Proceedings of the American Association of Equine Practitioners - Focus Meeting

Focus on Upper and Lower Respiratory Diseases

Salt Lake City, UT, USA – 2010

Next Focus Meetings:

July 24-26, 2011 - Focus on Colic
Indianapolis, IN, USA

September 18-20, 2011 – Focus on Dentistry
Location TBD

Reprinted in the IVIS website with the permission of the AAEP
http://www.ivis.org
Neonatal Pulmonary Disorders

Steeve Giguère, DVM, PhD, Diplomate ACVIM

Author’s address: College of Veterinary Medicine, University of Georgia, Athens, GA, 30602; e-mail: gigueres@uga.edu.

Take Home Message

The detection of respiratory disease in the newborn foal can be challenging. Clinical signs that are often associated with pulmonary tract disease in older foals and adult horses such as cough, fever, and nasal discharge are frequently lacking in the sick neonatal foal. This article reviews how to diagnose and treat the most common pulmonary disorders of neonatal foals.

Introduction

The transition from the fluid-filled lung of the fetus to an organ that is responsible for efficient gas exchange is a rapid and complex process. The transition can be complicated by a number of factors, including prematurity or dysmaturity, perinatal asphyxia, aspiration of meconium or milk, and bacterial or viral infection. A highly compliant chest wall, a naïve immune system, and failure of transfer of passive immunity are additional factors that predispose the equine neonate to respiratory problems.

The detection of respiratory disease in the newborn foal can be challenging. Clinical signs that are often associated with pulmonary tract disease in older foals and adult horses such as cough, fever, and nasal discharge are frequently lacking in the sick neonatal foal. In the absence of arterial blood gas data or radiographic information, the clinician must rely on vague signs, such as restlessness and agitation, increased respiratory rate or respiratory distress. This article reviews the most common pulmonary disorders of neonatal foals.

Bacterial Pneumonia

Bacterial infection of the lower respiratory tract most commonly occurs during or shortly after birth, but can also take place prior to parturition, through aspiration of contaminated amniotic fluid. This may take place in mares with bacterial placentitis. In the newborn foal pneumonia can result from direct aspiration or inhalation of bacteria or from the hematogenous spread of microorganisms in foals that are bacteremic. Pneumonia like many of the infectious diseases affecting the neonatal foal (meningitis, osteomyelitis, septic arthritis, and omphalophlebitis) is often secondary to bacteremia. Bacterial sepsis is the leading cause of morbidity and mortality in neonatal foals. Gram-negative bacteria account for 70% to 95% of the microorganisms isolated from cultures of blood samples in equine neonates, with \textit{Escherichia coli} being by far the most common isolate.\textsuperscript{1-3} Other Enterobacteriaceae (\textit{Klebsiella} spp, \textit{Salmonella} spp, and \textit{Enterobacter} spp) and nonenteric Gram-negative rods (\textit{Pasteurella} spp and \textit{Actinobacillus} spp) are also commonly isolated. Gram-positive cocci (β-hemolytic streptococci, \textit{Enterococcus} spp., and \textit{Staphylococcus} spp.) account for approximately 20% of isolates.
The identification of causative organisms should be an important component of the diagnostic work up. Isolation of bacteria can be attempted from blood culture or culture of amniotic fluid or placental tissue if in utero infection is suspected. Lower airway culture can be difficult, as a transtracheal aspirate can be dangerous in a compromised neonate. An alternative method involves passage of a guarded swab through a nasotracheal tube into the lower airway. The tip of the nasotracheal tube can also be cultured if it has been present in the airway for a prolonged period.

The treatment of bacterial lung disease involves a combination of respiratory support techniques and antimicrobial therapy. The neonatal foal readily develops dependent atelectasis in lateral recumbency. Consequently, positioning in sternal rather than lateral recumbency results in improved ventilatory capacity and higher arterial oxygen tension. Maintenance of sternal recumbency is aided by use of a V-pad. Proper antimicrobial therapy is of paramount importance. Treatment protocols for equine neonates must include antimicrobials with a high level of activity against enteric Gram-negative bacteria while providing adequate coverage against Gram-positive microorganisms. Bactericidal agents are preferred because neonatal foals have a naïve immune system and their defense mechanisms against bacterial pathogens are often compromised. The combination of an aminoglycoside (amikacin or gentamicin) with either penicillin, ampicillin, or ceftiofur is often initiated until culture results are available (Table 1). Such combination provides adequate coverage against approximately 90% of bacterial isolates recovered from blood cultures. Amikacin, although more expensive, is preferred to gentamicin because of its lower frequency of resistance amongst Enterobacteriaceae. Similarly, ampicillin is preferred to penicillin because of its higher activity against enterococci. In situations when an aminoglycosides should not be used such as renal failure, adequate coverage is provided by a third (ceftiofur, cefotaxime) or fourth (cefepime) generation cephalosporin.

The most common arterial blood gas (ABG) derangement associated with bacterial pneumonia is mild to moderate hypoxemia with normal or reduced PaCO₂. When indicated, humidified oxygen is the treatment of choice and is best delivered through a nasal insufflation tube. A good starting point for most foals is to deliver flow at 5 L/min. Rates of up to 10 L/min may be required. The response to therapy needs to be carefully evaluated. Ideally, an arterial blood gas is obtained to confirm an appropriate rise in PaO₂. The aim should be to maintain the arterial oxygen concentration at around 70 to 105 mm Hg. If an ABG analysis is not available then clinical improvement can be confirmed by noting a reduction in rate and or depth of ventilation, improvement in mucous membrane color, reduced agitation, etc.

**Viral Pneumonia**

Viral pneumonia is not common in neonatal foals although several viruses have been identified as causes of pneumonia in the neonatal foal. These include equine herpesvirus type 1 (EHV-1) and type 4 (EHV-4), equine influenza, equine viral arteritis virus and adenovirus. Of these, EHV-1 appears to be the most common and clinically relevant. Herpesviral pneumonia is typically fatal, even in the face of aggressive supportive therapies such as mechanical ventilation. The anti-viral drugs, acylovir or valacyclovir, have been used but efficacy data are lacking in foals with EHV-1 pneumonia. The main difficulty is to establish a diagnosis early in the course of treatment. In one study, foals with EHV-1 infection were more likely to have total white blood cell counts less than 3,000/µL and to be icteric as compared to foals with bacterial sepsis. The
presence of dilated retinal vessels and a red discoloration to the optic disc on fundic examination have also been suggested as a common ante-mortem finding.

Table 1. Recommended dosages for commonly used antimicrobial agents in foals less than 6 weeks of age.

<table>
<thead>
<tr>
<th>Drug preparation</th>
<th>Dose</th>
<th>Dose interval (h)</th>
<th>Route of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amikacin</td>
<td>25 mg/kg</td>
<td>24</td>
<td>IV/IM</td>
</tr>
<tr>
<td>Ampicillin sodium</td>
<td>20 mg/kg</td>
<td>6</td>
<td>IV</td>
</tr>
<tr>
<td>Cefepime</td>
<td>11 mg/kg</td>
<td>8</td>
<td>IV</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>40 mg/kg</td>
<td>6</td>
<td>IV</td>
</tr>
<tr>
<td>Cefpodoxime</td>
<td>10 mg/kg</td>
<td>8</td>
<td>PO</td>
</tr>
<tr>
<td>Ceftiofur</td>
<td>5.0 mg/kg</td>
<td>12</td>
<td>IV, IM</td>
</tr>
<tr>
<td>Fluconazole</td>
<td>5.0 mg/kg</td>
<td>24</td>
<td>PO</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>12 mg/kg</td>
<td>24</td>
<td>IV/IM</td>
</tr>
<tr>
<td>Penicillin G (Na, K)</td>
<td>22,000 IU/kg</td>
<td>6</td>
<td>IV</td>
</tr>
<tr>
<td>Trimethoprim-sulfonamide</td>
<td>30 mg/kg (combined)</td>
<td>12</td>
<td>PO</td>
</tr>
</tbody>
</table>


aNOTES:
1. Dosages and agents listed are extra-label and based on pharmacokinetic studies performed on small numbers of foals. As a result, efficacy and safety studies are not available.
2. Many of the drugs listed have the potential to cause adverse effects.
3. Veterinarians using this table are encouraged to consult current literature and product label for information regarding efficacy, safety, and potential adverse reactions.

Fungal Pneumonia

Fungal pneumonia is very rare in neonatal foals. Several fungi have been associated with neonatal pneumonia. In utero infection with Histoplasma capsulatum can result in placentitis, abortion, or birth of an infected foal with multiple organ disease including granulomatous pneumonia. Infection with Candida species (especially Candida albicans) is an infrequent complication in foals with chronic bacterial infection. Lengthy antimicrobial use is a likely risk factor for infection. The diagnosis is based on a history that often includes persistent low-grade fever, worsening respiratory disease or the development of synovitis, and isolation of the microorganism through blood culture. Many cases have concurrent oral infections (thrush). Successful treatment of neonatal candidiasis has been achieved with fluconazole. Amphotericin B may also be used.

Meconium Aspiration Syndrome (MAS)

The observation of a foal stained with meconium frequently reflects pre- or intra-partum asphyxia. Such an observation should be a warning of possible complications, including
neurological dysfunction (neonatal encephalopathy) and respiratory disease. Meconium is a sterile concretion of sloughed intestinal cells and mucus. When aspirated, meconium may obstruct airways, interfering with gas exchange, and cause severe respiratory distress. The degree of respiratory compromise is related to the volume of meconium aspirated, and whether or not secondary bacterial infection has occurred. The diagnosis of MAS is based on direct observation of meconium staining of amniotic fluid or of the foal itself. Radiographically, meconium aspiration is difficult to differentiate from bacterial pneumonia. The treatment of MAS should include clearance of the nasal passages and suctioning of the trachea shortly after birth. This can be achieved through passage of a soft, sterile catheter into the airway and gentle aspiration with a 60 mL dose syringe attached to a Foley catheter. Nasotracheal intubation will usually be necessary for effective suctioning of the lower airway. Many foals with MAS require minimal treatment or support. A course of broad-spectrum antimicrobial agents (see above for recommendations) is typically recommended to prevent secondary infections. If tachypnea or respiratory distress occur then additional therapy with intranasal oxygen or assisted ventilation may be required. The prognosis for mild uncomplicated MAS is generally good.

**Milk Aspiration**

Aspiration of milk into the lower airways may occur as a complication to a wide range of disorders. Unfortunately, the decreased sensitivity of the upper and lower airway to foreign material may make diagnosis of milk aspiration difficult as many foals will not cough after nursing. In addition, many foals that aspirate milk will not display nasal regurgitation of milk following nursing. Aspiration can occur in foals with cleft palate, persistent dorsal displacement of the soft palate, white muscle disease, botulism, neonatal encephalopathy, or generalized weakness due to sepsis or prematurity. Iatrogenic contamination of the airway can occur when bottle-feeding is forced or if the foal is too weak to swallow normally. Aspiration pneumonia may also result from inappropriate placement of nasogastric tube.

The diagnosis of milk aspiration is supported by historical data (nasal regurgitation of milk when present), physical examination findings (abnormal lung and tracheal auscultation immediately after nursing) and laboratory data (inflammatory leukogram, elevated fibrinogen, hypoxaemia). Endoscopy immediately post-nursing may also be helpful to demonstrate the presence of milk in the trachea. Radiographic examination commonly reveals a heavy, peri-hilar and/or ventral alveolar pattern.

Treatment involves long-term, broad-spectrum antimicrobial therapy and prevention of further contamination of the airway. The underlying cause should be pursued diagnostically and treated when possible. This may necessitate the use of further diagnostics tests such as endoscopy and contrast radiography. Enteral feeding through a nasogastric tube is indicated until the underlying problem has resolved. In many foals with no detectable underlying problems, the condition will resolve with time and supportive care.

**Fractured Ribs**

Thoracic trauma occurs commonly during the birthing process. Costochondral dislocation or rib fractures were reported in 21% (55/263) of foals at an Irish Thoroughbred farm. None of these foals developed clinical signs associated with thoracic trauma. The prevalence of thoracic trauma
is much higher among foals admitted to intensive care units. In a prospective study, 65% of foals presented to a referral institution had rib fractures. Most fractures were located within a few centimeters of the costochondral junction.

Potential clinical consequences include local pain and hematoma formation, hemothorax, lung laceration and pneumothorax, and pericardial/myocardial puncture. Diagnosis is by observation of chest wall symmetry and synchrony, palpation, ultrasound findings, and/or radiographic examination. Ultrasonography is much more sensitive than radiography or palpation for the detection of fractured ribs. Treatment involves recognition and treatment of potential complications and avoidance of further thoracic trauma. Surgical fixation is recommended when the fracture is displaced or when it has already caused lung or cardiac lacerations. Surgical fixation is also recommended when multiple consecutive ribs are fractured.

References