horses presented for poor performance evaluation at Purdue’s Equine Sports Medicine Center, 20% of cases were diagnosed with a combination of respiratory disease and at least one other problem involving a different body system. These findings underscore the importance of performing a comprehensive evaluation of poorly performing horses.

Further characterization of the type of inflammatory process may be achieved with BAL fluid cytology. Cytological analysis of BAL fluid allows recognition of three types of inflammatory profiles in IAD. Type 1 is the most commonly encountered and is characterized by an increased total nucleated cell count with mild neutrophilia (5–20% cells), lymphocytosis, and monocytosis (Fig. 2). Increased percentages of mast cells (>2%, Fig. 3) and eosinophils (>3%, Fig. 4) are observed in IAD type 2 and 3, respectively. In contrast, BAL of horses with RAO show moderate to severe neutrophilia (>20% cells), lymphopenia, and decreased alveolar macrophages. Cytology of BALF collected from horses with RAO in clinical remission may be normal if sufficient time away from offended allergens has been allowed. Some RAO cases may be clinically normal but still exhibit some degree of pulmonary neutrophilia and, therefore, may be differ
difficult to differentiate from IAD. A practical way to discriminate RAO from IAD is by performing a hay challenge and monitoring clinical signs of respiratory disease, which should develop within a few hours to a few days in RAO affected horses. Horses with IAD exposed to moldy hay may exhibit a worsening of coughing and pulmonary neutrophilia; however, they do not develop increased respi-
atory efforts or nostril flaring like RAO affected horses do.

4. Suspected Etiology
Putative causes of IAD include bacteria, viruses, and inhaled environmental pollutants with a modulatory role played by factors such as the horse’s immune response and genetic make-up.

The likelihood of isolating bacteria from tracheal wash samples is strongly associated with the cyto logic degree of inflammation. Bacterial species most frequently isolated are *Streptococcus* spp.,

![Fig. 4. Bronchoalveolar lavage fluid cytology from a horse diagnosed with IAD (Wright’s stain).](image)

![Fig. 5. Forced expiratory flow after 95% of the vital capacity has been exhaled (FEF<sub>95%</sub>) in healthy horses (normal), horses with IAD, and horses with recurrent airway obstruction or heaves during period of disease exacerbation (crisis) or clinical remission. Values are expressed as mean ± SD (vertical bar).](image)
**Pasteurella/Actinobacillus** spp., and *Bordetella* spp. Mycoplasma organisms have not been isolated in horses with IAD. However, the role of bacteria in the pathogenesis of the disease is unclear. First, no bacteria are cultured in more than one third of horses with IAD. Second, the presence of bacteria in the airways may result from decreased clearance capacity and not from primary infection. Third, the trachea is not a sterile environment and potentially pathogenic bacteria may be isolated by tracheal wash in 8–25% of healthy horses with isolation of non-pathogenic organisms in as many as 75% of those horses. Fourth, successful treatment of IAD with oral interferon-alpha or inhaled glucocorticoids suggests that infectious agents may not be causative agents but rather opportunistic invaders of the lower respiratory tract.

Contrary to a common belief, respiratory viruses do not appear to play an important role in IAD. Several reports have shown no evidence of viral infections in horses with IAD based on serology or virus isolation aimed at detecting equine herpes, influenza, adenovirus, and rhinoviruses. These findings are consistent with the fact that no relationship has been found between presence of fever and IAD. The role of exposure to dust in the pathogenesis of IAD is suggested by several studies. Healthy yearlings fed hay demonstrate BAL fluid neutrophilia and a higher airway inflammation score when housed in a stable than when kept on pasture. Natural exposure of healthy horses to moldy hay or virus isolation aimed at detecting equine herpes, influenza, adenovirus, and rhinoviruses. These findings are consistent with data showing that conventional horse management consisting of indoor housing with straw bedding and feeding of hay result in much larger dust exposure levels than housing of horses on wood shavings and pelleted feed or keeping them on pasture. Also, horses in training kept on straw bedding experience episodes of IAD that last longer than in horses bedded on paper. These findings are consistent with data showing that conventional horse management consisting of indoor housing with straw bedding and feeding of hay result in much larger dust exposure levels than housing of horses on wood shavings and pelleted feed or keeping them on pasture. Some horses with IAD demonstrate increased eosinophil or metachromatic cell counts in BAL fluid suggesting hypersensitivity response of the lower airways to inhaled allergens.

Ozone inhalation may result in lower airway inflammation; however, levels encountered during natural exposure are unlikely to induce IAD. Several additional factors commonly encountered in athletic horses may contribute to the pathogenesis of IAD. Transportation of horses over long distances may induce airway inflammation and colonization of the tracheobronchial tree by bacteria. Strenuous exercise results in a large increase in the number of bacteria (10- to 100-fold) penetrating the lower airways. Finally, airway response to environmental challenges is likely under the influence of certain genes as it is the case for heaves.

**5. Functional Significance**

Horses with clinical signs of IAD are more likely to perform poorly; nevertheless, the mechanism of exercise intolerance is speculative. Mild degree of airway obstruction is evident in some horses with IAD and may result in impaired gas exchanges (Fig. 2). Horses with marked airway obstruction such as RAO exhibit abnormal gas exchanges at rest characterized by increased ventilation/perfusion mismatching, arterial hypoxemia, and increased work of breathing at rest and exercise induces a marked deterioration of these parameters. Findings with IAD are equivocal since some investigators have found a more pronounced exercise-induced hypoxemia in affected horses than in healthy controls during standardized treadmill exercise, and others have reported no differences in pulmonary gas exchanges.

Airway hyperresponsiveness is a feature of IAD in horses with increased BALF eosinophil and mast cell counts. This increased bronchoconstriction in response to inhaled irritants plays an important role in the pathogenesis of the cough.

**6. Case 1**

**Signalment**

10-yr-old Quarter Horse gelding used for barrel racing.

**History**

The horse was evaluated for chronic coughing and exercise intolerance. Coughing started ~2 yr ago; however, exercise intolerance has only been observed since last year. Various treatments have been attempted with little success. Clinical signs are worse during spring-summer and tend to improve during the winter. The horse competed 2 wk ago and the owner observed epistaxis from the right nostril.

**Clinical examination**

Physical examination findings were $T = 100.5^\circ F$, heart rate of 42 BPM, and respiratory rate of 24 BPM. Bilateral serous nasal discharge was observed and cough could be elicited by compression of the trachea. Thoracic auscultation revealed normal breath sounds; however, presence of mucus in the trachea was suspected.

Upper airway endoscopy revealed moderate amounts of mucopurulent and blood tinged secretions in the trachea. Tracheal wash cytology findings were mild macrophagic/neutrophilic inflammation with minimal blood contamination. Bronchoalveolar lavage cytology results were: total nucleated cell count (TNCC) = 428/μl, eosinophils = 0%, epithelial cells = 1%, mast cells = 0%, neutrophils = 6%, lymphocytes = 44%, macrophages = 49%.

Pulmonary function tests, treatment, and case management will be discussed.
7. Case 2

Signalment

10-yr-old Standardbred gelding racehorse.

History

The horse presented for evaluation of poor performance. The horse had a 3-mo history of tracheal pur and decreased performance, had been coughing intermittently for 6–8 mo, and was considered a “bleeder.” The horse was treated with antibiotics for the last 6 wk with no apparent improvement.

Clinical examination

Physical examination findings were T = 100°F, P = 30 BPM, R = 18 BPM, bilateral serous nasal discharge, no inaudible cough, and normal thoracic auscultation.

Endoscopy revealed a mild amount of mucopurulent discharge in the trachea. Bronchoalveolar lavage cytology results were: total nucleated cell count (TNCC) = 494/μl, eosinophils = 9%, epithelial cells = 1%, mast cells = 2%, neutrophils = 3%, lymphocytes = 9%, macrophages = 83%.

Pulmonary function tests, treatment, and case management will be discussed.

References

healthy horses and horses with chronic obstructive pulmonary disease (COPD). Zentralbl Veterinarmed A 1983;30: 114–120.


