Strangles (*Streptococcus equi* subspecies *equi*) Disease Guidelines

Summary
Strangles is a highly contagious bacterial disease of horses caused by *Streptococcus equi*, commonly producing fever, swollen lymph nodes, and purulent nasal discharge. It spreads easily through direct contact or contaminated equipment, and nearly all susceptible horses exposed will become infected. Most horses recover within a few weeks with supportive care, but about 10% become long-term carriers that can continue to spread the disease.

Diagnosis relies on PCR testing and/or bacterial culture of upper respiratory and abscess samples, whereas guttural pouch samples are key for identifying carriers. Effective control depends on strict biosecurity practices, isolation of affected horses, and careful management of new arrivals, while vaccination may help prevent disease but is not recommended during outbreaks.

Causal Agent
Streptococcus equi subspecies *equi* (*S. equi*)

Prevalence
Strangles is highly prevalent, contagious, and is considered endemic worldwide (Iceland is the only country free from the disease). Consistently ranking as one of the top three most common upper respiratory tract infections in horses, nearly 100% of susceptible (naïve) animals in an exposed herd can become infected.

Definition
Streptococcus equi subspecies *equi* (*S. equi*) is the causative organism of the upper respiratory disease of equids, strangles. The disease is characterized by fever, swollen lymph nodes (lymphadenopathy), and mucopurulent nasal discharge. In certain cases, lymphadenopathy may occur in places other than the submandibular and retropharyngeal lymph nodes, which is a condition known as “metastatic” or “bastard” strangles.

Clinical Signs
Clinical signs may be age and immune status dependent, with older, previously exposed horses typically exhibiting milder signs of shorter duration. Vaccinated animals may show mild signs. Every horse is at risk of disease when challenged with substantial pathogen dose and frequency.

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Acute Infection

- Fever, if detected, typically precedes other clinical signs by 24–48 hours.
- Swollen lymph nodes +/- abscessation (retropharyngeal and submandibular lymph nodes are most commonly involved, but any lymph node can be affected).
- Bilateral or unilateral mucopurulent nasal discharge.
- Guttural pouch empyema is a frequent sequela to retropharyngeal lymph node abscessation.
- Pharyngitis leading to reluctance to eat and drink. Palpation of the larynx will often elicit pain.
- Soft non-productive cough that is often associated with eating.
- Upper airway stridor secondary to pharyngeal compression by the lymph nodes or neuropraxia-induced laryngeal hemiplegia.
- "Atypical" strangles with lessened or absent above clinical signs.

Persistent Infection/Carrier State

- Most cases are non-contagious 6 weeks beyond the resolution of clinical signs.
- Purulent material within the guttural pouches has potential to form chondroids and act as a chronic reservoir.
- Average of 10% of infected individuals in an outbreak become carriers and can continue to spread *S. equi*. Some, but not all of these horses, develop chondroids within the guttural pouch.

Complications

- Metastatic infection including pneumonia, abdominal abscessation, meningitis, lymphangitis, sinusitis
- Purpura hemorrhagica leads to petechial or ecchymotic hemorrhages on mucous membranes, sclera, and visceral surfaces such as the lung. Purpura hemorrhagica can result in subcutaneous edema most commonly involving the head, limbs, and trunk. Severe edema may result in oozing from the skin surfaces and sloughing of skin in the affected areas. Rhabdomyolysis and infarctive myositis are also associated with purpura hemorrhagica. Significant rhabdomyolysis with progressive atrophy has been identified in Quarter Horses (immune-mediated myositis/MYH1)
- Immune-mediated myopathies (muscle infarctions, acute myonecrosis, progressive atrophy)
- Myocarditis

Most horses with *S. equi* infections will also have leukocytosis, neutrophilia, hyperfibrinogenemia, hyperglobulinemia, and varying changes consistent with dehydration, inflammation, and anorexia.

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Differential Diagnoses

- *Streptococcus equi* subspecies *zooepidemicus (S. zooepidemicus)* infection
- Viral upper respiratory tract infections
- Bacterial pneumonia
- Pharyngeal cicatrix

Incubation Period

Translocation to the mandibular and retropharyngeal lymph nodes occurs within hours of exposure with clinical signs beginning 3–14 days later. Nasal shedding usually begins 2–3 days after the onset of fever.

Risk Factors

- Commingling with many horses of unknown origin and medical history.
- Sharing contaminated equipment such as water troughs or feeding buckets.

Transmission

- **Direct:** horse-to-horse contact
- **Indirect:** handlers; contaminated fomites including water troughs, veterinary equipment, twitches, blankets, grooming tools, buckets, tack, hoses, etc.

Transmission can occur from horses with no clinical signs who are incubating the disease or have developed a persistent subclinical shedder status.

Appropriate biosecurity and PPE should be utilized when examining, testing, or treating horses with suspected or confirmed S. equi.

Diagnostic Sampling, Testing, and Handling

Currently recommended diagnostic methods are summarized in Table 1 (on page 5). Because colony morphology is similar for *S. equi* and *S. zooepidemicus*, co-infection can be missed with standard PCR techniques. Thus, it is recommended to use a real-time PCR multiplex assay followed by culture of any of the below sample types.

Loop-mediated isothermal amplification (LAMP) assays and PCR assays are now considered the diagnostic gold standards, as they have improved sensitivity and specificity over culture alone. PCR of nasopharyngeal secretions is the recommended diagnostic test for horses that are pyrexic but not overtly draining from an external abscess.

Early in the course of disease and before colonization of local lymph nodes, low numbers of bacteria are present in nasal secretions. PCR is more sensitive than culture in detecting small amounts of bacterial DNA, but it does not differentiate live bacteria from dead or provide antimicrobial sensitivity guidelines. There is value in concurrent culture submission to rule out other pathogens that may present similarly.

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Horses that are PCR positive, but culture negative, should still be considered potentially contagious. The presence of *S. zooepidemicus* may cause false negative culture results as zoocins (antibacterial enzymes) produced by *S. zooepidemicus* kill *S. equi* bacteria. Strangles abscesses that rupture may be colonized by *S. zooepidemicus* bacteria, complicating diagnosis. Additionally, negative cultures can occur if bacteria die en route to the lab. The infectious potential of PCR positive, culture negative animals are unknown, though there is evidence that transmission is possible.

Samples collected early in the course of clinical disease (within 48 hours of onset of fever) may yield negative results on culture and PCR. If signs are consistent with *S. equi* infection, repeat testing 2–3 days later may detect *S. equi* shedding. Multiple samples from the same animal can increase the chances of organism recovery early in disease. If several animals are affected, submit single samples from as many animals as possible.

Guttural pouch lavage quantitative PCR in combination with endoscopy is the test of choice to determine the status of recovered animals, allowing for assessment of pharyngeal inflammation and examination of the guttural pouches for chondroids or purulent material. If nasal discharge persists for longer than 2 weeks, guttural pouch examination is indicated to identify horses that may have empyema and require additional treatment.

The SeM Antibody ELISA cannot differentiate antibodies due to natural infection from those induced by vaccination and is therefore of limited use in managing disease outbreaks. Its value is limited to screening animals that might react to vaccination, (those with titers >1:3,200) and to support a diagnosis of purpura hemorrhagica or metastatic disease (titers >1:12,800). **It is not a measure of protection from disease nor an indication of an active infection or carrier status.**

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Table 1: Diagnostic methods for *S. equi*
Previous antibiotic administration may affect results.

Sample	Test	Shipping	Handling	Pros	Cons
Aspirate of mature abscessed lymph node	PCR and culture	PCR-sample in plain red top tube; culture: bacterial transport media	PCR and aerobic culturette: chilled if held overnight	High yield of bacterial organism	Requires accessible abscesses to be present
Moistened pharyngeal swab (avoid rostral nasal swabs)	PCR and culture	Swab placed in plain red top tube; culturette with bacterial transport media	PCR and aerobic culturette: chilled if held overnight	Ease of sampling	False negative possible if early in disease or not shedding from guttural pouch
Naso-pharyngeal wash *(See instructional video link below)**	PCR and culture	Fluid can be sent in leak-proof container such as a plain red top tube.	PCR and aerobic culturette: chilled if held overnight	Ease of sampling; more sensitive than naso-pharyngeal swab	False negative possible if early in disease or not shedding from guttural pouch
Guttural pouch lavage	PCR and culture	Fluid in leak proof container such as a plain red top tube	PCR and aerobic culturette: chilled if held overnight	Best detection of carrier animals (50 times more likely to find organism than naso-pharyngeal wash)	Special equipment needed; false negative possible if lymph nodes have not ruptured into guttural pouch

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Additional Diagnostic Guidance Resources

- *Nasopharyngeal Wash Video

- Manual of Clinical Procedures in the Horse. Chapter 22: Nasopharyngeal Sampling, by Costa LRR and Boyle AG.

Postmortem Findings

Strangles is rarely fatal, and most horses will recover with supportive care. Death in the acute phase of the disease can occur as a consequence of upper airway compression from retropharyngeal or peritracheal abscess formation. Complications of Strangles can result in severe disease that may lead to euthanasia. Internal abscesses can form in the lung, liver, spleen, kidney, brain, mediastinum, and/or mesentery. Culture and PCR of abscesses identified during gross necropsy is usually diagnostic. Immune-mediated complications include purpura hemorrhagica, myositis, glomerulonephritis, and myocarditis.

Practitioners performing necropsies in the field are encouraged to contact their veterinary diagnostic laboratory for guidance regarding optimal test selection, sample collection methods, and handling instructions to maximize the likelihood of achieving a definitive diagnosis.

Shedding of Bacteria Following Resolution of Clinical Signs

Typically, shedding persists for 3–6 weeks following the cessation of clinical signs. However, intermittent shedding may occur for months to years when bacteria persist in guttural pouches or paranasal sinuses.

Treatment

Treatment consists of supportive care of the horse unless the animal is experiencing complications. For most Strangles outbreaks, antimicrobials are not indicated or required for adult horses and may affect the development of humoral immunity. Antibiotics should be used at the discretion of the attending veterinarian with the welfare of the animal and antimicrobial resistance/stewardship in mind. Indications for antibiotic use may include animals with profound lymphadenopathy and respiratory distress, horses with metastatic abscessation, cases of purpura hemorrhagica treated with corticosteroids, and guttural pouch infections treated locally (reverse thermodynamic gel with benzylpenicillin, gelatin mix, topical application of 20% acetylcysteine (w/v) solution) to treat the carrier state.

Persistent infections of the guttural pouch are typically treated with application or instillation of topical antimicrobials in combination with lavage—rarely are systemic antimicrobials needed in these cases. Antibiotics should not be used as a preventative. Their use has been shown to prevent a sufficient antibody response, potentially leaving the animal susceptible to reinfection. Penicillin is the ideal antimicrobial to target *S. equi*, although long-acting cephalosporins are useful in horses that are recalcitrant to frequent intramuscular injections.

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Prognosis

- The prognosis for uncomplicated cases is good, but full resolution can take greater than 3–6 weeks.
- Some horses develop a natural immunity to *S. equi* that can last for at least 5 years.
- Rare cases may develop complications.
- Complicated cases have a mortality rate up to 40%.
- A subset of horses (10%) become chronic carriers/shedders.

Vaccination

- Vaccination may be used as an effective method to aid in disease control in individuals and populations.
- Strangles is considered to be a "risk-based" vaccine. There are 2 vaccines commercially available in the US: an M-protein extract parenteral product and a modified live intranasal product. A recombinant fusion protein (subunit) product with DIVA capability is currently available in Europe and undergoing FDA/USDA regulatory approval processes. More detailed information can be found in the AAEP Strangles Vaccination Guidelines.
- After administration of the modified live vaccine a small number of horses may experience **noncontagious** transitory upper respiratory signs including nasal discharge or swollen lymph nodes, especially in animals less than 2 years of age.
- Nasopharyngeal wash samples may be positive on PCR for up to 6 weeks after administration of the attenuated live vaccine strain. Culture of nasopharyngeal wash samples may grow the vaccine strain for a few days following intranasal vaccine administration.
- Vaccination with M protein-based vaccines during an outbreak does increase the risk of complications, including purpura hemorrhagica, and is not recommended.
- Vaccination with the live intranasal vaccine should be used cautiously when giving other injectable therapeutics at the same time or administered at a different time than injectable products to minimize the risk of local abscessation at injection sites.
- SeM titers can be measured before vaccination with the goal to identify individuals at risk of developing complications from vaccination but are slow to rise during an outbreak.
- SeM titers do not indicate protection from infection.

Environmental Persistence

S equi has been shown to survive 1–2 days on dry porous surfaces. The survival time increases to 30 days in cool (mean temp 65°F) weather on wet surfaces. Contaminated surfaces (those exposed to nasal discharge) should be aggressively cleaned of organic material, disinfected, and allowed to dry thoroughly. Special attention should be paid to shared surfaces such as water, hay, and feed containers.

Pastures should be allowed enough "rest" time to allow for the bacteria to denature, especially in cold, wet conditions. Two weeks is probably sufficient when surfaces are exposed to sunny, dry conditions, but 6 weeks may be needed for damp and cold conditions.

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Specific Control Measures
Check state guidelines for "Reportable" status.

AAEP General Biosecurity Guidelines

In the face of an outbreak, animals should be separated into "clean," "exposed," and "sick" groups. Twice-daily monitoring of body temperature is recommended, and any horse showing fever should be isolated immediately. There is a lag between the initial fever and nasal shedding of bacteria, enabling clinicians to limit the spread of disease by moving febrile animals into the "sick" isolation area. The risk of personnel contamination must be balanced against the value of tracking temperatures. Leaving hand sanitizer at each stall is useful to encourage staff to disinfect their hands and be cognizant of the contagious nature of *S. equi.*

When working through barns, animals should be handled in the following order: "clean," "exposed," and then "sick;" or, ideally, have designated personnel for each group. Barrier precautions should be taken including personal protective equipment (PPE) when handling sick animals. Caretakers should ensure they are not contaminating hose handles when filling water buckets or shared feeding implements (e.g., scoops).

A detailed protocol for establishing a tiered risk system of handling horses during an outbreak is available in the ACVIM Consensus Statement.

Release of Animals from Isolation

- Evaluation of the guttural pouch via endoscopic examination and lavage is recommended to determine persistent *S. equi* infection. The lavage material should be submitted for PCR testing plus culture. One endoscopically guided guttural pouch lavage PCR on cases and their contacts to screen for carriers provides increased efficiency and sensitivity over 3 nasopharyngeal washes over 3 weeks.
    - Testing for potential carrier status should begin no sooner than 3 weeks after resolution of clinical signs or potential exposure with no clinical signs.
    - Testing horses that have been treated with antibiotics should not commence before 3 weeks after the cessation of antibiotic treatment.
    - All equipment must be disinfected between horses when sampling multiples on a farm.
- Animals are considered safe to move out of isolation on the basis of absence of obvious guttural pouch pathology in conjunction with negative guttural pouch lavage or three negative nasopharyngeal wash PCR results.
- **The only way to determine if a horse is no longer shedding is to test.**
    - In the absence of diagnostic testing to detect chronic shedders, horses should be considered infectious for up to 6 weeks post resolution of all clinical signs.

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Biosecurity Issues for Receiving Animals

Limiting exposure is the best method of preventing an outbreak on a farm. Quarantine new arrivals for 3 weeks while monitoring temperatures. In high-risk populations, guttural pouch lavage PCR and endoscopy is recommended prior to introduction into the farm population.

Animals with swollen lymph nodes, nasal discharge, or fever should be considered potentially infected and isolated immediately.

Check state guidelines for "Reportable" status.

Disinfection

Streptococcus spp., including *S. equi,* are relatively susceptible to disinfection after thorough cleaning to remove organic materials. Some products commonly used include bleach, quaternary ammonium compounds, phenolic compounds, potassium peroxymonosulfate, and accelerated hydrogen peroxides. Chlorine compounds and quaternary ammoniums are not active in the presence of organic material; therefore, it is particularly important to thoroughly clean the surfaces first. Both diluted bleach and foot baths contaminated by organic debris quickly become inactivated. (See AAEP Disinfectant Table).

Zoonotic Potential

Human infection with *S. equi* is uncommon but has been reported. Immuno- compromised individuals should take precautions to avoid exposure.

Additional Resources

Comprehensive information is available in the revised 2018 ACVIM Consensus statement, 'Streptococcus equi Infections in Horses: Guidelines for Treatment, Control and Prevention of Strangles-Revised Consensus Statement', Ashley G. Boyle, John F. Timoney, J. Richard Newton, Melissa T. Hines, Andrew S. Waller, and Benjamin R. Buchanan, *J Vet Intern Med* 2018;32:633-647.

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