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THE COUGHING HORSE
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Definition of cough
Cough is a defense mechanism of the respiratory tract with two major functions. One is to prevent or limit inhalation of foreign materials into the tracheobronchial tree and the other function is clearance of the airways. Cough is a reflex elicited by stimulation of receptors located in central airways from larynx to bronchi.

Role of cough
High gas linear velocities generated by high airflow cause shearing forces at the level of the airway walls and result in the suspension and clearing of secretions adherent to the airways. Higher flow velocities are achieved in large airways such as trachea and major bronchi. Therefore, coughing is likely to help clear materials from central airways but not from peripheral or small airways. Horses confined with head elevated for > 6 hours experience bacterial colonization of the tracheobronchial tree despite development of a cough, and resolution occurs within 12 hours if horses are allowed to lower their heads.(1) Elimination of normal respiratory secretions appears to depend mainly upon mucociliary clearance mechanisms and not cough. (2)

Pathophysiology of cough
Stimulation of irritant receptors located in the nasal passages produces sneezing. Cough is produced by stimulation of receptors located in the larynx and airways distal to it. Cough reflex is initiated by activation of nerve endings called irritant receptors that send impulses through myelinated vagal fibers to the cough center in the medulla of the brain and in return cause coughing, bronchoconstriction, and mucus secretion.(3) Irritant receptors are stimulated by both mechanical and chemical stimuli. Another type of receptor called C fibers receptors ("J receptors") are located in the alveolar walls in close association with the pulmonary capillaries and may cause coughing indirectly by releasing neurotransmitters such as tachykinins that, in turn, stimulate irritant receptors in the airways.(4) C fiber receptors may play a role in the mechanism causing increased cough sensitivity in inflamed airways. Coughing may result from a combination of pathways, which are important to understand in order to design an appropriate treatment plan. Coughing is an important defense mechanism of the tracheobronchial tree, however in some instances it does not have a useful purpose (i.e. non productive) and sometimes it may be deleterious to the horse (e.g. tracheal collapse). Chronic cough can contribute to fatigue and decrease food intake.

Clinical examination of the coughing horse
Signalment
Many respiratory diseases affect horses at a particular age. A neonatal foal coughing and displaying nasal regurgitation of milk while nursing bring to mind a possible congenital physical abnormality such as cleft palate, dorsal displacement of the soft palate, and subepiglottic cyst or, a functional abnormality such as hypoxic ischemic encephalopathy, hydrocephalus and pharyngeal-cricopharyngeal incoordination.(5) An acute onset of cough, fever, and serous nasal discharge in young horses suggest a potential viral etiology (e.g. influenza, herpervirus, viral arteritis).

History
Vaccination history of the horse and other horses on the premises, or of the mare in case of a foal, is important information in cases of contagious diseases. The type of anthelmintic used and frequency of administration may suggest the possibility of lungworm infection. Horses sharing pasture with donkeys are at risk of acquiring lungworm infection. The geographic location and history of travel may help determine the likelihood of certain diseases. Seasonality of the clinical signs suggests an allergic condition. Horses subjected to stressful situations such as long travel, strenuous exercise, or general
anesthesia are more likely to be immunosuppressed and are at risk of developing diseases such as pneumonia and pleuropneumonia. Horses housed in poorly ventilated stalls, fed badly cured hay, and bedded on straw are exposed to high levels of organic molds and endotoxin, which may result in lower airway inflammation and bronchial hyperresponsiveness. Assessment of the timing of the cough may guide diagnostic tests. Cough associated with feeding may indicate allergy to inhaled molds (e.g. heaves), inflammatory diseases of the pharynx and larynx, esophageal obstruction, or dysphagia with passage of ingesta in the airways. Exercise often exacerbates coughing because of the higher mechanical stress placed on pulmonary cough receptors and the larger amount of particles inhaled with the increase in ventilation.

**Physical examination**

It is important to try to make the horse cough because the cough’s characteristics may help determine the anatomical location of the disease. One way is by squeezing the dorsal aspect of the tracheal rings or by making the horse hyperventilate when breathing into a large plastic bag (10-15 liters) placed over the muzzle. Dry, short, loud, and harsh coughs with frequent bouts of coughing are common with upper respiratory tract inflammation, in particular viral infections. Deep, soft coughs usually result from lower respiratory tract diseases such as pneumonia and heaves. Painful conditions involving the upper (e.g. retropharyngeal abscess) or lower (e.g. pleuropneumonia) respiratory tract can both decrease the intensity of respiratory efforts and sounds produced during coughing. It is important to note the aspect of the nasal discharge in coughing horses. Serous nasal discharge is commonly seen in cases of early viral respiratory infections and rhinitis. Bacterial infections often complicate viral infections and lead to mucopurulent discharges. However, horses with non-infectious respiratory diseases such as heaves and inflammatory airway disease may exhibit mucopurulent nasal discharge. Presence of feed material in the nasal discharge suggests dysphagia, which may be seen in conditions such as esophageal obstruction, pharyngeal neuromuscular disease and pharyngeal masses impairing deglutition. Submandibular and retropharyngeal lymph nodes enlargement is common with viral or bacterial respiratory infections. Abscess formation and drainage of lymph nodes may result from strangles or other bacterial infections. In rare cases, lymph node enlargement is secondary to neoplastic infiltration (e.g. lymphosarcoma). Chest auscultation during rebreathing maneuver will make breath sounds more audible and increase the likelihood of detecting abnormal sounds (i.e. wheezes, crackles, friction rubs). Decreased intensity of breath sounds is associated with thick chest wall, pleural effusion, pulmonary consolidation, atelectasis, decreased ventilation, emphysema, diaphragmatic hernia, and pneumothorax. Increased intensity of breath sounds may be due to thin chest wall (e.g. foal), increased ventilation, lung mass and pulmonary consolidation. Symmetric enlargement of the area of pulmonary auscultation indicates hyperinflation of the lungs and when it is accompanied by abnormal breath sounds widespread over the chest it is strongly suggestive of diffuse peripheral airway obstruction (e.g. heaves). Percussion of the chest in adult horses should be interpreted with caution because thickness of the chest wall has a major influence on the findings.

**Diagnostic approach to the coughing horse**

**Acute onset of cough**

Horses with fever and cough should be carefully auscultated. Abnormal breath sounds suggest lower airway disease and is an indication for TW. Cytology specimen demonstrating predominance of neutrophils with various degrees of degenerative changes and presence of bacteria is consistent with an infection and should prompt microbiologic culture of the fluid. Decreased or increased intensity of breath sounds in the ventral chest should prompt ultrasonographic examination to determine the presence of pleural fluid, pulmonary consolidation or atelectasis. Thoracocentesis is indicated when there is evidence of pleural effusion or a thoracic mass. Cytology and culture of the fluid collected are essential in reaching a diagnosis. Normal breath sounds do not rule out pulmonary disease and, in the case of a horse with fever and cough, further diagnostic tests should be pursued such as endoscopy of the upper respiratory tract. Presence of serous discharge may be normal or indicative of viral respiratory infection. Decreased breath sounds in the dorsal thorax accompanied by respiratory distress and cough are suggestive of pneumothorax.
Thoracic percussion, radiography, and ultrasonography are particularly helpful to confirm the diagnosis.

Non-febrile horses with acute cough should be carefully examined for respiratory and cardiovascular abnormalities. Abnormal breath sounds and cough associated with clinical signs of heart disease strongly suggest left-sided heart failure with secondary pulmonary edema. Fever may be present when cardiac disease result from infectious disease (e.g. bacterial endocarditis). An increase in the percentage of neutrophils in TW and BAL fluids with no signs of sepsis in a horse with abnormal lung sounds and acutely increased respiratory efforts is consistent with heaves. Heaves is a chronic disease however, clinical signs may develop within few hours of exposure to the allergen. Endoscopic examination is indicated in horses with acute onset of cough or nasal discharge and no other signs of respiratory disease. Cough associated with feeding may be triggered by direct irritation of the pharynx and larynx, or secondary to aspiration of feed or saliva into the trachea. Coughing associated with dysphagia may result from obstruction, pain, or neurologic causes. A careful evaluation of the lower respiratory tract for signs of aspiration pneumonia is mandatory in dysphagic horses.

**Chronic cough**

Coughing is usually considered chronic if it is persistent for more than 3 weeks. Diseases resulting in acute cough may lead to chronic coughing if the initiating cause is persistent. Alternatively, several slowly progressive diseases and congenital abnormalities are associated with chronic coughing. Presence of abnormal breath sounds in a chronically coughing horse is consistent with pulmonary disease. Cytologic examination of TW or BAL fluid is often useful to reach a final diagnosis. Radiography and ultrasonography may help characterize the disease process. Horses with chronic cough and normal breath sounds suggest upper airway abnormalities or low-grade pulmonary disease.

**Treatment of the coughing horse**

First and foremost, therapy should start by addressing the primary cause of the coughing. Also, treatment should target potential causes of cough such as airway inflammation, bronchoconstriction, mucus, and inhaled dust particles. There are hundreds of remedies advocated for cough suppression however, because coughing is a normal defense mechanism, it may be contraindicated to suppress it in some circumstances. For example, suppressing cough in a dysphagic horse may increase the risk of aspiration pneumonia.

**Antiinflammatory drugs**

Non-steroidal antiinflammatory drugs are beneficial for the treatment of airway inflammation secondary to infectious agents or toxins however, allergic inflammation is mainly responsive to glucocorticoids (Table 1). Most horses are easy to treat by oral or injectable route and the cost of systemic therapy is usually less than that of aerosol therapy. Corticosteroids are indicated for the treatment of heaves (RAO, SPAOPD) and may be of benefit for some horses with IAD. However, systemic therapy with corticosteroids may result in adverse effects because of the dosages required for clinical efficacy. Administration of therapeutic aerosols (Table 1) has the advantage of delivering high concentration of the drug directly into the lungs while minimizing the amount absorbed systemically and therefore, reducing the risk of adverse effects. Aerosols may be produced by nebulizing a solution or administrating aerosols prepackaged in metered-dose inhalers. Antihistamine drugs are commonly used to treat RAO horses in the field, but they appear to have limited usefulness and no controlled study has proved their efficacy.

**Bronchodilators**

They are indicated to relieve airflow obstruction and cough, but they should not be used alone because they have no antiinflammatory properties and do not reduce airway hyperresponsiveness. In addition, prolonged use of certain type of bronchodilators (e.g. beta2-agonists) as solo medication induces airway receptor down regulation and renders the drug less effective. This phenomenon is prevented by combined use of beta2-agonists with corticosteroids. The three classes of drugs available as systemic bronchodilators are anticholinergics, beta2-agonists, and methylxanthines (Table 1&2).
Mucus clearance

Different types of drugs may enhance clearance of respiratory secretions including mucolytics (Table 1) and drugs capable of improving mucociliary transport (e.g. beta2-agonists), however none have been shown to be beneficial for the treatment of heaves.

Antitussive drugs

Cough suppression may be warranted in cases where it is non-productive or when it is deleterious to the horse (e.g. tracheal collapse). Antitussive drugs may be classified based on their site of action: peripheral or central. Peripheral antitussive drugs act outside the central nervous system to inhibit cough by suppressing the responsiveness of sensory receptors that produce cough. For example, intratracheal administration of diluted lidocaine solution (0.3 - 0.6 %) reduces cough frequency during BAL collection. Central antitussive drugs act at the level of the brain stem. Opioids such as butorphanol are central antitussive drugs.

Environmental management

Inhaled dust particles play a central role in the pathophysiology of chronic respiratory diseases such as RAO and IAD. Management of these diseases should always include recommendation to decrease environmental exposure to particulate matter. Two main approaches help reduce exposure of the horse's airways to respirable particles. The first approach is to use feedstuff and bedding that generate low dust levels. Simple changes such as switching bedding from straw to wood shavings and feeding pellets or silage instead of hay may decrease respirable dust by at least 5 fold. Environmental control targeting only the affected horse's stall and not the rest of the stable may be sufficient to improve clinical signs of RAO horses but not to normalize lung function and pulmonary inflammation. The ideal environment for horses with chronic respiratory diseases is pasture because exposure to dust is significantly less than in stalls, regardless of feed and bedding quality. The exception is for horses with SPAOPD that do better during the summer if kept in low-dust indoor housing.

References