Diagnosing Guttural Pouch Disorders and Managing Guttural Pouch Empyema in Adult Horses

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ABSTRACT: Clinical signs of guttural pouch disorders are associated with other structures in the area. Signs include cranial nerve dysfunction (cranial nerves VII through XII), epistaxis with mycosis of the internal and external carotid and maxillary arteries, and bilateral or unilateral mucopurulent nasal discharge. Guttural pouch empyema can be diagnosed by endoscopy and culture of the exudate. The most common bacterial species that result in guttural pouch empyema include Streptococcus zooepidemicus and Streptococcus equi. Treatment is often frustrating because of the cost and duration of guttural pouch lavages, systemic antibiotics, and antiinflammatories required to clear the exudate and infection. One-fifth of horses with guttural pouch empyema develop chondroids that may require more aggressive therapy.

Equine guttural pouches (auditory tube diverticula) are unique because of their size—Equine guttural pouches are the largest of several species examined in one study. The function of these pouches has been debated for nearly two centuries, with hypotheses that they are a voice-resonating chamber, a buoyancy device, or simply a space filler. A current hypothesis is that they play a role in cooling blood to the brain, although their purpose is still under debate.

Although diseases of the guttural pouches are relatively rare, it is important to be able to accurately diagnose and treat them to avoid sequelae, such as dysphagia or even fatal hemorrhage, as can occur with mycotic infections. This article reviews the anatomy and diagnostic imaging of the equine guttural pouch and discusses the clinical signs as well as diagnostics, treatments, and techniques used in adult horses with guttural pouch empyema.

RELEVANT ANATOMY

The equine guttural pouches are paired diverticula of the eustachian tubes, each normally containing approximately 300 ml of air. Each guttural pouch is draped over the stylohyoid bone, forming medial and lateral pouches, with the...
The plica salpingopharyngea, causes the digastricus, rectus capitis ventralis and longus capitis muscles. Below the longus capitis, the guttural pouches are in direct contact with each other, separated only by a thin medial septum. Each guttural pouch communicates with the pharynx via the pharyngeal orifice of the eustachian tube, covered by a thin plate of fibrocartilage. The pharyngeal orifice of the eustachian tube communicates with the guttural pouch through a funnel-shaped vestibule, which is wider rostrally than caudally. A mucosal fold at the caudal aspect of the eustachian tube, known as the plica salpingopharyngea, causes the narrowing and forms a continuous ventral connection between the medial lamina of the eustachian tube and the lateral wall of the pharynx. The plica salpingopharyngea can sometimes be redundant and act as a one-way valve, trapping air within the guttural pouch and, in turn, resulting in guttural pouch tympany.

Many important structures are anatomically related to the guttural pouch and must be considered when treating guttural pouch disease either medically or surgically. The internal carotid artery, cranial cervical ganglion, vagus nerve (i.e., cranial nerve X), glossopharyngeal nerve (i.e., cranial nerve IX), hypoglossal nerve (i.e., cranial nerve XII), accessory nerve (i.e., cranial nerve XI), and sympathetic nerves all course through the caudal lateral wall of the medial compartment. The ventral wall of the medial compartment contains the pharyngeal branch of the vagus nerve, the cranial laryngeal nerve, and retropharyngeal lymph nodes. The ventral aspect of the lateral compartment contains the external carotid artery (which becomes the maxillary artery), maxillary vein, chorda tympani nerve, and facial nerve (i.e., cranial nerve VII). The digastric muscle and the mandibular and parotid salivary glands border the lateral wall of the lateral compartment. The jugular and linguofacial veins course ventral and lateral to the pouches and just dorsolateral to the paired sternocleidomastoideus muscles, which lie ventral to the guttural pouches.

**Diagnostic Imaging**

A variety of diagnostic imaging techniques are available for investigating cases of suspected guttural pouch disease.

**Endoscopy**

Endoscopy is used most commonly and is an invaluable tool for diagnosing upper airway and guttural pouch disease. The fibrocartilage flap covering the pharyngeal orifice of the guttural pouch must be adducted or elevated to advance the endoscope. The following steps generally require adequate restraint in stocks and/or a nose or neck twitch. Sedation with detomidine hydrochloride (0.02 mg/kg IV) and butorphanol tartrate (0.01 to 0.02 mg/kg) is recommended. To perform this, a flexible biopsy instrument passed through the biopsy channel of the endoscope or a Chamber's catheter is necessary. The endoscope is passed nasally (ventral and medial) and directed toward the dorsal aspect of the ipsilateral guttural pouch; the flexible biopsy instrument is then advanced through the biopsy channel and under the fibrocartilage flap until it is well seated in the guttural pouch.

Problems can be encountered when the biopsy instrument is too far ventral and does not pass fully into the pouch or when the instrument has entered the nasal cavity too dorsally and adjustment of the endoscope should be necessary. Once the biopsy instrument is well seated, the endoscope is rotated counterclockwise for the right guttural pouch and clockwise for the left guttural pouch and advanced slowly into the guttural pouch. Because the biopsy channel is eccentrically located in the endoscope, the biopsy instrument actually rotates the flap away from the wall of the pharynx to facilitate passage of the scope into the guttural pouch. Once inside the guttural pouch, the biopsy instrument can be retracted into the biopsy channel. This process should be repeated in the opposite nasal passage to view the opposite guttural pouch.

Alternatively, a Chamber's catheter can be placed nasally, advanced into the nasopharynx, and viewed by the endoscope, which is passed into the opposite nostril. The Chamber's catheter is advanced into the guttural pouch opening that is on the same side in which the endoscope has been passed (opposite to the side in which the Chamber's catheter was passed). The catheter is rotated to open the guttural pouch flap, allowing easy passage of the endoscope. The guttural pouch is thoroughly examined by the clinician, who methodically looks at the medial and lateral compartments, dorsally and ventrally, for evidence of mycosis, emphyema, temporohyoid osteopathy, and less common conditions, such as chondroids, cysts, and neoplasia.

**Radiography**

Radiography can aid in diagnosing guttural pouch diseases, especially when endoscopy is limited because of
the severity of disease. Radiographic procedures are not technically challenging and can be performed by most x-ray machines. The caveat is that cassette holders and proper technique are required to optimize the safety of the patient while minimizing exposure to personnel. However, lesions identified on radiographs are rarely pathognomonic; therefore, further diagnostic tests (i.e., endoscopy or surgical exploration) are required.

For imaging guttural pouches at the Cornell University Hospital for Animals (CUHA), the horse is sedated while in standing stocks and placed in a halter made of gauze. A cassette holder is used to eliminate the need for a person near the primary x-ray beam. Using the machine at CUHA (Siemens Mobilette Plus, Siemens Medical Solutions, USA, Inc., Iselin, NJ), a technique using a 75 kilovolt peak (kVp) and 10 milliamp seconds (mAs) is usually adequate for an average-size horse. A fine screen is used without a grid to help minimize exposure time and dose while maximizing detail. If regular screens are used, the recommended exposure is a 66 kVp and 16 mAs. A routine examination includes opposite lateral radiographs (of the guttural pouch region). CUHA has a smaller portable unit (HF 80+, MinXray, Inc., Northbrook, Il) that can acquire the images as described. The high frequency 80+ and other small portable units are able to generate a 50 to 80 kVp and up to 15 mAs.

A lateral radiograph of the laryngeal region provides a clear outline of the guttural pouch (Figure 1). A ventrodorsal radiograph has been recommended to help differentiate unilateral from bilateral disease. However, this view generally requires general anesthesia, and thus the cost and risks outweigh the benefits of the diagnostic procedure. Portable radiograph machines can be used to obtain dorsoventral views with the use of heavy sedation to lower the horse’s head and prevent injury because the tube (located dorsally) cannot be moved away quickly if the horse raises its head abruptly. Radiation exposure is high, and exposure time may lead to motion artifact. Acquiring opposite lateral radiographs has been suggested to avoid general anesthesia. In a unilateral infection, the fluid line has a sharper margin.
when closest to the cassette\(^9\) (Figure 2). In the author’s experience (A. P.), right caudal–left cranial and left caudal–right cranial oblique radiographs allow enough separation of the guttural pouches to differentiate bilateral from unilateral disease.

The main finding with radiography of the guttural pouch is the presence of soft tissue/fluid opacity in the usually gas-filled structure. The appearance of the soft tissue/fluid opacity may vary with the disease process (e.g., smoothly marginated, irregularly shaped masses secondary to chronic guttural pouch mycoses [Figure 3]; fluid lines either unilateral or bilateral within the guttural pouches secondary to hemorrhage, emphysema, or diverticulitis). Also, the pharyngeal wall (i.e., ventral border of the guttural pouch) may appear thick or irregularly shaped with pharyngeal lymphoid hyperplasia.\(^7,8\)

**Other Methods**

Masses in or encroaching on the guttural pouch are rare but include masses of the parotid or retropharyngeal lymph nodes or primary cancer of the guttural pouch (i.e., usually squamous cell carcinoma or melanoma).\(^9\) Masses arising from the skull have also been described.\(^7\) Differentiating the masses from fluid is difficult and is usually done by ultrasonography or endoscopy. Because the parotid salivary gland can sometimes cause guttural pouch lesions secondary to occlusion of the auditory tube or erosion into the guttural pouch, a sialogram can be performed.\(^7\)

Before surgery for guttural pouch mycosis, carotid angiography has been recommended to help visualize the anatomy of the vasculature associated with the head\(^7,9\) (Figure 4). The technique has been thoroughly described,\(^3,8\) and the purposes of the procedure are to evaluate the size and margin as well as whether the vessels are patent by using a positive-contrast medium. For common carotid angiography, there are no special recommendations, although general anesthesia and fluoroscopy are recommended. Any contrast medium can be used; however, because of the large volume (100 ml), a pressure injector is recommended to achieve an adequate bolus. The use of fluoroscopy and angiography provides a road map of the vasculature when using arterial coil embolization for treating guttural pouch mycosis.

Neither computed tomography (CT) nor magnetic resonance imaging (MRI) has been reported as an aid in diagnosing guttural pouch disease in horses, except for cases of temporohyoid osteoarthropathy.\(^10\) This is most likely because most disorders of the guttural pouch are diagnosed using endoscopy and radiography. CT or MRI may help to more clearly define bony lesions that may cause secondary hemorrhage into the

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**Figure 3**—Lateral radiograph of the head of an adult horse showing chondroids in the guttural pouch. (Courtesy of the Section of Radiology, Cornell University)

**Figure 4**—Right lateral, positive-contrast angiogram of the left side of the head in an adult horse with left-sided guttural pouch mycosis. A 14-gauge catheter was placed in the common carotid artery. Iodinated, ionic contrast material (100 ml) was administered using a power injector set to administer a dose of 20 ml/sec with a 1-sec linear rise. The radiograph was obtained 3 sec after the injection was completed. No abnormalities were detected in the vascular structures of the head.
guttural pouches, such as fracture of the stylohyoid bone. The limitations of CT and MRI include the necessity for general anesthesia, the time required for positioning and the procedure, and limited availability of the technology for equine patients.

GUTTURAL POUCH EMPYEMA
Etiology and Clinical Signs
Guttural pouch empyema is characterized by the unilateral or bilateral accumulation of mucopurulent exudate in the guttural pouches. It can occur as a sequela to upper respiratory tract infection, typically with β-hemolytic streptococci: *Streptococcus equi* subspecies *zooepidemicus* or, of particular importance, *Streptococcus equi* subspecies *equi*. Horses with suspect guttural pouch empyema should be handled with appropriate biosecurity precautions because it is frequently a sequela to infection of the retropharyngeal lymph nodes with strangles. In a recent study, 30% of horses with guttural pouch empyema tested positive for strangles, and asymptomatic horses can carry *S. equi* in their guttural pouches for extended periods of time. Other isolates from horses with guttural pouch empyema include *Escherichia coli*, *Klebsiella* spp, *Corynebacterium* spp, *Bordetella* spp, and *Salmonella* spp.

The most common clinical signs of empyema are persistent mucopurulent nasal discharge (either unilateral or bilateral; it can be bilateral with unilateral empyema) and retropharyngeal swelling that is painful on palpation. Other clinical signs usually include cough, fever, anorexia, respiratory noise, depression, dyspnea, and dysphagia. Occasionally, cases of empyema are complicated by the presence of chondroids (oval masses formed by inspissated pus), which can prevent complete resolution of empyema until removed. Their presence can be confirmed endoscopically or radiographically.

Differential Diagnosis
Pharyngitis and upper or lower respiratory tract infections can have a mucoid discharge present at the pharyngeal orifices when examined endoscopically. Guttural pouch tympany can have concurrent empyema.

Diagnostic Evaluation
Endoscopic findings include purulent exudate on the floor of the guttural pouch, mucosal hyperplasia, thickening and discoloration of the cartilage flap at the pharyngeal orifice, pharyngeal edema or narrowing, pharyngeal lymphoid hyperplasia, pharyngeal asymmetry, and chondroids (Figure 5). Horses with strangles may have retropharyngeal lymph node enlargement noted on the floor of the guttural pouch (i.e., medial and/or lateral compartments, right and/or left guttural pouch), which can also result in dorsal collapse of the pharynx. Radiographs show unilateral or bilateral fluid lines and, in some cases, chondroids (Figure 3). Radiography is slightly less sensitive than endoscopy in detecting chondroids.

A sample taken directly from the guttural pouches endoscopically for aerobic and anaerobic culture and sensitivity is most representative of the infectious etiology of the guttural pouch empyema, although nasopharyngeal swabs can be obtained if the other is not feasible. The goals of culturing the affected guttural pouch are to confirm the presence of *S. equi* and obtain an antimicrobial sensitivity pattern. Very little work has been done to evaluate the normal flora of the equine guttural pouch, and it is assumed to be similar to that of the rest of the equine upper respiratory tract. Nearly 60% of percutaneous guttural pouch lavages from 30 clinically normal horses had positive cultures, and only a few were considered to be aerobic bacteria of recognized pathogenicity, such as *Pseudomonas aeruginosa*. No fungal organisms were isolated. Therefore, interpreting culture results may be difficult; a clinician must determine whether an isolated organism is the offending agent or normal flora.

A guttural pouch wash can be obtained by using sterile technique and advancing a sterile polyethylene tube through the biopsy channel of a previously sterilized endoscope into the guttural pouch. Before passing the tubing into the endoscope, a 14- or 16-gauge needle (that has had the sharp end sawed off) is placed in one end of the tubing to facilitate attachment of a syringe for aspiration. To maintain sterility, an injection cap can be placed on the end of the needle until the syringe is used. Once in the guttural pouch, the tubing is advanced, and up to 50 ml of sterile saline can be instilled into the guttural pouch and subsequently aspirated using the endoscope to visualize the fluid. The fluid is then submitted for culture as already described. These samples could...
also be submitted for *S. equi* PCR for diagnosis or follow-up evaluation of the previously infected guttural pouch to declare it free of *S. equi*.

**Treatment**

Guttural pouch empyema, when diagnosed early and treated appropriately, generally resolves uneventfully. Treatment requires lavaging the pouch on a daily basis for 5 to 10 days. Guttural pouch lavage and establishment of drainage are the most helpful factors in successfully treating guttural pouch empyema, and this is often accompanied by antiinflammatories and systemic antimicrobials. This can be costly to a client because lavaging the guttural pouches requires hospitalization (mean hospitalization time for horses was 8 days in one study, although the range was 1 to 176 days) or repeated visits to the farm. Also, a horse may require irrigation of the guttural pouches for an extended period of time beyond what was initially estimated. Twenty percent of horses with guttural pouch empyema have complications and may require more sophisticated and invasive procedures.

The efficacy of systemically administered antimicrobials for treating guttural pouch empyema may be decreased by poor drug penetration into the guttural pouch and into the interior of the exudate. It is important to remember that lavage and establishment of drainage are mainstays of successful management of guttural pouch empyema and that systemic antimicrobials are an adjunct to therapy. Indications for systemic antimicrobials in guttural pouch empyema include protection of the lower airways from contaminated drainage from the pouch, especially during lavage; prevention and treatment of aspiration pneumonia; and treatment of lymph node abscesses. The nasal discharge often persists with antimicrobial treatment alone. When treating with antimicrobials, the antibiotic of choice should be based on susceptibility patterns of the bacterial organism isolated. The drug of choice for the most commonly isolated organisms, *S. equi* and *S. zooepidemicus*, is penicillin; because the treatment is frequently prolonged, IV penicillin is preferred to avoid repeated high-volume IM injections (sodium or penicillin G potassium at 22,000 IU q6h). If the cost of IV penicillin is prohibitive, penicillin G procaine (22,000 IU IM q12h) or sodium ceftiofur (2 mg/kg IV or IM q12h) can be used. Seventy-five percent of isolates in one study were resistant to potentiated sulfonamides, making them a less favorable treatment option.

Irrigating the guttural pouch requires sedation of the horse to maintain restraint and keep the head low to encourage drainage of the contaminated guttural pouch fluid from the nostrils and prevent aspiration pneumonia. A Chamber’s catheter can be passed blindly and nasally into the nasopharynx and advanced into the guttural pouch by advancing the curved end beneath the flap of the medial lamina of the ipsilateral pouch. The Chamber’s catheter, when properly advanced to complete depth into the guttural pouch, has a very characteristic feel, without any resistance; otherwise, at this depth, resistance would be felt at the caudal aspect of the pharynx, and the horse would begin to swallow. If difficulty is encountered and/or to ensure proper placement, the endoscope can be passed in the opposite nasal passage to view the placement of the Chamber’s catheter. We advise against blind placement of the Chamber’s catheter and recommend that placement be confirmed by endoscopic visualization. Once the Chamber’s catheter is confirmed to be in the guttural pouch, a fluid administration line can be secured to the end of the catheter and a substantial volume (up to 3 to 5 L) of isotonic balanced electrolyte solutions can be flushed through the system using a pump, manual pressure, or a fluid pressure bag. This entire procedure may take 30 to 60 minutes.

Addition of antimicrobials or antisepsics to the lavage solution is controversial, although 47 of 91 (52%) horses with guttural pouch empyema had either antimicrobials (unspecified) or iodine solutions diluted to various concentrations added to the lavage solution. There were no discernible differences between horses treated with additives in the lavage fluid versus those treated solely with isotonic fluids. In fact, both the authors of this retrospective study and an experimental study in which 1% povidone-iodine and 3% hydrogen peroxide solution were infused into the guttural pouch of horses on three to four occasions, causing inflammation and exudate production, advise against using these substances in the guttural pouch. The mechanical action of the flushing most likely provides the most benefit in these horses. Therefore, we recommend lavaging the guttural pouches with isotonic balanced electrolyte solutions and discourage the instillation of noxious agents (e.g., betadine, acetylcysteine, hydrogen peroxide) into the guttural pouch because of harmful and serious adverse effects (e.g., dysphagia).

A Chamber’s catheter can be passed on a daily basis to irrigate the guttural pouches. Alternatively, a retention catheter can be made using an 8- or 10-Fr polypropylene male dog urinary catheter or polyethylene tubing (Figure 6), or a commercially available guttural pouch catheter can be used. These retention catheters are sometimes difficult to place, can only facilitate small amounts of fluid for irrigation, and are frequently sneezed or blown out by the horse. In addition, the problems with retention catheters must be weighed against the trauma...
to the pharynx induced by passage of a firm metal Chamber’s catheter on a daily basis. Alternatively, indwelling Foley catheters can be placed easily with the help of a Chamber’s catheter or stylet and visualized with the endoscope in the opposite nasal passage. Once the Foley is completely within the guttural pouch, the balloon is distended with saline and the stylet or Chamber’s catheter removed. Distention of the balloon within the funnel of the pharyngeal opening could cause pressure necrosis. Foley catheters can stay in place without suturing to the nares. Unfortunately, standard Foley catheters may not be long enough to reach the guttural pouch in large horses. Indwelling Foley catheters are superior for intermittent lavage of the guttural pouches because large volumes of fluid can be administered and they are easier to pass and maintain. Others have mentioned daily flushing with a larger bore tube, such as an equine stomach tube, guided into the guttural pouch by the endoscope and Chamber’s catheter.

Most horses (up to 80%) with uncomplicated guttural pouch empyema are successfully managed with daily irrigation of the guttural pouches for 5 to 10 days. If the horse is continuing to improve at the end of this time frame, it is justified to continue treating the horse medically with irrigation. In one study, 20% of horses with guttural pouch empyema showed no improvement with repeated flushing and had inspissated purulent material, chondroids, or abnormalities of the pharyngeal openings of the guttural pouch; therefore, more aggressive procedures were necessary. Management decisions can be difficult to make because of the risks involved with performing surgery in this area and the financial burden to the client. More invasive nonsurgical treatments for chondroids include using acetyl cysteine (i.e., 60 ml of a 20% solution infused into the pouch using polyethylene tubing through the biopsy channel of the endoscope) to break down the mucoprotein and allow subsequent drainage of the guttural pouch. This was successful in one horse, without any adverse complications. Nonsurgical endoscopic removal of chondroids using a snare can be attempted in standing horses or under general anesthesia. Removal of chondroids was successful in 7 of 16 (44%) horses using lavage and/or endoscopic snare technique and is therefore worth attempting. Frequently, these procedures are long and involved, requiring hours and innovative instrumentation. Should the procedure be unsuccessful, the surgical approach is the last viable option.

For chronic and/or recurrent empyema or abnormalities of the opening of the pharyngeal orifice of the guttural pouch, creating a fistula using a neodymium:yttrium–aluminum–garnet laser has been described by Hawkins et al. The procedure is performed in standing, well-sedated horses. The mucous membranes surrounding the pharyngeal orifice of the guttural pouch are topically anesthetized, and a Chamber’s catheter is inserted into the guttural pouch and then withdrawn until its distal end remains just inside the guttural pouch and can be observed tensing the pharyngeal mucosa dorsal to the pharyngeal opening. The neodymium:yttrium–aluminum–garnet laser is used to incise the portion of the cartilage directly over the Chamber’s catheter. To prevent premature closure of the new opening, a 22- to 30-Fr Foley catheter is inserted through the fistula and into the guttural pouch and maintained up to 14 days postoperatively. This procedure provides a large opening into the pharynx and improves drainage from the guttural pouches when the horse lowers its head to drink water or eat.

Complications from this procedure were not noted in the two horses. This procedure can be done in standing horses, avoids complications such as dysphagia and iatrogenic trauma to the cranial nerves associated with open surgical exposure of the guttural pouch, and could be used in place of traditional surgical techniques to establish drainage from the guttural pouch in horses with chronic guttural pouch empyema and chondroids. For example, a horse with chronic guttural pouch empyema with inspissated, purulent material improved 90% through a modified Whitehouse surgical approach. Then a fistula was made, more of the inspissated material could be removed, the rest of the exudate eventually drained, and the horse was cured. On a recheck examination several months later, the fistula had healed over. Further studies investigating the pros and cons of this procedure in the horse are warranted.

Parente E: Personal communication, New Bolton Center, School of Veterinary Medicine, University of Pennsylvania, Kennett Square, Pennsylvania, 2003.
More aggressive surgical treatment strategies may be needed for cases that are refractory to medical management. A modified Whitehouse approach with the horse in dorsal recumbency or a Viborg’s triangle approach can be used in standing horses, and these approaches are discussed elsewhere.6

REFERENCES

ARTICLE #5 CE TEST

The article you have read qualifies for 1.5 contact hours of Continuing Education Credit from the Auburn University College of Veterinary Medicine. Choose the best answer to each of the following questions; then mark your answers on the postage-paid envelope inserted in Compendium.

1. What cranial nerves course through the guttural pouches?
   a. glossopharyngeal nerve (IX), vagus nerve (X), accessory nerve (XI), hypoglossal nerve (XII)
   b. vagus nerve (X), accessory nerve (XI), hypoglossal nerve (XII)
   c. facial nerve (VII), vestibular nerve (VIII), glossopharyngeal nerve (IX), vagus nerve (X)
   d. trigeminal nerve (V), vagus nerve (X), accessory nerve (XI), hypoglossal nerve (XII)
   e. facial nerve (VII), glossopharyngeal nerve (IX), vagus nerve (X), accessory nerve (XI), hypoglossal nerve (XII)

2. What diagnostic modality assists the most in diagnosing guttural pouch disorders?
   a. ventral radiographic images of the guttural pouch
   b. nuclear scintigraphy
   c. endoscopy of the pharynx and guttural pouches
   d. lateral radiographs of the guttural pouch
   e. MRI

3. Horses with guttural pouch empyema should be handled with appropriate biosecurity measures because ___% have tested positive for S. equi subspecies equi.
   a. 10
d. 75
b. 30
e. 90
c. 50

4. What is a common sequela to guttural pouch empyema?
   a. chondroids
d. guttural pouch mycosis
   b. bastard strangles
e. dysphagia
   c. purpura hemorrhagica

(continues on p. 983)
5. To confirm the agent causing guttural pouch mycosis, aerobic and anaerobic cultures can be conducted on a
   a. transtracheal wash.
   b. nasopharyngeal swab.
   c. blood culture.
   d. guttural pouch wash.
   e. bronchoalveolar lavage.

6. Initial treatment of guttural pouch empyema consists of
   a. surgical removal of the purulent material.
   b. daily guttural pouch lavages, antibiotics, and anti-
      inflammatories.
   c. systemic antibiotics.
   d. administering procaine penicillin into the guttural
      pouch.
   e. ligation of the internal carotid artery.

7. When lavaging the guttural pouch, it is advised to use
   a. physiologic solutions.
   b. physiologic solutions with 0.5% povidone–iodine
      solution.
   c. water and 1% povidone–iodine solution.
   d. physiologic solutions with potassium penicillin
      added.
   e. physiologic solutions and 1% iodine and 3% hydrogen peroxide.

8. Patients with guttural pouch empyema that do not
   respond to repeated guttural pouch lavage frequently
   have
   a. S. equi subspecies zooepidemicus.
   b. chondroids.
   c. abnormalities of the pharyngeal opening of the gut-
      tural pouch.
   d. guttural pouch mycosis.
   e. guttural pouch tympany.

9. Lavage and/or endoscopic snaring of chondroids is
   successful ____% of the time and should be attempted
   before surgical removal.
   a. 15
   b. 44
   c. 60
   d. 80
   e. 100

10. The current theory on the purpose of the equine gut-
    tural pouch is that it
    a. is a buoyancy device.
    b. cools blood traveling to the brain.
    c. serves no purpose.
    d. assists voice resonance.
    e. aids digestion.