Update on Bacterial Pneumonia in the Foal and Weanling

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KEYWORDS

• Equine • Foal • Weanling • Pneumonia • Sepsis • Aspiration • *Rhodococcus equi*

KEY POINTS

- Bacterial pneumonia is a common cause of morbidity and mortality in foals of all ages.
- The most likely causal agents of bacterial pneumonia vary with the age of the foal, and knowledge of likely agents and their antimicrobial-resistance profiles is important for treatment selection.
- Macrolide antibiotics remain the treatment of choice for *Rhodococcus equi* infections, but resistance is emerging and effective alternatives are exiguous.

INTRODUCTION

Bacterial pneumonia is a common problem in foals of all ages. The causal agents of that pneumonia, however, vary with the age of the foal. Neonatal foals are more likely to have pneumonia as a component of systemic sepsis, whereas older foals and weanlings can have primary pneumonia. Knowledge of the likely agents is especially important when selecting empirical antimicrobials while awaiting microbial culture results. With appropriate treatment, prognosis for survival and athletic performance is good.

ETIOLOGY

Neonates

Neonatal foals may acquire pneumonia as a primary condition, but are more likely to develop bacterial pneumonia secondary to sepsis, the major cause of morbidity and mortality in the neonatal foal. Infection may occur in utero because of ascending

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infection of the fetal membranes or aspiration of contaminated fetal fluids. It also can occur at the time of parturition or during the postnatal period, whereby the respiratory tract, gastrointestinal tract, and umbilicus are all possible portals of pathogen entry. Microbial invasion of the bloodstream may result in systemic inflammatory response syndrome, causing the classical signs of sepsis, including fever, depression, anorexia, dehydration, tachycardia, and tachypnea. Signs of disease may remain generalized or may become localized. Localization may result either indirectly from septic shock-induced organ failure (eg, hemodynamic renal failure) or from infection localizing at sites, such as the lungs, gastrointestinal tract, umbilical remnants, synovial structures, bones, or meninges. Acute lung injury or acute respiratory distress syndrome may develop as part of the systemic inflammatory response to sepsis. In one study of 423 bacteremic foals, 79 (19%) were diagnosed with pneumonia. In that population, the presence of diarrhea was negatively associated with the presence of pneumonia; this may reflect the incidence of infections in that hospital population, routes of infection, or different localization patterns.[1] Other studies have reported the prevalence of pneumonia in septic foals as 28%[2] to 50%.[3] The most common bacterial organisms associated with pulmonary disease in neonates are identical to those that cause systemic sepsis. *Escherichia coli* has consistently been the most common etiologic organism isolated from the blood of septic foals.[1,4] The relative reported incidence of other bacteria varies with time and geographic location, but common organisms include *Klebsiella* spp, *Actinobacillus* spp, *Salmonella* spp, and other gram-negative aerobes. Mixed infections with gram-positive bacteria, such as *Enterococcus* spp, *Streptococcus* spp, and *Staphylococcus* spp also occur.[2,4,5]

Neonates may acquire primary bacterial pneumonia secondary to aspiration. Milk aspiration is generally related to a poor suckle reflex, weakness, or dysphagia associated with prematurity or neonatal maladjustment syndrome. Other causes of aspiration may include congenital diseases, such as cleft palate, subepiglottic cysts, megaesophagus, esophageal compression due to vascular anomalies, hyperkalemic periodic paralysis, or other causes of pharyngeal dysfunction.[6,7] Improper bottle feeding or incorrect placement or use of a nasoesophageal or nasogastric feeding tube may also result in aspiration pneumonia.

Meconium may also be aspirated in utero or at the time of parturition. Neonates with meconium aspiration syndrome have respiratory compromise because of a combination of mechanical airway obstruction, chemical pneumonitis, alveolar edema, and displacement of surfactant, which results in reduced lung compliance and small airway obstruction, leading to ventilation/perfusion mismatching.[8] Although meconium is sterile, secondary bacterial infection often can result as a complication of meconium aspiration.

Suckling and Weanling Foals

Pneumonia is the most common cause of morbidity and mortality in foals aged 1 to 6 months[9] and is usually acquired via inhalation. The most common bacterial cause of primary foal pneumonia is *Streptococcus equi* subsp *zooepidemicus*, which may be isolated alone or as part of a mixed infection. *S zooepidemicus* is a normal inhabitant of the upper respiratory tract, but viral infections (eg, equine herpes virus 1 or 4, equine influenza, or equine arteritis virus) may damage the mucous membranes, allowing for establishment of disease. Stressors such as high ambient temperature, weaning, and transport also have been implicated. Although isolates of *S zooepidemicus* from pneumonic foals and horses tend to be clonal (ie, the same) within individuals,[10] they are highly variable among individuals. Evidence of clones of *S zooepidemicus* causing epizootics has been described.[11]