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CHAPTER 18

Tracheal Washes

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Background and Definition

The tracheal wash is a minimally invasive diagnostic technique used to sample the respiratory tract of dogs and cats. Tracheal washes are used primarily to obtain samples from the large airways (trachea and primary bronchi) and are considered less helpful in the diagnosis of interstitial or alveolar lung disease. Specimens obtained from tracheal washes can be evaluated cytologically to identify and characterize the inflammatory response and to identify any infectious agents or neoplastic cells. Bacterial or fungal cultures can be performed on these specimens to confirm an infectious etiology.

Tracheal washes can be performed by either a transtracheal or endotracheal route. It has been suggested that the transtracheal wash (TTW) may be superior to an endotracheal wash (ETW) for sampling smaller airways and alveoli. Because sedation is usually not required for a TTW, the patient's cough reflex remains intact during the procedure, therefore potentially providing a sample from the smaller airways and alveoli. To the author's knowledge, no studies have been published comparing the diagnostic yield of TTW to ETW.

A few clinical studies have compared the diagnostic yield of endotracheal washes with bronchoalveolar lavage (BAL), in which ETW immediately preceded BAL.¹⁻³ In

dogs with multicentric lymphoma, pulmonary involvement was detected in 4 of 41 dogs via ETW.³ Although lymphoma was also detected via BAL in all 4 of these dogs, pulmonary involvement was documented in 23 additional dogs using BAL.³ Similarly, in 9 dogs that had systemic fungal infections with suspected pulmonary involvement, ETW was successful in identifying *Blastomyces* in 3 dogs. However, in this same population, BAL isolated *Blastomyces* in 5 dogs and *Histoplasma* in 1 dog.² A case report of a cat with pulmonary *Cryptococcus* stated that infectious agents were detected in both the ETW and BAL, however the ETW contained fewer organisms.¹ These studies suggest that although tracheal washes may provide useful diagnostic information, they are less sensitive than BAL.

Only one clinical study investigates TTW compared with BAL; however, this study includes both TTW and ETW into a general category of tracheal washes and does not report results individually.⁴ In this study, both a tracheal wash (TTW or ETW) and a BAL were performed in 66 dogs. The cytological interpretation of the samples retrieved differed between procedures in 68% of dogs. In this study, BAL more often detected hemorrhage, infectious agents, and neoplasia compared with tracheal washes. In addition, the cytological pattern of inflammation differed in 41% of animals between the two pro-

cedures.⁴ Because the type of tracheal wash performed was not reported in this study, it is not possible to determine if one type of tracheal wash might more closely correspond to results from BAL. In addition, because the primary disease process in these dogs was not always confirmed histopathologically, it is not possible to discern which of these techniques was more accurate.

Compared with BAL, the tracheal wash is a simple, noninvasive, diagnostic technique that can be performed without special training or expensive equipment. As such, it may be used as an initial screening test for the diagnosis of respiratory diseases. When a tracheal wash either fails to provide a diagnosis or the results do not fit with the clinical picture, then BAL should be considered.

Indications

Tracheal washes are most helpful in diagnosing large airway disease. The procedure can be performed in patients with lower airway, alveolar, and interstitial lung disease; however, diagnostic yield is reportedly inferior to that of BAL.^{2,3} This procedure is indicated in animals with persistent coughing, wheezing, or radiographic evidence of respiratory disease, particularly when other noninvasive diagnostics have failed to provide a diagnosis. Cytological characterization of the tracheal wash will help to narrow the differential list when inflammatory cells are found. For example, tracheal wash with primarily eosinophilic inflammation increases suspicion for an allergic or parasitic etiology. Identification of parasitic larvae or eggs within the tracheal wash specimen may provide a definitive diagnosis.

Although it is stated that tracheal washes mainly sample the large airways, it appears that the TTW is a suitable diagnostic tool for bacterial pneumonia. An experimental study in dogs found TTW to be an equally sensitive technique for isolating known *Streptococcus pneumoniae* infections compared with transbronchial biopsy, lung aspirates, and bronchoscopic cultures.⁵ However, the TTW was less specific (i.e., fewer pure cultures) than transbronchial biopsy, lung aspirates, or bronchoscopic brush culture.⁵ A more recent study in human patients found transtracheal aspiration to be a sensitive (77%) and specific (95%) technique for diagnosing bacterial pneumonia.⁶ Positive bacterial cultures have been reported in 44% to 57% of animals with suspected lower respiratory tract disease when samples were obtained via TTW.⁷⁻⁹

There is little information about the efficacy of tracheal washes to diagnose pulmonary neoplasia. As previously mentioned, the tracheal wash can determine pulmonary infiltration with malignant lymphoma; however, it is less sensitive than BAL.³ Primary lung tumors originating from the airway (e.g., bronchogenic carcinoma) may be more likely to exfoliate into tracheal wash specimens than metastatic neoplasia, which is more likely to reside in the interstitium. However, in a recent retrospective study of dogs with primary lung tumors, the TTW failed to identify neoplastic cells in all 6 dogs that had this procedure performed.¹⁰

The ETW is recommended for smaller patients (cats and small dogs), those patients who cannot be ade-

quately restrained for a TTW, or patients who are scheduled to undergo general anesthesia for other reasons. Whereas this procedure causes less tracheal injury and is technically less difficult, diagnostic sampling of the small airways may not occur because the patient is unlikely to cough while anesthetized. In addition, ETW is associated with a higher risk of oropharyngeal contamination.

Contraindications

Although a TTW is minimally invasive and generally does not require sedation, respiratory distress may be exacerbated in dyspneic patients. This procedure is contraindicated in fractious or uncooperative patients because undue stress to the patient and tracheal injury (e.g., laceration) can result. Although light sedation may make TTW feasible in a fractious patient, ETW with anesthesia may be more appropriate.

TTW should not be performed in animals with abnormalities in primary (thrombocytopenia or thrombocytopenia) or secondary (hypocoagulability) hemostasis because uncontrollable bleeding at the site of tracheal puncture may occur. In addition, TTW should be avoided in patients with severe skin disease on the ventral neck because it may result in contamination of the tracheal wash and inoculation of debris into the airway. TTW may be more difficult in patients with megaesophagus and could result in tracheal wash contamination if the esophagus cannot be moved out of the way. The TTW may exacerbate airway irritation in dogs with severe tracheal collapse and could result in precipitation of a respiratory crisis.

ETW may be a more suitable diagnostic tool in any of the above listed situations. The ETW is contraindicated in patients too unstable for general anesthesia or patients in severe respiratory distress where extubation may not be possible following the procedure, particularly if mechanical ventilation is not an option.

Side Effects

In general, tracheal washes are associated with minimal side effects or complications. Transient worsening of respiratory status and exacerbation of coughing may occur following either TTW or ETW. This is rarely clinically significant unless the patient's respiratory status is already markedly compromised. These procedures can cause airway irritation and bronchoconstriction, particularly in patients with chronic airway disease (e.g., cats with feline asthma). Treatment with a bronchodilating agent (theophylline or terbutaline) prior to the procedure may help to minimize this side effect.

Subcutaneous emphysema and pneumomediastinum can occur following TTW; however, this rarely causes clinical consequence. If a significant leak from the trachea develops, pneumomediastinum could potentially progress to a pneumothorax and result in respiratory distress. Other uncommon complications of TTW include tracheal laceration, esophageal perforation, endotracheal hemorrhage, cardiac arrhythmias, and inoculation of in-

fection into the needle tract.¹¹ In addition, it is possible that a portion of the catheter could be severed during the procedure, resulting in a bronchial foreign body.

If mechanical suction is employed for ETW, it is important to limit the extent and duration of negative pressure used during suctioning. Pressures exceeding the recommended 100 to 170 mm Hg of negative pressure¹² can cause untoward effects such as tracheal mucosal injury, regional pulmonary atelectasis, cardiovascular instability, and hypoxia.¹³

Instrumentation

Clippers, gauze sponges, and antiseptic scrub (e.g., 4% chlorhexidine gluconate) are needed to prepare a sterile field on the ventral neck for a TTW, and 2% lidocaine should be used to provide local anesthesia. Sterile gloves should be worn during both TTW and ETW to prevent contamination of the sample, and syringes (10 and 20 ml) should be prefilled with a sterile lavage fluid using aseptic technique.

Transtracheal washes can be performed with a through-the-needle, long intravenous catheter* (19- to 22-gauge, 8-inch catheter for cats and small dogs; 19-gauge, 12- or 24-inch catheter for large dogs). This type of catheter is optimal because the needle can be withdrawn from the trachea and covered following catheter placement to minimize tracheal injury or catheter damage during the procedure. If this catheter is not available, a 16-gauge needle or a 14-gauge over-the-needle catheter can be inserted into the trachea, and a sterile 3.5 Fr red rubber catheter can be fed through the needle and down the trachea.

To perform an endotracheal wash, a sterile laryngoscope should be used to facilitate rapid intubation and to minimize oropharyngeal contamination. A sterile endotracheal tube should be used for this procedure. A red rubber catheter will be needed to deliver the lavage fluid into the trachea. In addition, mechanical suction, a suction catheter,† and a sterile suction trap‡ (Figure 18-1) may be needed to collect the sample.

Sterile saline (0.9%) should be used for the tracheal wash, avoiding bacteriostatic preparations, which would inhibit bacteria growth. The use of 0.9% saline provides an isotonic solution that will preserve cellular and bacterial integrity for cytological evaluation and culture. Hypotonic solutions (sterile water, 0.45% saline) should be avoided because cell lysis will occur and preclude cytological evaluation.

Technique for Transtracheal Wash

Transtracheal washes should be performed without sedation in cooperative animals, thereby allowing the patient to cough when saline is infused into the trachea,

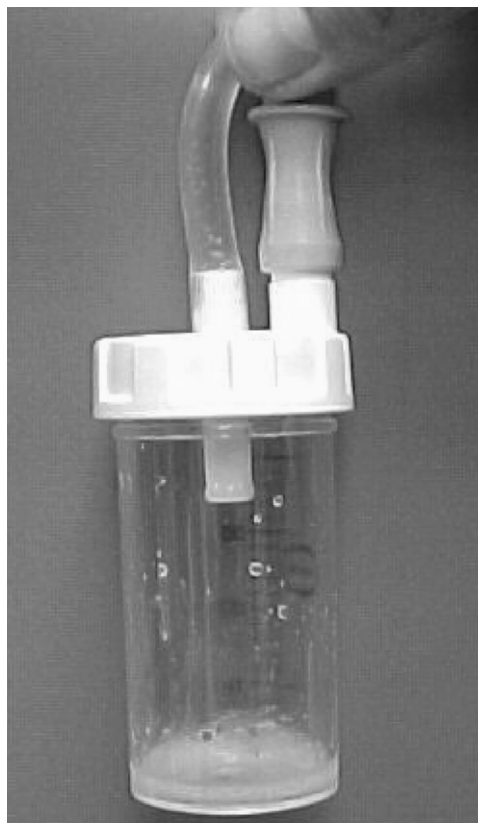


Figure 18-1. A sterile specimen container can be used to collect the endotracheal lavage sample. This container has two ports, one that can be attached to a mechanical suction device and the other that can be attached to a suction catheter placed into the patient's airway. Following collection of the sample, the two ports can be connected to provide a closed container for transport to the laboratory.

improving sampling from the lower airways, and improving diagnostic yield. If sedation is required to facilitate catheter placement in uncooperative or fractious animals, pure opioids (e.g., oxymorphone 0.05 to 0.2 mg/kg IV) or a combination of ketamine and diazepam are recommended. Pure opioids can be fully reversed with an opioid antagonist (e.g., naloxone 0.022 mg/kg IV) once the catheter has been placed into the airway so that the patient can cough during the procedure. Ketamine, on the other hand, does not inhibit the cough reflex.

The patient should be positioned in sternal recumbency with the neck dorsiflexed. If the patient has unilateral lung disease, the procedure can also be performed in lateral recumbency with the affected lungs positioned on the dependent side. A full surgical preparation with wide margins should be performed on the ventral neck of the animal, including the larynx and proximal cervical trachea (Figure 18-2, A). Lidocaine (2 to 5 mg/kg in dogs) can be infused intradermally and into the subcutaneous tissue to provide local anesthesia during the procedure. The onset of action for lidocaine is 10 to 15 minutes.¹⁴ Strict asepsis should be adhered to throughout the procedure.

*Intracath®, Becton Dickinson Vascular Access, Sandy, Utah.

†Safe T Vac® Suction Catheter, Kendall Co., Mansfield, Mass.

‡Bard® Mucous Specimen Trap, CR Bard Inc., Covington, Ga.

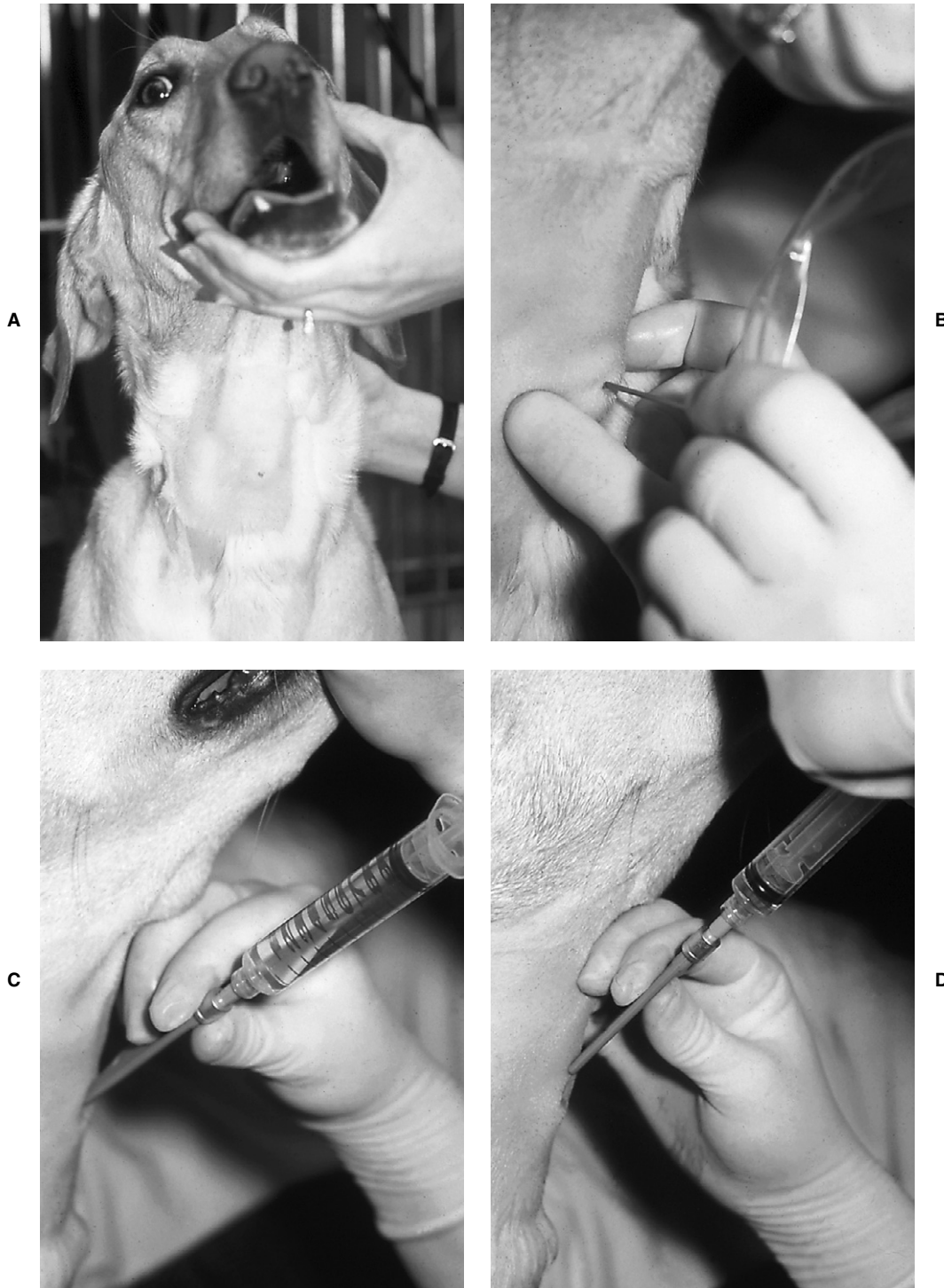


Figure 18-2. This series of pictures demonstrates the technique used to perform a transtracheal wash. (From King LG: *Bacterial infections of the respiratory tract in dogs and cats*, Trenton, NJ, 1997, Veterinary Learning Systems.)

The catheter can be inserted into the trachea either through the cricothyroid ligament or just distal to the larynx on the midline between two tracheal rings (Figure 18-3). The cricothyroid ligament has been recommended for small dogs and cats, whereas either method is ac-

ceptable for large dogs. When palpating the larynx, the cricothyroid ligament can be felt as a wide, triangular depression located between the prominent thyroid cartilage orally and the cricoid cartilage aborally. Personal experience with the cricothyroid approach is that patients

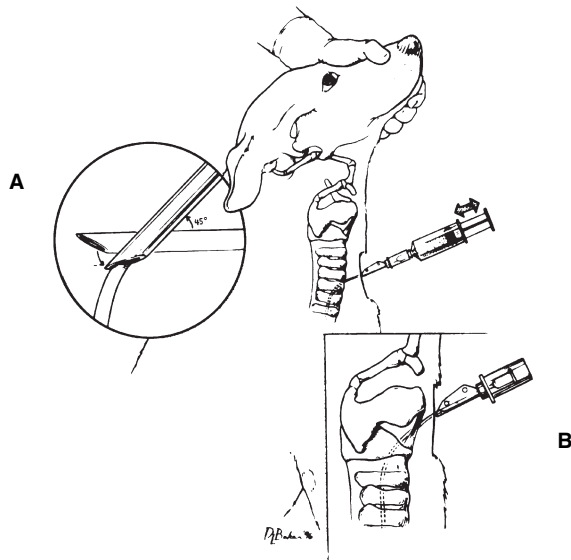


Figure 18-3. Schematic drawing of two accepted techniques for transtracheal washing. **A**, Insertion of the catheter between two tracheal rings (used most commonly in large breed dogs). **B**, Insertion of the catheter through the cricothyroid ligament. The needle should be inserted with the bevel down; once the trachea has been entered, the needle is raised to a 45-degree angle to allow the catheter to be fed down into the trachea. (From King LG: *Bacterial infections of the respiratory tract in dogs and cats*, Trenton, NJ, 1997, Veterinary Learning Systems.)

often retch or swallow after catheter placement, making the procedure more difficult.

A small stab incision can be made in the skin to facilitate needle placement, although this is not always necessary. After the needle has been inserted through the skin, the larynx or trachea is stabilized with one hand. The needle is then inserted, with the bevel down, into the trachea using steady pressure (see Figure 18-2, B). When the needle has entered the airway, the tip of needle should be lowered and the catheter should be fed its entire length into the airway. The patient may start coughing at any point after penetrating the tracheal lumen. If resistance is noted, the needle should be backed out a small distance and the catheter fed again because the needle may have been abutting the opposite wall of the trachea. Once the catheter has been fed into the airway, the needle can be withdrawn from the trachea and covered with a needle guard. The stylet should be removed at this time.

A syringe prefilled with sterile saline (3 to 5 ml for cats and small dogs, 10 to 20 ml for larger dogs) can be attached to the catheter and flushed into the catheter (see Figure 18-2, C). The syringe should then be aspirated slowly to retrieve lavage fluid. At this time, the patient should be gently coupaged to encourage coughing, which will improve the quality of the sample. If the syringe fills with air, it can be detached to evacuate the air and reattached for additional aspiration. This procedure should continue with additional saline-filled syringes until an adequate sample is obtained. Only a small por-

tion of the fluid instilled into the airway may be retrieved (about 0.5 to 2 ml) following TTW, and the remaining fluid is quickly absorbed by the bronchopulmonary tree (see Figure 18-2, D). It has been reported that up to 1 ml/kg of saline can be injected into the airway at one time without causing signs of respiratory distress¹⁵; however, no study has been published validating this recommendation. After a sufficient sample has been obtained, the catheter should be removed from the trachea and gentle pressure and a bandage applied to limit bleeding and air leakage from the site.

Technique for Endotracheal Wash

Endotracheal washes require the patient to be at an adequate plane of anesthesia to facilitate intubation. Short-acting anesthetic agents (e.g., propofol or thiopental) are recommended to allow quick induction and recovery following the procedure. Ketamine and diazepam can also be used; however, these agents are associated with a slower anesthetic recovery.

The patient is usually positioned in sternal recumbency for the procedure. Alternatively, the patient can be placed in lateral recumbency with the affected side down, which may aid in obtaining a diagnostic sample from patients with focal disease. Topical lidocaine can be sprayed into the pharynx of cats to decrease laryngospasm and facilitate intubation. A laryngoscope should be used to assist intubation to minimize oropharyngeal contamination of the endotracheal tube. A sterile endotracheal tube is required, and if possible the patient's endotracheal tube should not be connected to the anesthetic circuit until after the procedure has been completed (Figure 18-4, A).

As soon as the patient has been intubated, a sterile red rubber catheter is introduced into the airway through the endotracheal tube and fed as far as possible beyond the tip of the endotracheal tube. A syringe prefilled with sterile saline (3- to 5-ml aliquots for cats and small dogs, 10- to 20-ml aliquots for larger dogs) is attached to the catheter and flushed into the airway (see Figure 18-4, B). A catheter adapter* may be required to secure the syringe to the catheter. Care should be taken to hold onto the catheter while flushing to prevent the catheter from becoming detached and lodging within the trachea.

Endotracheal wash fluid can be retrieved by a variety of techniques. The syringe used to flush the saline into the airway can be flushed with air then manually aspirated to retrieve the sample. Mechanical suction can also be used, which may result in a higher yield. A mechanical suction device that can provide regulated low-pressure suction (100 to 170 mm Hg)¹² can be attached to a suction catheter† and sterile specimen container‡ (see Figure 18-1). Using this technique, the red rubber catheter is removed from the airway and the suction catheter is quickly fed into the trachea beyond the en-

*Catheter Adapter, Becton Dickinson Co., Franklin Lakes, N.J.

†Safe-T-Vac Suction Catheter, Kendall Co., Mansfield, Mass.

‡Bard Mucous Specimen Trap, CR Bard Inc., Covington, Ga.



Figure 18-4. This series of pictures demonstrates the technique used to perform an endotracheal lavage.

dotracheal tube. Gentle intermittent suction is applied to retrieve a fluid sample. Saline flushes can be repeated until an adequate sample has been obtained.

Sample Handling

The tracheal wash sample should immediately be allocated for cytological evaluation and saved for microbiologic culture. Samples can be submitted in a variety of containers (e.g., capped syringe or vial) for cytological evaluation, depending on the preference of the diagnostic laboratory. Highly cellular samples should be placed in an EDTA tube to prevent clot formation and clumping of cells.¹⁶ If cytological evaluation cannot be performed immediately, slides should be prepared to preserve cellular integrity or the sample should be refrigerated. Labeling the sample with the method by which it was obtained and providing a medical history including any microbial concerns are extremely important measures to facilitate appropriate testing because microorganisms such as *Mycoplasma* spp. and fungal agents require special culture techniques.

Most microbiology laboratories prefer to receive the actual fluid rather than a swab of the sample, if possible because a larger sample size increases the possibility of isolating microorganisms. However, if the sample cannot be plated within 3 hours, it should be placed in a vial containing transport media to prolong the viability of microorganisms and to prevent bacterial overgrowth. Samples placed in transport media can remain at room temperature for up to 4 hours for isolation of aerobic bacteria but should be refrigerated if they are stored beyond that time. By refrigerating samples and placing them in transport media, aerobic cultures can be performed on the sample for about 2 to 3 days. Optimally, culture for anaerobic bacteria should be performed within 10 minutes of collection if the sample is kept under anaerobic conditions (e.g., in a syringe with all air expelled and capped with a rubber stopper) without transport media. Special transport media are available

BOX 18-1 Bacteria Isolated From the Lower Respiratory Tracts of Healthy Dogs^{19,20}

Acinetobacter spp.
Corynebacterium spp.
Enterobacter aerogenes
Klebsiella pneumoniae
Moraxella spp.
Pasteurella multocida
Staphylococcus (coagulase positive and negative)
Streptococcus (alpha and nonhemolytic)

BOX 18-2 Bacteria Isolated From the Lower Respiratory Tracts of Healthy Cats^{18,21}

<i>Acinetobacter</i>	<i>Klebsiella</i>
<i>Bordetella</i>	<i>Micrococcus</i>
<i>Corynebacterium</i>	<i>Pasteurella multocida</i>
<i>Enterbacter</i>	<i>Pseudomonas</i>
<i>Escherichia coli</i>	<i>Staphylococcus</i>
<i>Flavobacterium</i>	<i>Streptococcus</i>

for anaerobic cultures, which may sustain the viability of microorganisms for up to 2 days when refrigerated.¹⁷

Interpretation of Results

The tracheobronchial tree and lungs are not sterile in healthy dogs and cats. In fact, several studies have isolated a variety of bacteria from the trachea and lower respiratory tract in 40% to 50% of healthy dogs and cats (Boxes 18-1 and 18-2).¹⁸⁻²¹ These bacteria are usually present in low numbers (less than 10^3 CFU/ml)¹⁹ and are not associated with clinical signs of illness, radiographic

abnormalities, or cytological evidence of inflammation. Positive bacterial cultures from tracheal washes must therefore be interpreted in light of clinical signs and other diagnostic test results.

Quantitative or semiquantitative cultures can be used to determine whether a cultured organism represents a true infection or is a contaminant or part of the normal airway flora. Microbial quantitation has not been routinely performed in veterinary medicine but is becoming more routine. In humans, bacterial isolation at concentrations less than 10^4 CFU/ml is considered to be either a contaminant or insignificant. Isolation of greater than 10^5 CFU/ml of bacteria is supportive of infection, with most significant bacterial infections being present in concentrations greater than 10^6 to 10^8 CFU/ml.²² Culture results should be interpreted with caution in patients receiving antibiotics prior to tracheal wash because these cultures may yield false negative results or less than 10^3 CFU/ml of bacteria.

Because tracheal washes are performed by instilling saline into the airway, any bacteria isolated will be diluted, making quantitation inaccurate. Protocols can be developed in collaboration with the diagnostic laboratory to standardize the volume of fluid used during the procedure and culture to more accurately quantitate the results.

Tracheal wash samples can vary in the degree of cellularity. Direct smears can be evaluated in highly cellular samples; however, cytocentrifugation is often required to concentrate cells for evaluation. Cytological evaluation should include an estimate of cellularity, differential cell counts, characterization of cell morphology, and identification of any neoplastic cells or infectious agents. Tracheal wash samples from normal airways may contain respiratory epithelial cells, occasional inactive macrophages, small amounts of mucus, and rare neutrophils or lymphocytes.¹⁶

Identification of intracellular bacteria is specific for bacterial infection but not particularly sensitive because microorganisms may be detected cytologically in only one third to one half of patients with bacterial pneumonia.^{11,23-24} Culture and sensitivity testing is warranted if neutrophilic inflammation is present or if there is clinical evidence suggestive of pneumonia, even if bacteria are not seen cytologically. When possible, antibiotics should be discontinued for at least 1 week prior to testing to limit the possibility of false negative cultures.¹¹

Conclusion

Tracheal washes can provide useful information for a variety of airway and lung disorders of dogs and cats. They can be performed quickly and inexpensively in most patients and should be used as an initial diagnostic test in patients with respiratory disease. Cytological evaluation should be performed routinely on tracheal wash fluid, and microbial culture should be routine in those patients with suspected infections or evidence of neutrophilic inflammation.

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