When you Hear Hoofbeats, Think Horses not Zebras

Bronchopneumonia of a Zebra Foal

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Introduction

Pneumonia is a major cause of morbidity and mortality in foals. The main pathogens associated with foal bronchopneumonia are *Rhodococcus equi* and *Streptococcus equi* spp. *zooepidemicus). R. equi* is commonly found in the soil, and the foals inhale dust particles that contain the bacteria. Foal pneumonia caused by *R. equi* is often seen at farms with a high horse density. *S. equi zooepidemicus* is another common cause of foal bronchopneumonia, and it is a commensal organism that is normally found in the tonsils and mucosa of the upper respiratory tract of healthy foals. Clinical signs of foal bronchopneumonia include lung crackles or wheezes, cough, fever, tachypnea, and increased respiratory effort. Stress or impaired pulmonary defenses can predispose a foal to bronchopneumonia. Good foal management, decreasing stressful events, and keeping horse density low can help prevent bronchopneumonia in foals.

This is a case of a zebra foal that after a series of stressful events and poor management died from a *Streptococcus equi* spp. *zooepidemicus* bronchopneumonia.

History and Presentation

Zeb is an approximately 4-5 month old, intact male Grant zebra. He is a wild caught zebra from Africa that was taken from the mare at approximately 2 weeks of age. He was then shipped by boat with many other zebra foals to Florida. After the required quarantine period was over, Zeb was purchased by his owner to be part of a traveling petting zoo. On the evening of November 15, 2019, Zeb was found down in the pasture during a rain storm, and he was shivering. After consulting with Dr. Lack at MSU-CVM, Zeb was taken into the barn and warmed up. His initial temperature was too low to read on the thermometer. The following (11/16/19) day Zeb was seen by his primary veterinarian and diagnosed with pneumonia, and he

was treated with antimicrobial medications (unknown products). He was also dewormed with Ultraguard at that time.

Zeb is normally housed in a barn, but he also has access to a pasture that he shares with a donkey. His normal diet consisted of 16% sweet feed and Bermuda grass hay. There are many different animals on the property including a kangaroo, horses, goats, sheep, camels, and calves.

Zeb died on the evening of November 17, 2018 and presented to the MSU-CVM Necropsy Service the following morning. Zeb was the second zebra foal to die on the property, and both Zeb and the first zebra foal were purchased at the same time. The necropsy of the first zebra foal revealed severe malnutrition and multi-organ failure.

Necropsy Findings

Upon gross examination, there was a moderate amount of autolysis present, and a right jugular catheter was still in place. Zeb had a body condition score of 4/9. The zebra foal had pale pink mucous membranes. Submandibular edema and brisket edema were also noted on presentation.

The main findings on necropsy include abnormal lungs, lymph nodes, edema, and serous atrophy of fat. The thoracic cavity contains approximately 20 mls of a clear, yellow fluid. Negative pressure was present when dissecting into the thorax, but the lungs were poorly collapsed. Affecting both the left and right lungs, there was cranioventral consolidation and the lungs are dark red to purple in color with a sharp line of demarcation compared to the dorsocaudal lungs. There were many widely disseminated to coalescing, irregularly marginated, firm, white nodules that are approximately 1 cm in diameter in the cranioventral lung lobes. The cranioventral segments of lung sank in formalin. There were multifocal dark red nodules

surrounded by less affected lung parenchyma in the caudodorsal lungs. A moderate amount of red foamy fluid was present in the trachea, and the tracheobronchial lymph nodes are 2-3 times larger than normal. A yellow to red gelatinous material was present around the base of the heart, but the remainder of the heart was grossly normal.

Other less significant necropsy findings include, locally extensive, approximately 1 mm, soft, round, black nodules in the ileum (hyperplastic peyers patches). The abdominal cavity contained minimal fat, and there was little to no fat present in the omentum. There was diffuse serous atrophy of mediastinal and epicardial fat.

Histopathology revealed many neutrophils within the bronchiolar lumens and alveolar spaces, indicating suppurative inflammation within the airways. The inflammation has destroyed some of the bronchiolar epithelium and has seeped into the adjacent alveoli. Fibrin is intermixed within the inflammation along with areas of hemorrhage. Few bronchi were also filled with blood. A sample of affected lung was submitted for aerobic bacterial culture and revealed *Streptococcus equi zooepidemicus*.

Pathophysiology

Pneumonia is an inflammatory process of the lungs, and in animals it is classified using texture, appearance, distribution, and exudation.[6] The classification of pneumonia can make it easier to predict the causative agent of the pneumonia.

Interstitial pneumonia is caused by damage to the alveolar epithelium or type 1 pneumocytes, and it has a diffuse distribution where rib imprints can be observed in the lung lobes.[6] There are many causes of interstitial pneumonia, but a few include toxic gases or fumes, pneumotoxins, bacterial toxins and pneumotrophic viruses. Granulomatous pneumonia has

multifocal nodules in all lung lobes, and it can be caused by many infectious organisms such as intracellular bacteria, parasites, or fungi. Embolic pneumonia is centered around the pulmonary arterioles and alveolar capillaries, and it has a multifocal distribution in all lung lobes.[6]

Bronchopneumonia indicates inflammation in the bronchial, bronchiolar, and alveolar lumens. It is characterized by cranioventral consolidation of the lungs, and bronchopneumonia is generally caused by bacteria. The initial inflammatory process begins in the mucosa of the bronchioles and spreads upward to the bronchi and down towards the alveoli. When severe pulmonary injury occurs, there is an increase in vascular permeability and the airways are filled with fibrinous exudate or hemorrhage.[6]

Pneumonia is a significant cause of disease and death in foals. Foal pneumonia is often associated with a stressful event or a compromised immune system, such as failure of passive transfer.[12] The most common bacterial pathogens associated with foal pneumonia in older foals are *Rhodococcus equi* (*R.* equi) and *Streptococcus equi* spp. *zooepidemicus* (*Strep. zoo.).* *Rhodococcus equi* is a gram-positive, facultative intracellular bacteria that infects macrophages, and it is commonly found in the soil.[2] It can also be a commensal organism in the gastrointestinal tract of adult horses.[3] The route of infection for the foals is most commonly inhalation of dust particles with *R. equi*, but it may also be found in equine feces, soil, and in water sources. Increased airborne concentrations of *R. equi* have been positively associated with foal pneumonia, and the airborne concentrations tend to be higher in the barn that out in the pasture. An increased density of mares and foals, such as at breeding farms, has also been positively associated with an increased number of *R. equi* foal pneumonia.[1]

Another common cause of foal pneumonia is *Streptococcus equi* spp. *zooepidemicus* (*Strep. zoo*), which is a gram-positive, beta hemolytic (Lancefield group C) bacteria. *Strep. zoo.*

is a commensal organism that is found in the tonsils and mucosa of the upper respiratory tract of healthy horses.[10] Opportunistic infections usually occur following a viral infection, heat or cold stress, weaning or prolonged transportation. *Strep. zoo.* has also been noted to cause multiorgan disease in foals, such as pneumonia, diarrhea with peritonitis, and death.[3]

The clinical signs of *Rhodococcus equi* and *Streptococcus equi* spp. *Zooepidemicus* are similar in the foal. In the newborn foal, it is difficult to detect respiratory disease early, because clinical signs of respiratory infection may be absent until the disease is extensive. Dyspnea, paradoxical breathing, restlessness, and cyanosis may be seen in severely affected newborn foals.[13] Older foals will generally show respiratory clinical signs earlier in the disease process than newborn foals. Clinical signs of foal bronchopneumonia include abnormal auscultation of the lungs (crackles or wheezes), cough, fever, increased respiratory effort, and tachypnea. Nasal discharge is more commonly seen in *Strep. zoo.* pneumonia than with *R. equi.*[13] Septic polyarthritis can also be seen in foals with bronchopneumonia, and the synovitis will usually resolve along with the clinical signs of pneumonia.[2] Thoracic ultrasonography and radiographs can aid in diagnosing bronchopneumonia earlier in a foal. A foals clinical signs can aid in diagnosing foal pneumonia, but further diagnostics are required to determine the pathogen involved. Microbiologic culture is the gold standard diagnostic test for the causative agent in foal pneumonia. Polymerase chain reaction can also be used, and it often provides results faster than a culture. Thoracic ultrasonography and radiographs can aid in diagnosing bronchopneumonia earlier in a foal.

Treatment

The treatment and prevention of foal pneumonia varies depending on the agent involved. Treatment for a *Rhodococcus equi* pneumonia includes a macrolide (Clarithromycin or Azithromycin) and rifampin.[2] The combination of a macrolide plus rifampin has been shown to be more effective than either drug alone. It is also important to ensure that the foal is adequately hydrated, and flunixin meglumine can also be added. Prevention of *R. equi* includes prevention of overcrowding, over grazing, and keeping foals away from dusty dry lots. Administering hyperimmune plasma to the foal prior to contracting the disease has been reported to reduce the incidence of disease.[1] An effective vaccine for the mare or foal is currently not available for prevention of *R. equi*. Prophylactic treatment of foals is not recommended, because it leads to resistant infections.

Treatment of *Strep. zoo* is slightly different, and there are also some preventative steps that can be taken. Traditional therapies for *Strep. zoo.* foal pneumonia include β-lactam antimicrobials such as penicillins or ampicillin, or a cephalosporin such as ceftiofur can be administered. An aminoglycoside (gentamicin or amikacin) can also be used in combination with penicillin.[5] Prevention of *Strep. zoo.* foal pneumonia revolves around preventing stressful events for the foal. It is vitally important that the foal receives colostrum within the first 24 hours of live, and that it is raised a dry, clean, and warm environment.

Foal Management

A zebra that is taken from its mare at such a young age should be managed like an orphan foal. It is essential that the foal have a dry, clean, and warm environment. As the zebra foal becomes older and stronger, it can be turned out into a small pasture. During inclement weather

or cool temperatures, the foal should be kept indoors in a warm, dry environment where supplemental heat can be provided when needed. If possible, the zebra foal should be raised in a group of other orphaned zebra foals or horses. Behavior problems such as being nippy, pushy, and aggression can develop in hand-raised orphan foals that have not had adequate interaction with other foals.[11]

If the zebra foal is taken or abandoned by the zebra mare within the first 24 hours of life or does not nurse, the foal would ideally need to receive zebra colostrum or plasma. Older, healthy orphan foals can be fed a milk substitute by bottle feeding or bucket feeding, which is less labor intensive and will help decrease the human bond. Normal foals will drink approximately 20-25% of its body weight daily, and it will need to be fed every two hours to mimic how often it would nurse from its mare. Orphaned foals can be weaned at 3-4 months by slowly mixing the milk replacer with milk pellets and later a junior feed.[8] The foal should always have access to hay, so the foal can investigate and become familiar with it.

Zebra foals can be susceptible to many of the same diseases as horses, so vaccination should be considered for the zebra foals. Exotic animals are vaccinated extra-label, because the vaccines have only been tested and approved for domestic animals. Killed vaccines are recommended for exotic animals, because modified live vaccines have the potential to cause disease and abortion in pregnant animals. Rabies vaccines cannot be given to zebras, because they are not licensed for use in wild animals.[4] Zebra foals can be vaccinated extra-labelly for tetanus, Eastern and Western Equine Encephalomyelitis, and West Nile Virus. Because the zebra mare was most likely not vaccinated, the zebra foal can be vaccinated following the American Association of Equine Practitioners (AAEP) vaccine recommendations for a foal from

an unvaccinated mare. The vaccination schedule for foals from unvaccinated mares is shown in the table below.

AAEP Recommended Vaccination Schedule for Foal from an Unvaccinated Mare.[7]

Disease	**Foals and Weanlings of Unvaccinated Mares**
Tetanus	3-Dose Series: - 1st dose: 3-4 months of age - 2nd dose: 4-6 weeks after 1st dose - 3rd dose: 10-12 months of age
Eastern/Western Equine Encephalomyelitis (EEE/WEE)	3 Dose Series: - 1st dose: 3-4 months of age (3 months if in SE) - 2nd dose: 4 weeks after 1st dose - 3rd dose: 8 week interval after 2nd dose
West Nile Virus (WNV)	3-dose series: - 1st dose: 3-4 months of age (3 months if in SE) - 2nd dose: 4 weeks after 1st dose - 3rd dose: 8 week interval after 2nd dose

Parasite control is also important in the management of young foals. The AAEP recommends that during the first year of a foal's life it should receive a deworming treatment at least four times. Around 2-3 months of age, it is suggested that the foal be given a benzimidazole dewormer to treat ascarids. A similar treatment is recommended at approximately 4-6 months of age or just before weaning. At weaning, AAEP recommends performing a fecal egg count to determine whether the worm burden is primarily strongyles or ascarids and then deworm appropriately. The fourth treatment should occur around 9-12 months of age, and it should target strongyles and tapeworms. Yearlings and 2-year olds should have a fecal egg count performed about 3 times a year and dewormed accordingly.[7]

Foal pneumonia is a major cause of morbidity and mortaility in foals. The main pathogens associated with foal bronchopneumonia include *Rhodococcus equi* and *Strep zoo*.

Good foal management and decreasing stressful events can go a long way at keeping foals healthy and prevent diseases.

In our case, Zeb had bronchopneumonia that was caused by *Streptococcus equi* spp. *zooepidemicus.* Zeb was taken from his mare at a very young age, followed by extensive travel to a distant continent. Once Zeb reached his new home, he received insufficient nutrition for a growing foal and lived in poorly managed conditions. As a result, Zeb was underweight and malnourished. These series of series stressful events, poor management practices, and improper care impaired his immune system and predisposed him to opportunistic infections, which led to his eventual death.

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