**Streptococcus equi** subspecies *equi* Infection (Strangles) in Horses

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**Abstract:** *Streptococcus equi* subspecies *equi* (strangles) is a highly contagious upper respiratory infection in horses. The infection is transmitted by inhalation or direct contact with mucopurulent discharge from an infective animal, resulting in fever, depression, and submandibular and retropharyngeal lymph node enlargement that can lead to respiratory distress. Complications include purpura hemorrhagica and metastatic abscessation. Control of outbreaks requires strict isolation protocols and hygiene measures. Detection of carriers is essential for preventing disease recurrence on a farm.

Strangles is a worldwide, acute upper respiratory infection in horses, resulting in high morbidity but low mortality. The etiologic agent is the gram-positive coccus *Streptococcus equi* subspecies *equi*. The infection is characterized by fever, lethargy, purulent nasal discharge, and regional lymph node abscessation. Highly concentrated and transient populations are at greater risk of contracting the disease.1,2

**Pathophysiology**

*S. equi* subsp *equi* is inhaled or ingested after direct contact with mucopurulent discharge from infected horses or contaminated equipment. The bacterium attaches to the crypts and epithelium of the lingual and palatine tonsils with the assistance of fibronectin binding protein.1,3 The organism does not colonize the mucosal surface but penetrates into deeper tissue and enters the mandibular and pharyngeal lymph nodes. The hyaluronic acid capsule and the SeM protein allow the bacterium to avoid phagocytosis by neutrophils. Clinical signs develop 3 to 14 days after exposure. In as many as 20% of cases, *S. equi* subsp *equi* spreads via the hematic or lymphatic systems or by close proximity to an existing abscess. This results in metastatic abscessation (also known as bastard strangles), which can affect any organ system.1,2

**Clinical Signs**

The first clinical sign of strangles is acute-onset fever (often >103°F [39.4°C]), followed by lethargy, depression, bilateral mucopurulent nasal discharge (FIGURE 1), lymphadenopathy, and abscessation of the retropharyngeal and mandibular lymph nodes (FIGURE 2). Occasionally, the parotid and cranial cervical lymph nodes are affected. Retropharyngeal lymph node enlargement can lead to narrowing of the pharynx, resulting in respiratory stridor, dysphagia, and neck extension. Empyema results when the retropharyngeal lymph nodes drain into the guttural pouches. This can sometimes result in the formation of chondroids or inspissated pus (FIGURES 3 and 4). On endoscopic examination, drainage from the opening of the guttural pouch and difficult entry into the pouch are suggestive of guttural pouch empyema.
In addition, horses may develop respiratory distress due to retropharyngeal abscesses that are not externally mature. Upper airway endoscopy often reveals a narrowed pharynx due to axial deviation of the guttural pouches and enlarged retropharyngeal lymph nodes that bulge through the respiratory mucosa on the floor of the guttural pouch. Clinical signs are more severe in immunologically naïve (1 through 5 years of age), geriatric (older than 20 years), and immunocompromised horses. Some horses may develop complications such as metastatic abscessation, purpura hemorrhagica, and myositis.

**Bastard Strangles (Metastatic Abscession)**

In cases of bastard strangles, clinical signs depend on the organ system involved. Aspiration of mucopurulent discharge or hematogenous or lymphatic spread to the lungs can cause pneumonia. Abscessation in the mesentery, liver, spleen, and kidneys is common, leading to peritonitis and clinical signs of colic. Abscessation of the cranial mediastinal lymph nodes can cause tracheal compression and respiratory distress. Neurologic signs are present when abscession occurs in the brain. The mortality rate of horses with strangles is less than 2%, but the presence of bastard strangles increases the mortality rate to as high as 62%, according to some reports.

**Purpura Hemorrhagica**

Purpura hemorrhagica is an aseptic necrotizing vasculitis that can occur in mature horses after repeated natural exposure to infection or after vaccination of horses that have had strangles. Timoney and others have suggested that horses with high SeM-specific serum antibodies may be predisposed to purpura when vaccinated for *S. equi* subsp *equi* with an attenuated live intranasal *S. equi* vaccine. The actual incidence of this type III hypersensitivity response secondary to strangles or vaccination is unknown. A report from 1999 noted two cases of purpura-like disease per 100,000 doses of attenuated live intranasal *S. equi* subsp *equi* vaccine sold. Clinical signs range from mild to life-threatening, including pitting edema of the head, trunk, and distal limbs as well as petechiae and ecchymoses of the mucous membranes. In some cases, antigen–antibody complexes affect other sites, including the gastrointestinal tract, muscles, lungs, and kidneys.
Transmission and Immunity

Shedding of *S. equi* subsp *equi* begins 2 to 3 days after onset of fever. In most cases, shedding persists for a minimum of 2 to 3 weeks. Horses that have recovered from strangles have been shown to shed for an additional 6 weeks. If organisms are harbored in the guttural pouches, horses can shed *S. equi* subsp *equi* for months or years. These outwardly healthy horses (i.e., carriers) that still shed organisms are a source of infection when introduced into a new population of horses. Transmission occurs through nose-to-nose contact; close proximity of housing; shared equipment (e.g., water buckets, feed buckets, tack, twitches); clothing of people or horses; and equipment of owners, caretakers, farriers, and veterinarians. Under laboratory conditions, not field conditions, *S. equi* subsp *equi* has been shown to persist on wood for 63 days at 35.6°F (2°C) and for 48 days on glass and wood at 20°C (68°F). Moist environments (e.g., water buckets) allow the organism to persist for extended periods.

Seventy-five percent of horses that have been infected with *S. equi* subsp *equi* and have not been treated with antimicrobials develop lasting immunity for approximately 5 years or longer. Older horses that have had a milder form of the disease can shed virulent *S. equi* subsp *equi* that can produce significant disease in the naïve population. Foals of mares that have recovered from strangles are usually protected by maternal antibodies until weaning.

Diagnostics

Early definitive diagnosis is essential for containing this highly infectious disease. Suspicion of disease can be supported but not confirmed if cytologic evaluation reveals gram-positive extracellular cocci in long chains. The gold standard for diagnosis is bacterial culture of *S. equi* subsp *equi*. This can be performed on abscess aspirates. Culture can also be performed on nasopharyngeal swabs, nasopharyngeal washes (Box 1), and guttural pouch lavage samples. To be diagnostic, nasopharyngeal swabs must be long enough (e.g., unguarded uterine culture swabs, sterile human

**Box 1. Performing a Nasopharyngeal Wash**

For a nasopharyngeal wash, most horses require sedation and a nasal twitch. While wearing appropriate barrier protection over his/her clothing and nonsterile gloves, the clinician advances a sterile uterine insemination pipette into the lumen of a sterile rectal sleeve. The sleeve is then placed over the nose of the sedated horse, and the pipette is advanced to the level of the medial canthus of the eye (~10 cm). Sterile saline (50 mL) is infused through the pipette into the pharynx, and the sample is caught in the rectal sleeve. The volume of one finger of the rectal sleeve is sufficient for bacterial culture and PCR testing. The sample is steriley obtained from the finger via the uterine pipette.

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**Figure 5. Endoscopic examination of a yearling with strangles.**
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To enter the pharynx. To detect the DNA of the organism, polymerase chain reaction (PCR) testing can be used on nasopharyngeal swab and wash samples at the onset of disease and on guttural pouch lavage samples for weeks after the onset of disease. PCR testing is more sensitive than bacterial culture but detects both dead and live S. equi subspp. equi. Therefore, positive PCR samples should be confirmed with bacterial culture of the guttural pouch fluid. 

Carriers can appear outwardly healthy but harbor S. equi subspp. equi in their guttural pouches. Definitive determination of carrier status requires endoscopic examination of the guttural pouches as well as culture and PCR testing of guttural pouch fluid.

Sero logical testing involves the use of ELISA to detect the SeM protein (Box 2). Serology is useful for detecting recent, but not current, infection; assessing the need for vaccination; identifying horses that may be predisposed to purpura hemorrhagica; and diagnosing S. equi subspp. equi-associated purpura hemorrhagica and metastatic abscission.

A complete blood count reveals neutrophilia and hyperfibrinogenemia during the initial stages of the disease. Patients with acute cases may have temporary hemolytic anemia secondary to a high fever. Cases of metastatic abscessation may be characterized by anemia of chronic disease. Chemistry profiles reflect abnormalities indicative of the body system affected in bastard strangles and purpura hemorrhagica. The latter disease often produces an abnormal coagulation profile. Rectal examination, abdominal ultrasonography (using a 2.5-MHz probe), and rectal ultrasonography (using a 5-MHz probe) of patients suspected of having metastatic abscessation often reveal an intraabdominal mass.

Treatment

The goal of treating strangles is to control transmission and eliminate infection while providing future immunity to the disease. Uncomplicated cases of strangles are often left to run their course with supportive care, providing lasting immunity. Affected horses should be isolated in a clean, dry stall and fed moist, palatable food. NSAIDs should be used judiciously to decrease swelling and promote eating. Hot compresses or topical 20% ichthammol can be used to accelerate maturation of abscessation. Mature external abscesses should be lanced to allow drainage, followed by daily lavage of open abscesses using 3% to 5% povidone iodine solution (Figure 6). This expedites resolution of abscessation as well as alleviation of compression of surrounding structures, such as the pharynx.

While the use of antimicrobials for treating strangles is controversial, horses with complications such as metastatic disease or purpura definitely require the use of systemic antimicrobials for

**Box 2. SeM-Specific Antibody Levels**

**Negative (titer: <1:200)**
No SeM-specific antibodies are detected. This result may be obtained from a horse with recent exposure (<7 days after exposure).

**Weak positive (titer: 1:200–1:400)**
SeM-specific antibodies are detected at a very low level. This is an equivocal result, and repeat testing is recommended in 7–14 days to confirm a presumptive diagnosis of strangles or exposure to S. equi subspp. equi.

**Moderate positive (titer: 1:800–1:1600)**
SeM-specific antibodies are detected at an intermediate level. This level may occur in a horse at 2–3 weeks after exposure or when the infection occurred 6 months to 2 years previously.

**High positive (titer: 1:3200–1:6400)**
SeM-specific antibodies are detected at a high level. High levels are found 4–12 weeks after infection or intranasal vaccination with live, attenuated organisms. Vaccination with injectable extracts results in high levels in 1–2 weeks. Vaccination is contraindicated in horses with existing high antibody levels.

**Very high positive (titer: ≥1:12,800)**
SeM-specific antibodies are detected at a very high level. These levels are often found in horses with metastatic abscessation or purpura hemorrhagica (immune-mediated vasculitis) after exposure to strangles vaccine or S. equi subspp. equi. Vaccination is contraindicated in horses with existing high antibody levels.

Interpretation of ELISA results from foals younger than 6 months must consider that all or part of the SeM antibodies may have been passively acquired. Foals receive crucial antibodies from colostrum but eventually become susceptible as their passively acquired IgG levels decline with time.
Box 3. To Treat or not to Treat?

Veterinary opinion is mixed as to whether to use antimicrobials to treat strangles. Many horses with strangles primarily require supportive care such as rest, a comfortable stall, readily available water, and soft, moist food. The following guidelines are from the 2005 ACVIM Consensus Statement on treatment of strangles:

Horses With Early Clinical Signs
During an outbreak, antimicrobial treatment for 3 to 5 days in early cases (e.g., fever, depression) may prevent focal abscessation. However, treated horses will not develop protective immunity and will be susceptible to reinfection once treatment is discontinued, if the horse is still exposed to other horses with strangles.

Horses With Lymph Node Abscessation
If the horse has significant lymphadenopathy, fever, depression, and anorexia, antimicrobials are needed to decrease the size of the abscess and prevent complete airway obstruction. Additional therapy, including a tracheostomy and antimicrobials are needed to decrease the size of the abscess and prevent complete airway obstruction. Additional therapy, including a tracheostomy and intensive supportive care, may be needed in some severe cases, especially if the horse has dyspnea due to enlarged lymph nodes.

If the horse has external lymphadenopathy but otherwise appears alert and healthy, antimicrobial therapy is probably contraindicated because it will prolong the inevitable enlargement and rupture of lymph node abscessation. Therefore, it is recommended to encourage maturation of the abscess by topical treatment such as application of hot packs and ichthammol. The abscessed lymph node can be surgically drained if the abscess has matured and thinned ventrally. Daily flushing of an open abscess with 3% to 5% povidone–iodine solution is recommended until discharge abates. NSAIDs are especially helpful for decreasing the horse’s fever, pain, and swelling.

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extended periods. In addition, horses with severely enlarged lymph nodes and dyspnea often require an emergency tracheostomy and intensive supportive care. The preferred antimicrobial is penicillin (procaine penicillin [22,000 to 44,000 IU/kg IM q12h] or aqueous potassium penicillin [22,000 to 44,000 IU/kg IV q6h]). The use of antimicrobials during the acute phase of fever and depression may prevent abscess formation but also the development of lasting immunity. It has been argued that antimicrobial use after abscess development may lead to metastasis based on the theory that protein synthesis by the organism is changed by antimicrobial treatment and that a decreased immunogen level results in a suboptimal immune response. However, there are no experimental or clinical data to support this theory. There are also reports of outbreaks in which no antimicrobials were used and the incidence of complications was high. In cases with complications such as S. equi subsp equi internal abdominal abscesses, the mean duration of antimicrobial treatment was 2 months in one study. Cases of purpura hemorrhagica also require the use of systemic corticosteroids (dexamethasone, 0.1 to 0.2 mg/kg IV or IM q12–24h; prednisolone, 0.5 to 1 mg/kg PO q24h) for an average of 3 weeks to reduce systemic vasculitis.

Elimination of guttural pouch empyema requires repeated lavage with a solution of 20% acetylcysteine in buffered saline via extended periods. In addition, horses with severely enlarged lymph nodes and dyspnea often require an emergency tracheostomy and intensive supportive care. The preferred antimicrobial is penicillin (procaine penicillin [22,000 to 44,000 IU/kg IM q12h] or aqueous potassium penicillin [22,000 to 44,000 IU/kg IV q6h]). The use of antimicrobials during the acute phase of fever and depression may prevent abscess formation but also the development of lasting immunity. It has been argued that antimicrobial use after abscess development may lead to metastasis based on the theory that protein synthesis by the organism is changed by antimicrobial treatment and that a decreased immunogen level results in a suboptimal immune response. However, there are no experimental or clinical data to support this theory. There are also reports of outbreaks in which no antimicrobials were used and the incidence of complications was high. In cases with complications such as S. equi subsp equi internal abdominal abscesses, the mean duration of antimicrobial treatment was 2 months in one study. Cases of purpura hemorrhagica also require the use of systemic corticosteroids (dexamethasone, 0.1 to 0.2 mg/kg IV or IM q12–24h; prednisolone, 0.5 to 1 mg/kg PO q24h) for an average of 3 weeks to reduce systemic vasculitis.

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Penrose tubing through an endoscope or via a chambers catheter. Chondroids are particularly difficult to remove, possibly requiring manual removal with endoscopic equipment such as a memory helical polyp retrieval basket (FIGURE 7), repeated lavage via indwelling catheters, or surgical removal. Successful elimination of S. equi subsp equi in these carriers requires local treatment of the guttural pouch with a gelatin/benzyl penicillin mixture (i.e., 20 mL of 3% gelatin in phosphate-buffered saline containing 5 × 10^6 IU of benzylpenicillin per guttural pouch) after removal of the material within the guttural pouch. Repeated local treatment and systemic treatment with procaine penicillin (22,000 to 44,000 IU/kg IM q12h) or potassium penicillin (22,000 to 44,000 IU/kg IV q6h) for 7 to 10 days are necessary for refractory cases.

Vaccination
The several available intramuscular vaccines do not provide complete protection against infection with S. equi subsp equi. The immunity level provided by these vaccines is lower than that produced during recovery of natural disease. Due to potential complications associated with intramuscular strangles vaccines, advisement of vaccination is based on a risk assessment of the patient. These intramuscular vaccines tend to cause injection-site reactions; therefore, they are not administered routinely. An intranasal vaccine is also available and contains an attenuated live strain of S. equi subsp equi that is antigenic with low pathogenicity. Experiments performed by the manufacturer of the intranasal vaccine have shown a more significant reduction of clinical disease with the use of the intranasal vaccine than with...
Be careful to use good hygiene to avoid fomite transmission between horses during sampling.

**Box 4. How to Screen for Asymptomatic Carriers**

**Horses Moved to a New Farm**

All new horses on a farm should be isolated from the resident equine population for 3 weeks. Screen new horses: obtain samples from nasopharyngeal swabs or washes to test for *S. equi subsp equi* by culture and PCR testing. If the results are positive, examine the horse’s guttural pouches by endoscopy for evidence of empyema or chondroids; obtain guttural pouch lavage samples for culture and PCR testing.

**After an Outbreak**

Once all cases of strangles on the farm have resolved, obtain at least three nasopharyngeal swabs or washes from convalescing horses and their contacts at weekly intervals and test for *S. equi subsp equi* by culture and PCR testing. If the results are positive, examine the horse’s guttural pouches by endoscopy for evidence of empyema or chondroids; obtain guttural pouch lavage samples for culture and PCR testing.

**Repeated Strangles Outbreaks**

If a farm has repeated strangles cases, screen for subclinical carriers by obtaining samples from nasopharyngeal swabs or washes to test for *S. equi subsp equi* by culture and PCR testing. If the results are positive, examine the horse’s guttural pouches by endoscopy; obtain guttural pouch lavage samples for culture and PCR testing.

Be careful to use good hygiene to avoid fomite transmission between horses during sampling.

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**Methods of Outbreak Control**

Most outbreaks are thought to originate from introduction of an infected horse into a naïve population. All new horses should be isolated for 3 weeks and monitored for signs of disease, including fever. If cost is not prohibitive, horses should be screened for *S. equi subsp equi* infection using nasopharyngeal washes or swabs. Many farms with repeated infections have resorted to screening for infection by culture and PCR testing of guttural pouch lavage samples (BOX 4). Once an outbreak has occurred, twice-daily monitoring of rectal temperatures of all horses on the farm is essential to contain the outbreak. Because febrile horses do not shed disease for the initial 2 days, immediate identification of febrile horses enables caretakers to isolate these horses before shedding occurs. All movement of horses to and from the farm should be stopped until they are determined to be noninfectious. All equipment (e.g., pitchforks, buckets, grooming tools) for an affected horse should be isolated and used only for that horse. Personnel handling infected horses should wear barrier precautions (i.e., gowns, gloves, plastic boots that cover shoes) and, ideally, should not handle noninfected horses or should handle infected horses last. Water buckets should be disinfected daily. Facilities and equipment should be cleaned first to remove all organic material and then disinfected with a phenol.

**Critical Points**

- Twice-daily rectal temperature assessment and immediate isolation of febrile horses are essential for rapid control of an *S. equi subsp equi* outbreak.
- Asymptomatic carriers are the most likely source of strangles.
- Asymptomatic horses that test positive for *S. equi subsp equi* according to PCR testing and culture of a nasopharyngeal swab or lavage should undergo endoscopic examination of the guttural pouches for evidence of empyema or chondroids.
- Seventy-five percent of horses that have been infected with *S. equi subsp equi* and have not been treated with antimicrobials develop lasting immunity for approximately 5 years or longer.
- Carriers can appear outwardly healthy but harbor *S. equi subsp equi* in their guttural pouches. Definitive determination of carrier status requires endoscopic examination of the guttural pouches as well as culture and PCR testing of guttural pouch fluid.
- Because the intranasal vaccine for strangles is an attenuated live vaccine, it should not be given concurrently with other routine intramuscular vaccines, to avoid contamination of the intramuscular injection site.
- Once all cases of strangles have resolved on a farm, three nasopharyngeal washes or swabs should be obtained from convalescing horses and their contacts at approximately weekly intervals and tested for *S. equi subsp equi* by culture and PCR testing to detect carriers.

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an iodophor, a chlorhexidine compound, or steam cleaning.\textsuperscript{1,12} Surfaces and equipment must be allowed to dry thoroughly. Paddocks that hold infected horses should be rested for 4 weeks. Once all cases of strep have resolved on a farm, three nasopharyngeal washes or swabs should be obtained from convalescing horses and their contacts at approximately weekly intervals and tested for \textit{S. equi} subsp \textit{equi} by culture and PCR testing to detect carriers. Because of the costliness of this testing, a minimum recommendation includes bacterial cultures on the first two samples and PCR testing on the third sample.\textsuperscript{1,13} If any of these samples has a positive result, the guttural pouch should be examined by endoscopy for evidence of guttural pouch empyema or chondroids and lavaged to perform culture and PCR testing. The percentage of carriers per outbreak could be as high as 10\%\.\textsuperscript{1,14-11} The SeM ELISA does not detect carrier status.\textsuperscript{22} Eradication of this disease will not be possible until the subpopulation of carriers is eliminated.\textsuperscript{28}

The use of vaccination during an outbreak is controversial. The 2005 ACVIM Consensus Statement recommends that live vaccine should be administered only to healthy animals with no known exposure to infected horses during an outbreak, but no published data show that vaccine use during an outbreak is detrimental.\textsuperscript{1} The AAEP Infectious Disease Committee does not recommend vaccination during an outbreak.\textsuperscript{29} It is suggested that horses recovering from infection should not be vaccinated for 1 to 2 years.\textsuperscript{21}

**Future Directions/Research**

Streptococcus equi is a highly contagious upper respiratory disease that persists in nature due to the presence of silent carriers. Improved diagnostics are needed to detect infection earlier, more conveniently, and at less cost. Stall-side detection would accelerate identification of affected horses, which, in turn, would lead to faster quarantine protocols and reduced spread of disease.\textsuperscript{1,27,30} The Animal Health Trust in the United Kingdom recently developed a new serologic test that detects antibodies differently than the SeM ELISA. This new test appears to be more sensitive for detecting animals with recent exposure (as little as 2 weeks) to \textit{S. equi} subsp \textit{equi}. However, this test is currently not available in the United States.\textsuperscript{3,12} Researchers are also working to develop new vaccines.\textsuperscript{1,33}

**References**

1. Which is not an accurate method of confirming a diagnosis of current *S. equi* subsp *equi* infection in horses?
   a. SeM ELISA (titer: ≥1:3200)
   b. culture of abscess aspirate
   c. culture or PCR testing of a nasopharyngeal wash or swab
   d. culture or PCR testing of guttural pouch fluid

2. Which is/are a clinical sign(s) of strangles?
   a. submandibular, retropharyngeal, and parotid lymph node enlargement
   b. respiratory distress
   c. guttural pouch empyema
   d. all of the above

3. What is the definitive method of determining *S. equi* subsp *equi* carrier status?
   a. PCR testing or culture of nasopharyngeal wash
   b. endoscopic examination of the guttural pouches as well as culture and PCR testing of guttural pouch fluid
   c. SeM ELISA (titer: ≥1:3200)
   d. PCR testing of peripheral blood

4. What is the most effective method for controlling a strangles outbreak?
   a. intranasal strangles vaccination during the outbreak
   b. isolation of horses at the first sign of mucopurulent nasal discharge
   c. twice-daily temperature monitoring and isolation of febrile horses
   d. isolation of horses at the first sign of lymph node enlargement

5. What is the incubation period for strangles?
   a. 2 months
   b. 3 weeks
   c. 3 to 14 days
   d. 24 hours

6. *S. equi* subsp *equi*
   a. colonizes the mucosal surface of the lingual and palatine tonsils.
   b. attaches to the crypts of the lingual and palatine tonsils.
   c. has a hyaluronic acid capsule, enabling phagocytosis of the bacterium by neutrophils.
   d. all of the above

7. A 3-year-old Thoroughbred gelding presents with chronic colic, intermittent fever, and chronic weight loss. Blood work reveals anemia, hyperproteinemia characterized by hyperglobulinemia, and hyperfibrinogenemia. The horse had clinical strangles 3 months before presentation. This gelding most likely has
   a. purpura hemorrhagica.
   b. intermittent large colon displacement.
   c. metastatic abscessation (bastard strangles).
   d. inflammatory bowel disease.

8. The preferred antimicrobial for treating *S. equi* subsp *equi* infection is
   a. enrofloxacin.
   b. trimethoprim–sulfamethoxazole.
   c. penicillin.
   d. ceftriaxone.

9. Which vaccination precaution(s) should be followed when using the intranasal vaccine against *S. equi* subsp *equi*?
   a. Administer all other intramuscular vaccines before handling strangles vaccine.
   b. Avoid other procedures (e.g., joint injections, castration) at the time of vaccination.
   c. Consider measuring the SeM ELISA titer before vaccination of valuable horses.
   d. all of the above

10. What is the recommended protocol for releasing a farm from quarantine?
    a. obtain three *S. equi* subsp *equi*–negative nasopharyngeal washes of affected animals and their contacts
    b. wait 6 weeks after the last clinical signs
    c. wait until no horses have draining abscesses
    d. wait until all horses are afebrile