DAIGNOSIS AND MANAGEMENT OF OTITIS

Normal anatomy

Key points:

- The external ear consists of the external acoustic meatus which collects and locates the origin of sounds.
- The middle ear consists of the tympanic membrane, the ossicles, the auditory tube, and the tympanic cavity. It serves to transducer incoming airborne sound waves into waves in a liquid medium.
- The inner ear consists of the cochlea, the vestibule, and the semicircular canals. These structures relate the head to gravity, allowing the visual system to compensate for movement and to perceive both linear and rotational acceleration.

Tympanum

This is a thin, semitransparent membrane with a rounded elliptical outline. Its mean size in the dog is 15 x 10 mm with an area of approximately 63 sq mm. The shorter dimension is nearly vertical. The long axis is directed ventral, medial and cranial. The feline tympanum is more circular and smaller. The majority of the external surface is rough, thin and glistening (the pars tensa) with the outline of the manubrium of the malleus being clearly visible. The manubrium exerts tension on the tympanum giving it a concave shape as seen from the outside (like the speaker cone of a loudspeaker). The pars flaccida is more opaque, pink, or white in colour. It is confined to the upper quadrant of the membrane.

Otoscopy

Abnormal appearance of the ear canal and tympanic membrane

When evaluating the ear, one should note the condition of the ear canal (eg, erythema, stenosis, proliferation, ulceration); look for any foreign bodies or masses; note the presence, consistency, and color of any exudate; and evaluate the patency of the tympanic membrane. Inflammation as a result of any primary cause of otitis externa can result in oedema and erythema. The swelling caused by the oedema appears clinically as stenosis of the ear canal. There is gross enlargement and hypersecretion of sebaceous glands. A mixed infiltration of inflammatory cells migrates into the epidermis and dermis. In the early stages of otitis externa, intervention with anti-inflammatory drugs is important to stop the progression of the proliferative changes in the ear canal. Anti-inflammatory medications, such as oral and topical glucocorticoids, are indicated to reduce the inflammation and for pain control. If glucocorticoids are contraindicated in a patient, nonsteroidal anti-inflammatory medications may be used.

With persistence of the ear disease, clinically, the ear canal continues to close down. Clinically, there are variable degrees of nodular proliferation. With time, the continued inflammation can lead to calcification and ossification of the auditory cartilages and fibrosis. A recent study documented that the changes that occur in the external ear canal in chronic otitis may be breed related, with moderate to severe hyperplasia and dilation of the apocrine glands occurring in more than 70% of Cocker Spaniels, whereas these changes were present in only 31% of the other breeds evaluated. Once these severe changes have occurred, it is usually not possible to resolve them even with anti-inflammatory drugs; in many cases, surgical intervention is necessary.

Ulcerations of the ear canal are uncommon; when present, they are usually associated with a gram-negative bacterial infection, such as *Pseudomonas aeruginosa*. Inappropriate cleaning of the ear canal with cottontipped applicators, especially in an infected ear, can also result in ulcerations. If the ear is infected, oral and topical treatment is determined based on otic cytology and bacterial culture and antibiogram testing. In addition,

glucocorticoids may be necessary to decrease the pain and inflammation associated with the ulcerations. Topical ear cleaners containing alcohol should be avoided until the ulcers begin to heal.

An animal with a tumor in the ear canal may present with clinical signs similar to any patient with chronic otitis externa. Any tumor in the ear canal needs to be biopsied for identification. This may be accomplished using alligator forceps through the handheld otoscope, although it is best performed using the biopsy forceps through the working channel on the video otoscope under guided visualization. In some instances, there is a secondary infection, and the exudate may inhibit visualization of the mass. It may be necessary to clean the ear before the examination. Depending on the amount of exudate, the animal may need to be anesthetized to clean the ear completely. Once the ear canal is clean and a tumor is identified, a biopsy may be obtained. Tumors of the ear canal can arise from any of the structures of the ear canal, such as the squamous epithelium, glandular structures, and mesenchymal tissues. The tumors may be benign or malignant. The most common tumor found in the ear canal of the dog and cat is a ceruminous gland tumor. There is a greater tendency for malignancy and aggressive biologic behavior of these tumors in the cat than in the dog. Other tumors of the ear canal include squamous cell carcinoma, papillomas, sebaceous gland tumors, and mast cell tumors. There are nonneoplastic diseases that can mimic tumors of the ear canal, including hyperplasia of the ceruminous glands, inflammatory polyps, ceruminal gland cysts, and nodular hyperplasia of the sebaceous gland.

Foreign bodies can cause an acute, painful, unilateral otitis externa. Rarely, they may cause a bilateral otitis externa. Some of the more common foreign bodies include plant awns, impacted wax, and inspissated otic preparations. The animal should be placed under general anesthesia to remove foreign bodies, especially if they are in close proximity to the tympanic membrane. With the aid of the video otoscope, grass awns may be removed using the grasping forceps through the working channel on the otoendoscope. Impacted wax and otic concretions should be dissolved with a ceruminolytic agent and then gently flushed out of the ear canal. In some instances, a curette is used to dislodge the obstruction.

In most cases of chronic otitis externa, the tympanic membrane is difficult, if not impossible, to visualize otoscopically on the initial examination. Otic flushing is necessary to clean the ear so as to allow visualization of the tympanic membrane. If the ear canals are ulcerated or stenotic, however, administration of oral and topical glucocorticoids for 2 to 3 weeks is needed to decrease the inflammation and open the ear canals to allow for a proper ear flush. For a deep ear flush, the animal should be placed under general anesthesia and entubated. In this way, if a myringotomy is required or if the tympanic membrane is ruptured, the airway is protected to avoid aspiration of any fluid that may pass from the middle ear into the oral pharyngeal region via the Eustachian tube. In dogs with acute otitis externa, the incidence of otitis media is only 16%, whereas in dogs with chronic otitis externa, up to 88.9% may have concurrent otitis media. An intact tympanic membrane does not rule out otitis media and may be found in up to 72.5% of the ears of dogs with otitis media. In addition to allowing visualization of the tympanic membrane, the ear flush removes exudate that is irritating, masking a foreign body or tumor, serving as a nidus for infection, or capable of inactivating medications (eg, gentamicin, polymyxin B).

If the tympanic membrane is ruptured, the animal has otitis media. Samples should be obtained from the middle ear for bacterial culture and antibiogram (C/B) and cytology. Using a handheld otoscope, a sterile otoscopic cone is inserted into the horizontal ear canal and a sterile swab is passed into the middle ear cavity. The first swab is used for C/A. A second swab is passed into the middle ear cavity for cytologic analysis. If the video otoscope is used, an open-ended 3.5-French tomcat catheter attached to a 10-mL syringe is placed through the working channel of the endoscopic otoscope. One milliliter of sterile saline is flushed into the middle ear cavity and aspirated back. The fluid is then cultured. A second sample is obtained for cytologic evaluation. The middle ear is flushed repeatedly with saline using an open-ended 3.5-French tomcat catheter attached to a 10-mL syringe passed through an otoscopic cone or through the working channel on the endoscopic otoscope to remove any ear cleanser from the middle ear completely so as to reduce the chance of ototoxicity.

If the tympanic membrane is abnormal (eg, hemorrhagic, bulging, opaque, brown, grey), a myringotomy should be performed to obtain samples for bacterial C/A and cytology and to allow flushing and drainage of the middle ear cavity. It is important to make the myringotomy incision in the caudoventral portion of the pars tensa to avoid damaging the delicate structures in the middle ear. Using a handheld otoscope, an otoscopic cone is inserted into the horizontal ear canal and the tympanic membrane is visualized. Using a sterile swab, an incision is made blindly into the caudoventral quadrant of the pars tensa. The swab used for the myringotomy incision is submitted for bacterial C/A. A second swab is inserted into the original incision, and the sample obtained is

used for cytologic analysis. If the video otoscope is used to perform the myringotomy, an open-ended 3.5-French tomcat catheter is placed through the working channel of the endoscopic otoscope, and under direct visualization, the tomcat catheter is used to make the incision into the caudoventral quadrant of the pars tensa. One milliliter of sterile saline is flushed into the middle ear cavity and aspirated back using a 10-mL syringe attached to the tomcat catheter. The fluid is then cultured. A second sample is obtained for cytologic evaluation. Once the samples have been obtained, the middle ear is flushed gently with saline through the tomcat catheter until the fluid aspirated back is clear.

The normal tympanum has been shown experimentally to heal in 21 to 35 days. Therefore, if the ear is kept free from infection after the myringotomy procedure or if the membrane was already ruptured, the tympanic membrane should heal. Possible complications of ear flushing and myringotomy are Horner's syndrome, facial nerve paralysis, vestibular disturbances, and deafness. Owners should understand these complications and sign a consent form before the procedure.

Once the ear canal has been evaluated otoscopically, samples obtained for otic cytology and C/A, the ear flushed, and a myringotomy performed (if necessary), it is important to address the primary causes as well as predisposing and perpetuating factors associated with the otitis. Additional diagnostics may be required to determine these causes and factors. Specific treatment for any infections should be implemented immediately.

Cytology

The principal value of otic cytology is identification and characterization of microbial overgrowth or infection that contributes to clinical signs and perpetuates inflammation. This information strengthens interpretation of culture and susceptibility data, guides rationale therapeutic decisions, and permits more accurate monitoring of response to treatment.

Practitioners may be tempted to make conclusions based on the odour and appearance of the otic exudate rather than on cytology. For instance, *O cynotis* is classically associated with dry, grainy, black discharge, sometimes described as ''coffee grounds.'' In contrast, yellow or light brown discharge is reported to indicate bacterial infections, whereas waxy honey-coloured or brown exudate is associated with *Malassezia*. Unfortunately, these observations are not consistent or reliable. Veterinarians are cautioned to avoid relying on the physical character of discharge, odour, or past experience when making a diagnosis or selecting therapy. Rather, these decisions should be based on evidence established by careful microscopic evaluation of exudate. Failure to do so may result in inappropriate use of antimicrobial agents, failure to recognize and treat relevant pathogens, and an inability to monitor changes in pathogens on subsequent examinations. The ultimate result is poor quality of case management, prolongation of treatment, or even treatment failure and progression of disease. Veterinarians are encouraged to view cytology as a mandatory test for every patient presenting for clinical signs of otitis.

Sample preparation

Separate cytologic specimens should be prepared from each ear canal, even if the patient presents for unilateral disease. This permits comparison between the diseased ear and the normal ear as well as early recognition of bacterial or yeast overgrowth in the less obviously affected ear. Independent evaluation of each ear is also necessary in patients with bilateral disease. Clinically relevant differences in bacteria and yeast are expected when comparing the two ears. Without independent evaluation, documentation, and monitoring of each ear separately, veterinarians may fail to make appropriate management decisions.

Sample collection should always be performed before introduction of any cleaning agent or therapy. The sample can be most easily obtained using a clean cotton-tipped ear bud or Cytobrush® introduced gently into the external canal. In most cases, material obtained from the deeper horizontal canal is more clinically relevant than material obtained from the superficial vertical canal. To obtain consistent samples without causing undue risk to the patient's tympanum, veterinarians should aim for the junction of the vertical and horizontal canal, where the cartilage bends at an angle of 75°. In the case of otitis media, systemic therapy should be directed at organisms colonizing the tympanic cavity rather than the external canal. In one study, isolates from the tympanic

cavity differed from isolates from the horizontal canal in 89.5% of cases. In the same study, the tympanic membrane appeared to be intact in 71.1% of the ears with proven otitis media.

Once the sample is collected, roll the swab onto a clean glass slide, evenly distributing a thin layer of material. Care should be taken to identify which ear was sampled by labeling the slide. Because cerumen has high lipid content, briefly heat the slide to fix material to the glass, preventing loss of valuable information in the stain solvent. Avoid overheating the slide, because this may distort cells, bacteria, or yeast. Most morphologically coccoid bacteria found in the ear canal are gram positive organisms and most rod bacteria are gram-negative.

The high-dry ×40 objective (×400 magnification) is adequate for identification of leukocytes, red blood cells, cornified epithelium, yeast, and larger bacteria. After examination of the slide with the high-dry objective, switch to the high-magnification oil immersion lens (×100 objective, ×1000 magnification) for detailed evaluation; otherwise, additional smaller or lightly stained bacteria may be missed. Higher magnification also permits better visualization of morphologic characteristics of bacteria as well as evaluation of the cytoplasm of neutrophils and macrophages for phagocytized bacteria.

Evaluate each cytologic preparation for the number and characteristics of three specific features: yeast, bacteria, and leukocytes. To estimate the numbers, evaluate 5 to 10 areas; record the average count per high-powered field. A complete and consistent record of cytologic findings is necessary to monitor progression of disease or response to therapy. These details allow the primary clinician or any colleague following the case to determine if the infection is resolving, changing, or worsening.

Normal cytology

Microscopic examination may demonstrate normal cornified squamous epithelial cells seen as sheets of lightly stained basophilic keratin. These cells may roll up on themselves during smear preparation, resulting in deeper staining and a shard-like appearance. Desquamated keratinocytes may
contain melanin granules, which appear as tiny yellow to brown ovoid or round structures (often misidentified as small cocci).

The external ear canal of dogs and cats contains small numbers of normal resident bacteria. Differentiating bacteria from debris or stain precipitate can be challenging if there are only a few
organisms per field. With the exception of *Corynebacterium*, rod-shaped bacteria are rarely found in normal ear canals. Any bacteria found in the presence of leukocytes should be considered abnormal. Another finding on normal otic cytology is basophilic staining yeast. Characteristically, these organisms exhibit unipolar budding, which creates the commonly described ‘‘peanut,’’ ‘‘snowman,’’ or ‘‘footprint’’ shape easily recognizable as *Malassezia.* Although these organisms are normal residents of the canine and feline ear canal, under the appropriate circumstances, *Malassezia* can become important opportunistic pathogens contributing directly to severity of clinical signs as well as to progression and perpetuation of disease.

Abnormal cytology

Malassezia yeast

M pachydermatis is present in 15% to 49% of normal canine ear canals and in up to 83% of dogs with otitis externa. Although more commonly isolated in the external canal, *Malassezia* may also colonize the tympanic cavity. In one study, *Malassezia* was recovered from 65.8% of external ear canals and 34.2% of middle ears of dogs with chronic otitis. When otitis media is suspected, cytologic evaluation of debris from the tympanic cavity should be performed. Because *Malassezia* can be found in normal patients or mixed in with predominantly bacterial infections, veterinarians need to determine the clinical significance of *Malassezia* for individual patients. Cytology is the most useful tool for differentiating between normal resident colonization and overgrowth. Unlike bacterial infections, suppurative inflammation is not a common feature of *Malassezia* otitis and thus cannot be used to determine a pathologic state.

A recent study by Ginel et al proposed using semiquantitative criteria for the diagnosis of significant yeast otitis. By comparing cytologic specimens from normal and diseased ears, the authors concluded that 2 or fewer yeast

organisms per high-dry field (×40 objective, ×400 magnification) in the dog and cat was normal. Mean counts of 5 or more yeast organisms per field in dogs and 12 or more yeast organisms per field in cats were abnormal. The intermediate values were considered a grey zone. Using these values to diagnose otitis externa, cytology had a specificity of 95% in dogs and 100% in cats. The sensitivity was only 50% for dogs and 63% for cats because of the fact that some cases of otitis externa were exclusively bacterial with minimal yeast involvement. Semiquantitative estimation of numbers provides a guideline for the clinician, but, ultimately, the decision to treat or not to treat *Malassezia* depends on a combination of cytologic findings, severity of clinical signs, past history of yeast otitis, and previous response to therapy in the individual patient.

Bacteria

The most common pathogens associated with otitis externa are coagulase-positive staphylococci, B-hemolytic streptococci, Pseudomonas spp, and Proteus spp. Although the same classes of bacteria are frequently isolated from the tympanic cavity, there may be considerable variability between the two locations within the same patient. In a study comparing isolates from the horizontal canal and the tympanic cavity of dogs with chronic otitis externa and media, there were differences in the species or antimicrobial susceptibility of bacteria isolated in 89.5% of the cases. Therefore, samples for cytology and culture should be obtained from the tympanic cavity rather than from the external canal. The distinction between bacterial ‘‘overgrowth’’ and ‘‘true infection’’ is subtle but clinically important. In general, overgrowth of bacteria in the debris and on the epithelial surface of the external canal does not warrant culture and susceptibility testing or expensive systemic therapy. Systemic therapy is not necessarily more effective for these cases, because the concentration of antibiotic achieved by topical medications can far exceed that achievable by systemic routes. In contrast, in the case of bacterial infection of the tissue of the external canal or within the tympanic cavity, high-dose long-term systemic antibiotic therapy is necessary for successful resolution

Based on the results reported by Ginel et al, 5 or fewer bacteria per high-powered dry field (×40 objective) should be considered normal, whereas 25 or more bacteria per field suggests an abnormally increased population, with the intermediate numbers in a grey zone subject to interpretation. For cats, 4 or fewer bacteria per field was consistent with normal and 15 or more bacteria per field was abnormal. Using these mean count criteria to differentiate normal from diseased ears yielded 95% specificity and 50% sensitivity in dogs and 100% specificity and 63% sensitivity in cats.

Another important piece of evidence supporting a diagnosis of infection versus overgrowth is the presence of abundant leukocytes on cytology. Leukocytes are not found in the normal canal, nor are they frequently present during overgrowth of organisms on the surface of the external canal.

The best method for diagnostic evaluation of bacterial otitis is cytology in combination with culture and susceptibility testing. Cytologic evidence is available immediately, allowing the veterinarian to initiate rational empiric therapy while awaiting susceptibility results. When the laboratory report arrives later, knowledge derived from cytology determines which organisms are most relevant, directing alterations in the initial plan.

Leukocytes

In addition to evaluating cytologic preparations for bacteria and yeast, otic exudate must be carefully examined for white blood cells. Although yeast and bacteria are normal findings, leukocytes should not be present in otic cytology from normal patients. Neutrophils, macrophages, and other inflammatory cells only gain access to the lumen of the canal as the result of exudative inflammation, ulceration of the epithelial lining, or extension from the tympanic cavity during otitis media. Thus, finding leukocytes on cytology suggests a more severe disease process.

If the immune system is responding to an infection with suppurative or pyogranulomatous inflammation, systemic antibiotic therapy is almost always indicated. In many patients with otitis externa, the only evidence of concurrent otitis media during the initial evaluation is extension of purulent exudate from the tympanic cavity into the external canal. Because otitis media is present in 16%of dogs with acute otitis externa and in up to 82% of dogs with chronic disease, any cytologic evidence of leukocytes in the external canal should increase the clinician’s suspicion for concurrent otitis media, warranting specific diagnostic evaluation. When appropriate, culture and susceptibility samples should be obtained directly from the middle ear. If leukocytes are present

during initial evaluation, the disappearance of leukocytes from subsequent cytology is a clear indication of response to therapy and movement toward resolution.

Causes otitis externa

During the early stages of acute otitis externa, the underlying process causing inflammation of the external ear canal initially results in varying degrees of erythema of the pinnae, external meatus, and lining of the external canal. Subsequently, there can be a wide range of clinical signs, including head shaking, ear scratching, otic discharge (ceruminous or purulent), evidence of self-trauma and excoriations (including aural hematomas and acute moist dermatitis near the base of the ear), malodor, swelling, and pain. In cases of recurrent or chronic otitis externa, these clinical signs may progress to include proliferative changes such that the external ear canal becomes stenotic and is ultimately occluded; at that time, the tympanum becomes more susceptible to rupture and the development of a concurrent otitis media. This chronic inflammation is also associated with hyperplastic changes of the soft tissues surrounding the external ear canal. When the underlying problems are not addressed and identified, these chronic, hyperplastic, soft tissue changes may progress to the development of fibrosis and mineralization of the tissues surrounding the external ear canal. At this stage, medical treatment is invariably unsuccessful, requiring some form of additional surgical treatment. In addition, the lining of the external ear canal may develop erosions and ulcerations, resulting in a marked increase in pain of the canals.

Primary causes

These causes are defined as processes or factors that directly initiate the inflammation of the external ear canal. The successful treatment of the patient thus requires specific identification and treatment of this process.

1. Parasites

Otodectes cynotis (ear mite) has been reported to account for up to 50% of cases of otitis externa in cats and 5% to 10% of cases in dogs. Initially, the exudate is usually a dark brown to black color; however, chronic cases may become secondarily infected with bacteria or yeast; at that time, the exudate may develop more ceruminous or purulent characteristics. *Demodex canis* may infrequently cause a ceruminous otitis externa in dogs (with or without concurrent skin lesions of demodicosis), and *Demodex cati* may infrequently cause a ceruminous otitis externa in cats.

2. Foreign bodies

Plant awns can be a cause of otitis.. Plant awns are capable of migrating into the deepest portion of the horizontal ear canal and rupturing the tympanum, resulting in a concurrent otitis media. Less frequently observed foreign body reactions may be induced by dirt, sand, dried otic medications, broken/loose hairs, and dead insects .

3. Allergic skin disease

In dermatology referral practice, greater than 90% of the cases presented for chronic/recurrent bilateral otitis externa (and occasionally unilateral disease only) are a result of the presence of atopic dermatitis or food allergy in dogs. In most instances, the history and physical examination indicate the presence of inflammation and pruritus on other areas of the body associated with the potential problem of atopic dermatitis or food allergy. These areas include the face (especially the muzzle and periorbital regions), feet, inguinal/ventral abdominal region, axillary region and flexural surfaces of the foreleg (elbow and carpus). It has been reported that up to 55% of dogs with atopic dermatitis have concurrent otitis externa, with 3% to 5% of cases exhibiting otitis externa as the only clinical sign. Additionally, up to 80% of dogs with food allergy have concurrent otitis externa, with 25% of cases exhibiting otitis externa as the only clinical sign.

4. Keritinization disorders

Endocrine disorders, such as hypothyroidism, hyperadrenocorticism, and sex-hormone imbalances, may alter keratinization and cerumen gland production in the external ear canal, resulting in an initial ceruminous and seborrheic form of otitis externa. A similar form of otitis externa may occur in cases of sebaceous adenitis and idiopathic seborrhea.

5. Autoimmune disease

The autoimmune skin diseases that may affect the pinnae or the external ear canals include pemphigus foliaceus, discoid lupus erythematosus, cutaneous vasculitis, bullous pemphigoid, and mucous membrane pemphigoid. These are all relatively rare causes of otitis externa, and, invariably, there are skin lesions at other locations of the body or lesions on various mucous membranes.

Predisposing causes

These causes are defined as processes or factors that increase the risk of developing otitis externa and work in concert with the primary or perpetuating causes of otitis externa to cause clinical disease. It is important to recognize and possibly control these problems as a part of the complete therapeutic plan.

1. Anatomic and conformational factors

These factors include dogs with long pendulous ears, stenotic ear canals, and excessive hair in the external ear canal. It is controversial as to whether or not such conditions alone can cause otitis externa.

2. Excessive moisture

An excess accumulation of water from frequent swimming or bathing can lead to maceration of the stratum corneum lining the external ear canal. This removes the protective barrier to secondary infection, and the normal resident microflora of the external ear canal can become opportunists, causing a subsequent otitis externa. This frequent wetting of the ear canal may also stimulate the activity of the ceruminous glands, causing a ceruminous otitis externa.

3. Iatrogenic factors

These factors include the use of cotton-tipped swabs for ear cleaning, traumatic removal of hair from the ear canal, inappropriate topical or systemic antibacterial treatment predisposing to resistant strains of opportunistic bacteria, and the use of known irritating solutions.

4. Obstructive ear disease

Inflammatory polyps and tumours of the ear canal prevent exudate drainage, which predisposes the ear to secondary infection.

Perpetuating causes of otitis externa

These causes are defined as processes or factors that are not responsible for the initiation of the otitis externa but do cause the disease to continue once established. Once present, these causes must be specifically treated, but always in conjunction with treatment of the associated primary and predisposing causes.

1. Bacteria

It is important to emphasize that the external ear canal has a low number of resident as well as transient bacteria present under normal circumstances, and culture of the normal external ear canal has been reported to include *Staphylococcus pseudintermedius, Pseudomonas* spp, *Streptococcus* spp, and *Proteus* spp. Once overcolonization of the external ear canal occurs, the most commonly isolated bacterial pathogens include *S pseudintermedius*, *Pseudomonas aeruginosa, Proteus mirabilis, Escherichia coli, Corynebacterium* spp, *Enterococcus* spp, and *Streptococcus* spp. In cases of chronic or recurrent bacterial otitis externa, the most common problematic opportunistic pathogen is invariably *P aeruginosa*.

2. Yeast

Similarly, it is important to emphasize that the external ear canal has a low number of resident yeast present under normal circumstances and that culture of the normal external ear canal may reveal the presence of *Malassezia pachydermatis*. Once overcolonization of the external ear canal occurs, the most commonly isolated fungal pathogen is *M. pachydermatis*, with the occasional isolation of *Candida* spp.

3. Otitis media

Inflammation and infection of the middle ear cavity often play an important role in cases of chronic or recurrent otitis externa. Such infection usually develops as an extension of otitis externa through a ruptured tympanic membrane but may also be present in instances where the tympanic membrane is noted to be intact. Inflammation and infection of the middle ear cavity may also occur from potential pathogens in the nasopharynx via extension through the auditory tube (Eustachian tube) or, rarely, via hematogenous spread.

Investigating chronic otitis

The first step in investigating the chronic ear is to make the distinction between a SURGICAL ear and the MEDICAL ear. This is a fundamemntal step and in any chronic ear, making this distinction early saves time, suffering and money.

"Chronic" is defined as otitis present for more than 2 months or as recurrent disease over a period of 6 months or more. The primary factors must be identified and managed. If they are not the end result will inevitably be total ear canal ablation (TECA) normally with a lateral bulla osteotomy (BO). Remember what these primary factors are – they initiate ear canal inflammation and include parasites, allergies, foreign bodies, endocrinopathies autoimmunities and polypoid masses. The perpetuating factors will prevent resolution of disease and will need to be addressed in the immediate and short term (these include bacteria, yeast and otitis media. It is important to remember that bacteria and yeats are not primary causes of chronic disease. Never forget the role that otitis media plays in chronic disease (this is traditionally underestimated). If primary causes are not addressed recurrent infections will result and the ear canal pathology may get to the point of being irreversible. Irreversible damage to the canal will necessitate surgical removal (TECA-BO). The old so called "Zepps" operation is no longer used or indicated.

The first question that must be settled in any case that is chronic is, "Is this a surgical candidate or not?". If it is not, the perpetuating factors must be resolved (infection, otitis media) and an investigation into the primary factors must be instigated. The indications for surgery are:

1. Severe calcification of the ear canal cartilages
2. Irreversible soft tissue pathology
3. Bony changes in the tympanic bulla
4. Persistent infection of the middle ear
5. When a dog has become completely averse (aggressive) towards the owner applying topical treatments, this would normally also indicate a surgical ear.

Calcification and bony changes are determined on radiographs and/or (preferably) computed tomography scan (CT). Irreversible soft tissue changes cause ear canal stenosis that is unresponsive to 4 week of anti-inflammatory

treatment. The degree of stenosis is regarded as sever if the tympanic membrane is not easily visualised, if you cannot perform cytology and culture of the middle ear and if the ear canal cannot be cleaned and treated. Severe hyperplastic changes should be treated with between 1 and 4 weeks of glucocorticoids topically and systemically. Systemic prednisolone can be given on a declining dose starting at 1mg/kg bid for 3 days, then 1 mg/kg oid for 5 d then 0.5 mg/kg oid for a week and then on an alternate day basis. Topical glucocorticoids can be used with commercially available 'poly-pharmacy' otic preparations or dexamethasone can be made up in a 1:1 dilution (2mg/ml dexa mixed 1:1 with saline). Daily cleaning can be considered if the animal will tolerate it. It is crucial that any cleaning procedure not become painful as the animal will become to head shy to treat and that will then almost certainly necessitate surgery.

A typical 'plan' for a case of chronic disease would look something like this:

Day 1:

ALWAYS consider the skin as a whole and never just focus on the ear disease alone. Almost all allergic skin disease that effects the ears will also show clinical disease on the skin (axillae, groin, feet, palmar surfaces). The owner will usually complain of pruritus elsewhere besides the ears.

The skin as a whole will need to be managed (antibiotics, shampooing) and assessing response to treatment or diagnostic trials will involve the owner scoring the skin disease as a whole, not just the ears.

I always perform a CT of the head to rule out calcification of the ear canal and/or bony changes to the bullae. If these are present I do not proceed any further with medical treatment but recommend a TECABO straight away. Sadly, because few ears are worked up well to start with, the majority of chronic ears I see are beyond salvaging.

Determining the reversibility of ear canal swelling (if the imaging provides n evidence of a surgical ear) requires a course of high dose glucocorticoids (7-10 days) followed by reassessment.

If oedema or proliferative changes preclude visualization of the entire canal to the level of the tympanum, topical therapy should be initiated based on cytologic findings, and the patient should be discharged on an anti-inflammatory regimen or oral prednisolone

Determining the PRIMARY cause in a chronic ear that is going to be medially managed is absolutely mandatory.

I always start a novel protein dietary trial at this point (lasting 8 weeks with strict instructions on how to conduct this). Always emphasise to the owner that a well conducted dietary trial can never fail; if it is well done, the results are always useful. 'Failure' simply means food allergy is not playing a significant role. Partial success means food allergy is playing some role – and atopy is more than likely the remaining contributing factor. A good response obviously means food allergy.

Day 14-28

The ear canal should be open. At this point a general anaesthetic is given, the ears are imaged (radiographs, CT)

Imaging and ear canal examination will determine at this point whether or not this is a surgical case or not. If it is surgical, proceed no further medically, perform a TECA-BO.

If it is not a surgical candidate the canal should be tested cytologically, samples should be collected for culture and anibiogram, the external ear canal should be cleaned (flushed) and the middle ear evaluated by myringotomy

Treatment with second-line or third-line antimicrobials may be indicated depending on the history of prior therapies. The client should be prepared for longer term topical therapy (at least 4 weeks in duration). In extremely chronic cases, several months of rigorous topical therapy may be necessary to return the external canals to their normal state. Systemic antibiotics may be indicated if there is extensive tissue swelling (potentially indicating deeper infection), ulceration, or significant periaural dermatitis. Rechecks should be scheduled every 2 to 4 weeks for cytologic and otoscopic examination until complete resolution is achieved.

Day 60

At this point the effect of the diet trial to control ear canal inflammation must be established. Should the food trial diagnose atopy, a discussion with the owner around the long term control of atopy will be necessary. The three options are typically occasional short term, lowest possible dose

glucocorticoids (as long as the dog remains side effect free); life-long cyclosporine; allergen specific immunotherapy.

Diagnostic imaging

Radiographs

Radiographs are useful for evaluating the osseous tympanic bulla. Additionally, the external ear canals can be evaluated for chronic changes, such as mineralization or stenosis. Radiography is a widely available imaging modality familiar to veterinarians and is often the initial modality used for the evaluation of ear disease.

Technique and positioning

General anesthesia is necessary to achieve adequate positioning when making radiographs for evaluation of the tympanic bulla. Without general anaesthesia, it is not be possible to make a complete radiographic study. Radiographic evaluation of the tympanic bulla includes lateral, dorsoventral, or ventrodorsal; latero-20° ventral-laterodorsal oblique; and rostro-30° ventral-caudodorsal open-mouth oblique radiographs.

Radiographic appearance of disease states

Otitis externa

The ventrodorsal view has been described as best for evaluating a patient for otitis externa. Radiographic findings with otitis externa include stenosis or mineralization of the wall of the ear canal. Additionally, abnormal soft tissue opacity replacing gas in the external ear canal can be visualized.

Otitis media

The latero-20° ventral-laterodorsal oblique and rostro-30° ventral-caudodorsal open-mouth oblique radiographs are best for evaluation of the tympanic bullae. Radiographic findings associated with pathology of the middle ear include soft tissue opacity in the bulla, sclerosis of the wall of the tympanic bullae or petrous temporal bone, bony proliferation of the petrous temporal bone, and signs of otitis externa. If the infectious process is severe enough, lysis of the tympanic bullae can also be visible.

Nasopharyngeal polyps

The latero-20_ ventral-laterodorsal oblique and rostro-30° ventral-caudodorsal open-mouth oblique radiographs are best for evaluation of the tympanic bullae, whereas a lateral view allows evaluation of the nasopharyngeal canal. Radiographic findings of unilateral or bilateral increased soft tissue opacity within the tympanic bulla and sclerosis of the osseous bulla are suggestive of nasopharyngeal polyps. Additional signs that can be seen with nasopharyngeal polyps are findings of otitis externa and soft tissue opacity in the horizontal ear canal. Nasopharyngeal polyps may also cause nasopharyngeal obstruction, seen radiographically as increased soft tissue opacity in the nasopharyngeal region.

Neoplasia

Neoplasia within the tympanic bulla can produce radiographic findings of soft tissue opacity within the tympanic bulla and sclerosis of the osseous bulla. Some neoplastic processes lead to lysis of the osseous bulla. Radiographic findings associated with neoplasia within the external ear canal include a soft tissue mass effect around the external ear canal with impingement or obliteration of the external ear canal. Aggressive neoplasms, including squamous cell carcinoma and mucinous gland adenocarcinoma, can result in obliteration of the external ear canal as well as lysis of the adjacent calvaria.

CT

CT evaluation of the ear canal is particularly useful for cases of otitis media. It is also useful for the evaluation of nasopharyngeal polyps and unilateral or bilateral otitis externa and to determine the extent of neoplasia. Additionally, CT is used to evaluate the communication of fistulous tracts and abscesses with the external ear canal. At the Onderstepoort Veterianry Academic Hospital CT scanning of the head has become a standard part of the investigation of chronic otitis externa and radiographs are seldom used for this purpose.

Medical therapy of otitis

The medical approach to therapy of otitis externa and media may currently be best described as an art rather than a science. Although the veterinary literature evaluating diagnostic techniques for otitis has grown considerably in the past few years, veterinary studies documenting medical therapies (beyond ototoxicity research) are quite scarce.

Because dermatologists deal with otic infections on a daily basis, this group of specialists has contributed much to the anecdotal knowledge base on the subject. Multiple approaches are routinely discussed, which often vary in the empiric choices of topical drugs and cleansers employed, the frequency and technique of ear canal lavage (both in-office and as administered by the pet owner at home), and the types and frequencies of prophylactic therapies recommended after resolution of chronic infections. One point of agreement (and much concern) is the growing evidence for multidrug-resistant strains of *Pseudomonas aeruginosa* and methicillin resistant *Staphylococcus* spp.

Topical versus systemic therapeutics

Topical therapy is key to the successful resolution of otitis externa, which is essentially a surface infection. Unless the ear canal epithelium has been eroded or ulcerated extensively, systemic (oral) antimicrobials are unlikely to achieve therapeutic concentrations within the fluid and waxy exudates of the external canals in which the infectious organisms are harboured. Penetrating this ‘‘vat’’ of infection is best accomplished by the application of sufficient volumes of a topical antimicrobial. The choice of active ingredients for treatment of otitis externa is usually made empirically, based on cytologic examination of ear canal exudates and otoscopic examination of the inflamed canals. In contrast, the middle ear (tympanic bulla) contains a highly vascular mucous membrane lining, which may allow for better diffusion of drugs from the vascular compartment to the bulla space. The choice of systemic antibiotics for treating the middle ear compartment is preferably based on culture and susceptibility testing. Despite this, topical therapy in otitis media remains crucial in most cases.

Information gleaned from culture and susceptibility testing reflects the serum level of drug required to kill the organism in question and may not be relevant in choosing topical antimicrobial preparations. Susceptibilities are typically expressed as minimum inhibitory concentrations (MICs) or reported simply as ‘‘susceptible,’’ ‘‘intermediate,’’ or ‘‘resistant’’ based on the Kirby-Bauer disk diffusion method. For several reasons, this in vitro information may relate poorly to the choice of topical antimicrobial. As already mentioned, adequate levels of drug (which reach the MIC for the organism) may not be achieved at the surface of the external ear canal epithelium. In addition, the concentrations of specific antimicrobial ingredients in topical preparations often greatly exceed those that could be safely achieved in the systemic circulation. For example, an organism that is reported to be resistant to gentamicin on a culture/susceptibility test may not be resistant to the high concentration of gentamicin that can be safely delivered locally within the ear canal itself. Finally, not all active ingredients used topically are represented on standard culture/susceptibility profiles. Therefore, veterinarians should be comfortable with basing an empiric choice of topical antimicrobial on the cytologic identification of the organism (or class of organism) and otoscopic evaluation of the extent of ear canal inflammation and chronic changes.

Ingredients of topical antibacterials

Most commercially produced topical products contain one or more active ingredients (antibacterial, antifungal, and anti-inflammatory) in various combinations as well as a vehicle and various solubilizers, stabilizers, and surfactants. The formulation of the topical product with regard to the vehicle may be as important as the active ingredient to the success of therapy.

Vehicles are chosen to maximize drug solubility, to maintain drug activity locally for the maximum period, and to minimize systemic absorption. The most commonly used vehicles are water (which may be buffered and pH adjusted to maximize drug activity), demulcents, and emollients. Demulcents are compounds of high molecular weight capable of forming stable emulsions or suspensions of drugs that are not water soluble. They coat and protect underlying tissue. Polyhydroxy demulcents, which are the most hydrophilic yet potentially irritating compounds within this class, are also the most commonly used carriers used in otic products. They include polyethylene glycol, propylene glycol, and glycerine. The former two are commonly implicated in contact/irritant reactions. Emollients are occlusive agents used as carriers for water-insoluble drugs and are protective and hydrating to the stratum corneum. Examples include vegetable oils, animal fats (eg, lanolin), and hydrocarbons (eg, petrolatum, mineral oil, paraffin).

Active ingredients are generally classified as antibacterials, antifungals, and anti-inflammatories.

Antibacterials

Aminoglycosides

The aminoglycoside antibiotics are the most commonly used class of topical otic products. They act on susceptible bacteria by binding to the 30s ribosomal subunit in the bacterial nucleus, thereby inhibiting protein synthesis, and are considered to be bactericidal. Their antibacterial spectra vary by individual drug potency but include some aerobic gram-positive bacteria and many aerobic gram-negative species. They are ineffective for anaerobes and fungi. Their antimicrobial activity is enhanced in an alkaline environment, which is germane to topical therapy of the ear canal. If acidifying cleansers are used in conjunction with aminoglycosides, the products should be applied at least 1 hour apart. Also of noted importance is the ototoxic potential of aminoglycosides, especially when administered parenterally. Auditory symptoms are more common with neomycin and amikacin, whereas vestibular symptoms are most typical of gentamicin, especially in the cat. The ototoxic potential of this class of drugs when topically applied may be overestimated.

Neomycin

Often considered to be a first-line topical antibacterial, neomycin has the lowest potency of the class, showing significantly less efficacy against several gram-negative organisms; most notably *Escherichia coli* and *P aeruginosa*. Its activity against gram-positive cocci remains quite good. Manufactured topical products containing neomycin are plentiful and are recommended for acute bacterial otitis in which cocci predominate cytologically.

Gentamicin

Considered to be a ‘‘second-line’’ antibacterial, gentamicin has intermediate potency within the class. Its activity against gram-positive cocci is excellent; however, resistant strains of *E coli* and *P aeruginosa* are not uncommon. Manufactured topical products containing gentamicin are plentiful and are recommended for chronic/recurrent otitis when clinical evidence of neomycin-resistant rods is available. In general practice, these products are often used as first-line antibacterials. Despite continuing anecdotal concern over the ototoxic potential of topical gentamicin, a study in dogs designed to simulate clinical exposure via a ruptured tympanum failed to document any toxicity

Amikacin

Considered to be a third-line antibacterial, amikacin is most commonly indicated for chronic/recurrent otitis caused by gentamicin resistant gram-negative bacilli (especially *P aeruginosa*). Amikacin is not available as a

commercially produced topical product, but the injectable product is often diluted to a concentration of 30 to 50 mg/mL (in sterile saline or a tromethamine–ethylenediamine-tetraacetate [Tris- EDTA] product) by veterinarians for topical use.

Tobramycin

Also a third-line antibacterial, indications for use of tobramycin are similar to those for amikacin. Although an otic topical product is not available, ophthalmic formulations are. Dilution of injectable tobramycin with sterile saline to a concentration of 8 mg/mL has been used, but the long-term stability (>1 week) of the solution is unknown and remains a concern.

Fluoroquinolones

This class of antibiotics acts by inhibiting bacterial DNA-gyrase, which prevents DNA supercoiling and synthesis and is thus bactericidal. Bactericidal activity is dependent on concentration, and bacterial resistance is known to occur by rapid mutation, especially in the presence of subtherapeutic concentrations. Fluoroquinolones have good activity against a wide range of gram-negative bacilli and gram-positive cocci (including staphylococci, although activity is variable for streptococci). Their use as second- or third-line antibiotics for chronic/recurrent bacterial otitis, especially cases associated with *P aeruginosa*, has become common. Studies comparing two human-labeled topical fluoroquinolone products (ciprofloxacin and ofloxacin) with polymyxin B have shown the fluoroquinolones to be safe, with less ototoxic potential.

Carboxypenicillins

This class includes the expanded-spectrum penicillins, which exhibit activity against gram-negative organisms (including *Pseudomonas* spp) because of their ability to penetrate the gram-negative cell membrane. Ticarcillin is the carboxycillin for which topical use has been most commonly reported in the treatment of canine *Pseudomonas* otitis. One pair of authors recommends dilution of the 6-g bottle with 12 mL of sterile water and the addition of reconstituted ticarcillin, 2 mL, to 40 mL of an acidifying ear cleanser (with the remainder frozen for future use). The stability of this solution is unknown but may not exceed 3 days.

Polymyxins

Polymyxin B and colistin sulfate (polymyxin E) are polypeptide antibiotics that exert bactericidal effect by increasing permeability of the bacterial cell membrane via chelation of membrane phospholipid components, leading to osmotic damage. The ototoxic potential of polymyxin B has been well described experimentally in several species of animals, both in vivo and in vitro. There is speculation that the ototoxicity of these products could be more specifically attributable to the propylene glycol vehicle, however. One positive aspect of topical polymyxin B is its reduction of the inflammation induced by endotoxin components of gram negative bacterial cell walls. The relevance of these findings to dogs and cats is unknown.

Silver sulfadiazine

Used for more than three decades in human medicine as a burn wound protectant, silver sulfadiazine (SSD) has broad-spectrum antibacterial activity (most notably against *P aeruginosa*) and does not interfere with re-epithelialization and neovascularization of wounds. In fact, it may enhance wound healing. The spectrum of activity includes most pathogens associated with otitis (including methicillin-resistant staphylococci), with the exception of *Malassezia pachydermatis*, against which activity is low. Resistant strains of *P aeruginosa* have been reported but are extremely rare. Silver exerts its antibacterial effect via impairment of DNA replication and bacterial cell wall damage, leading to osmotic changes. Although the cream is not readily miscible in water, a homogeneous emulsion can be achieved with gentle mixing. SSD has become the favored topical therapy for *Pseudomonas* otitis in the, especially when the external ear canals are ulcerated. The ototoxic potential of SSD is unknown, although the collective experience of a large group of veterinary dermatologists suggests that it is safe for use even in the context of a ruptured tympanum. Because it is known that significant amounts of silver can be absorbed from burn wounds of human beings and silver has the potential to produce systemic toxicity, caution may be warranted in veterinary patients with extensive ulceration. Evidence implicating SSD in systemic toxicity of dogs or cats has not been, and a 1% suspension has been used in scores of dogs and several cats for more than 3 months without incident at the University of Pennsylvania.

Tromethamine–ethylenediamine-tetraacetate (EDTA)

This is commonly used as either a pre-soak or a carrier vehicle (for aminoglycoside antibiotics) in the treatment of gram-negative infections. EDTA promotes increased permeability to extracellular solutes and increased sensitization to antibiotics, whereas Tris serves as a buffer.

Antifungals

Nystatin

A polyene antifungal, nystatin binds to sterols in the fungal cell membrane, thereby altering permeability and mediating cell death by osmotic destruction. Nystatin is primarily used to treat infections by *Candida* spp, but it also exhibits activity against *M pachydermatis* clinically. Because most preparations containing nystatin are occlusive ointments, I may be better to avoid using them in cases of exudative or ceruminous otitis externa (fairly typical for *Malassezia* otitis).

Azole antifungals

Benzimidazoles (eg, thiabendazole), imidazoles (eg, clotrimazole, miconazole, ketoconazole), and triazoles (eg, itraconazole, fluconazole) all share a common mode of action against fungi: disruption of cell wall ergosterol biosynthesis via P450 enzyme inhibition. An in vitro study comparing the efficacy of the azoles against *Malassezia* spp yeast indicated that thiabendazole is the least effective, followed by clotrimazole (with efficacy comparable to nystatin), miconazole (with 10 times the potency of nystatin), ketoconazole, and itraconazole, respectively]. A more recent in vitro study showed equal efficacy of ketoconazole, itraconazole, and terbinafine against *M pachydermatis*, whereas a Hungarian study suggested that ketoconazole is the most effective, followed by clotrimazole, miconazole, and nystatin, respectively.

Veterinary topical preparations of thiabendazole, clotrimazole, and miconazole are commonly employed for the treatment of Malassezia otitis in dogs and cats. Ketoconazole is available only under human labels as oral tablets and a topical cream. Both may be used to formulate 1% to 2% solutions for otic treatment of veterinary patients when other more available azoles are failing clinically. Miconazole is the topical agent most commonly employed against *Malassezia* otitis. Topical azole antifungals are said to be uniformly nontoxic to the inner ear. Although antifungal ototoxicity does not seem to be clinically problematic in dogs and cats, contact/irritant reactions may be noted with any of the azoles. It is difficult to exclude the role of vehicle versus the azole drug in many cases, however. Oral ketoconazole or itraconazole may be used for canine otitis media associated with *Malassezia* spp, whereas itraconazole is generally preferred for this purpose in cats.

Anti-inflammatory agents

Almost every case of otitis deserves the benefits of topical corticosteroids because of their anti-inflammatory, antiproliferative, antipruritic, and antiexudative (glandular secretory) effects. Systemic steroids [preferably prednisolone] are also highly efficacious in reducing acute stenosis caused by oedema as well as more chronic stenosis caused by proliferative hyperplasia and fibrosis.

Topical steroids are present in a large proportion of commercially prepared otic products, and their potency may depend not only on the drug's inherent anti-inflammatory quotient but on the drug concentration and vehicle used in the product. In general, the potency of topical steroids is assumed to concur with their biologic activities. Relative potencies compared with hydrocortisone are: hydrocortisone (1), prednisolone (5), triamcinolone (5), dexamethasone (25), betamethasone (25), and fluocinolone (100). Some authors believe that nothing more potent than hydrocortisone should be used in cases of ulcerative *Pseudomonas* otitis. Side effects related to topical steroids include systemic absorption with suppression of the hypothalamic-pituitary-adrenal axis (which likely increases with the higher potency steroids).

The only nonsteroidal agent used in a topical otic preparation is dimethyl sulfoxide (DMSO). In addition to its significant anti-inflammatory activity, DMSO may reduce fibroplasia. Topical ear formulations with DMSO are not available in RSA.

Therapy of acute otitis externa

In general a first-line antimicrobial should be chosen based on cytologic and otoscopic findings. Twice-daily therapy for a minimum of 7 to 14 days depending on the degree of inflammatory changes (oedema, hyperplasia, and erosion/ulceration) combined with at-home cleansing is the prescribed regimen. Of utmost importance is delivering a sufficient volume of topical agent to the canal. For example, large-breed dogs (eg, retrievers, shepherds) should receive a minimum of 10 to 12 drops (or 1 mL) per application. Re-evaluation at the end of the regimen to evaluate the cytologic and otoscopic status of the ears is recommended but not mandatory for success in most cases.

Otitis media

Otitis media, an inflammatory disease in the middle ear cavity, is a common disease process that goes unrecognized in most veterinary practices. Otitis media in dogs is much more prevalent than previously thought. In dogs, secondary otitis media occurs in approximately 16% of acute otitis externa cases and in as many as 50% to 80% of chronic otitis externa cases. The fact that otitis media is present in more than half of canine patients with chronic otitis externa should stimulate a reformulation of the thought process when faced with these cases. Just the common history that the patient has been treated repeatedly for ear infections should alert the veterinarian to think about otitis media as a possibility. Otitis media should also be considered when the veterinarian is presented with a patient showing any neurologic disease affecting the head, including vestibular disease, Horner's syndrome, or facial nerve damage.

The diagnosis of otitis media in dogs can be quite difficult to make because of the long, bent, funnel-shaped conformation of the dog's ear canal, which makes it hard to see the tympanic membrane (TM). In addition, many patients with otitis media have an intact TM, giving the clinician the impression that there is nothing wrong in the middle ear. Most canine patients with otitis media also have chronic otitis externa with pathologic changes to the ear canal that cause stenosis, making visual examination of the TM impossible. It is often theorized that otitis media is an extension of otitis externa that was not treated, improperly treated, or resistant to treatment. The end result is significant damage resulting in porosity to the eardrum over time.

The diagnosis of otitis media in cats may be easier to determine with the otoscope because of their relatively short ear canals. Otitis media in cats most often results as a sequela to respiratory disease; thus, a history of sneezing, ocular discharge, or nasal discharge may aid in providing a clue. Some cats with otitis media also have a visible polyp in the ear canal after the ear is cleaned of the dried exudates and mucus. Many feline otitis media patients have a dark, dried, crumbly exudate in the ear canal that mimics an ear mite infestation.

The diagnosis of OM is based on otoscopy and diagnostic imaging (as described elsewhere. Myringotomy is an especially useful technique as is briefly described below:

Myringotomy

To diagnose patients with otitis media, it is sometimes necessary to perform a myringotomy to get a cytology specimen and to allow for culture and antibiotic sensitivity testing on the material trapped behind the eardrum. If there is fluid pressure pushing on the eardrum or negative pressure retracting
the eardrum, perforation of the eardrum using a controlled myringotomy incision immediately relieves the intense pain associated with these pressure changes.

To perform a myringotomy, the patient is anesthetized and the external ear canal is thoroughly cleaned with a disinfectant, such as dilute povidone iodine. The ear canal is then dried using suction. A sterile rigid polypropylene catheter (a tom cat catheter is suitable) is cut to an angle of 60° with a surgery blade to provide

a sharp point. A long spinal needle can also be used to puncture the eardrum. The tip of the cut catheter is advanced under good visualization, and the pars tensa is punctured at either the 5-o'clock or 7-o'clock position to remain away from the germinal epithelium and blood vessels overlying the manubrium of the malleus.

Fluid under pressure may freely flow into the horizontal canal as the perforation begins, and it should be suctioned to ensure that the myringotomy incision is large enough to accommodate a 3.5- or 5-French catheter. In the case of suppurative otitis media, myringotomy serves to decrease the fluid pressure behind the eardrum. The fluid escapes into the external ear canal and may continue to drain for several days; thus during therapy, the ear canals need to be flushed to remove this debris. The catheter is advanced through the incised TM and directed ventrally into the bulla, and gentle suction is used to retrieve any material within the bulla. If a spinal needle was used, the stylet is withdrawn before suctioning. If the bulla is dry, 1 or 2 mL of normal saline can be infused into the bulla and then immediately retrieved. This material is submitted for cytology, bacterial culture, and antibiotic sensitivity.

Treatment of otitis media

Planning treatment of otitis media requires a stepwise protocol for maximal effect. An organized approach allows the clinician to formulate treatment or to change existing treatment based on observations. The steps outlined provide a framework for treating otitis media:

1. Access middle ear.
2. Perform cytology and bacterial culture.
3. Flush bulla.
4. Infuse topical medications into the bulla.
5. Reduce inflammation with corticosteroids.
6. Administer systemic and topical antimicrobials.
7. Recheck weekly, and retreat two to three times.
8. Consider surgery.

It is important to obtain samples for cytology and bacterial culture. Many infections are polymicrobial, including mixed infections of bacteria (rods or cocci) and yeasts. Cytology of a middle ear specimen may reveal *Malassezia* yeasts, which would not be reported if only bacterial culture was submitted to the laboratory. Additionally, cytology may not reveal bacteria because they are often protected from the cytology stains by mucus. Many cytologically negative specimens have been reported as culture-positive. In ear disease, laboratory assessment based on culture and sensitivity does not always correlate to clinical response

Flushing and suctioning the bulla

The most important technique for treating otitis media is probably flushing the bulla. Topical otic medications cannot penetrate through the thick exudate that fills the middle ear during otitis media; thus, this exudate and secretory material must be removed. Additionally, many destructive enzymes that are trapped in the mucoid secretions in the bullae remain in contact with the mucoperiosteum, which prolongs the disease. Hydrating the mucus with the water in flushing solutions makes it less dense and easier to suction.

Using fluid under pressure to irrigate the bulla loosens mucus from the tissue. This material does not stick to the mucous membrane as cerumen sticks to the epithelium in the external ear canal. A useful fluid used for flushing the bulla is warmed extremely dilute povidone iodine solution in warm tap water. If there is an identifiable bacterial infection, warmed Tris- EDTA is also infused into the bulla. Acidic solutions should be avoided in the middle ear so as to prevent pain and irritation. Using a device that delivers the fluid under high pressure allows the mucus and pus to flush out of the bulla either into the external ear canal, where it can be suctioned out, or through the auditory tube into the throat.

Bulla infusion

Removal of the mucus and pus within the tympanic bulla during the treatment of otitis media allows topical medications to penetrate in and around the thickened and folded mucoperiosteum. The use of aqueous

formulations of nonototoxic topical antibiotics, steroids, or antifungals placed on the mucoperiosteum hastens recovery from otitis media. Topical levels of these drugs may be many times the level that can be achieved using parenteral therapy, even when there is severe hyperemia of the mucoperiosteum. Antibiotic concentrations are high in inflamed tissues, because the increased blood flow allows increased serum levels of antibiotic to perfuse the inflamed tissue. Even these levels may not achieve the minimum inhibitory concentration (MIC) necessary to kill the bacterial target, however. Infusing drugs into the bulla is an effective method of providing long-acting high-concentration effects. The tympanic bulla in the dog and cat is a deep blind pouch. When the bulla is filled with antibiotic, the fluid cannot escape easily. Most of the topical antibiotic solution can remain within the bulla for several days after infusion.

During the first bulla infusion, less than 1 mL of solution can be infused into the inflamed bulla. The entire procedure of flushing, suctioning, and bulla infusion should be repeated weekly during therapy. With each successive treatment, the mucoperiosteum should retract slightly, increasing the volume of fluid the bulla can accommodate.

Reduce inflammation with corticosteroids

Corticosteroids slow the intense inflammation and exudation found in middle ear disease. As described earlier, the mucoperiosteum undergoes severe pathologic changes in response to inflammation. Corticosteroids can reverse some of the extensive granulation that forms in the bulla, which enhances the ability of topically applied antibiotics to penetrate into the infected tissue. The tympanic cavity is crowded out by this hyperemia and proliferating granulation tissue; thus, the amount of free space within the bulla decreases. Reducing the inflammation helps this lining membrane to retract back toward the bone, increasing the volume within the bulla. When the eardrum heals, this space should refill with air. Corticosteroids also reduce the amount of mucus produced in the bulla and decrease the viscosity of the secretions from the inflamed mucous membrane in the bulla. Changing the character of the mucus aids in its removal. Corticosteroids may also function in reducing the swelling in the auditory tube, increasing lumen diameter, which has the beneficial effect of offering limited drainage of mucus into the nasopharynx.

Aqueous topical corticosteroids, such as dexamethasone sodium phosphate (4 mg/mL) or a dimethyl sulfoxide (DMSO)/cortisone combination may be infused through a catheter placed into the cleaned and dried bulla. These potent topical anti-inflammatories are not ototoxic. Other potent injectable topical corticosteroids are formulated with ototoxins, such as benzyl alcohol or propylene glycol, or they are in suspension. These should not be used in the bulla.

If there is bacterial or fungal disease and the space in the bulla is needed for antibiotic or antifungal topical therapy, systemic corticosteroids may be used for a few weeks during the recovery phase of otitis media. High initial doses of corticosteroid are required, which mirror those used for other diseases, such as inflammatory bowel disease. Patients should be screened for diabetes, hyperadrenocorticism, demodicosis, and potential pregnancy before using the high doses of corticosteroids. Prednisone or prednisolone, 2 to 4 mg/kg daily for 2 weeks and then decreasing to 1 mg/kg every other day, provides high enough levels to decrease inflammation within the bulla. Owners of these animals need to be warned that there will be side effects of prednisone at this high dose. Many owners discontinue the medication when the side effects occur. It may be preferential to use a 0.2-mg/kg intravenous dose of dexamethasone (2 mg/mL) at the time of treatment and then to repeat this injection weekly at the recheck appointment if there is significant exudate that needs to be suctioned from the bulla. This has fewer mineralocorticoid-related side effects and prevents the owners from having the choice of stopping the medication.

Systemic and topical antimicrobials

The dilemma facing the clinician treating otitis media is that systemic drug levels may not reach sufficient MIC in the bulla and topical treatment requires frequent applications. Using maximal doses of oral antibiotics along with weekly bulla infusions of a fresh supply of antibiotic increases the therapeutic successes. Topical antibiotic treatment of otitis media has gained recent favour in veterinary medicine. The use of topicals is based on the high levels of antibiotic that can be placed into the bulla coupled with the poor drainage of the tympanic bulla. Aqueous solutions of nonototoxic antibiotics can be placed directly onto the infected mucoperiosteum. Infused

antibiotics can remain in contact with the inflamed granulating middle ear mucosa much longer, because the fluid filling the bulla cannot readily escape. When topical therapy of otitis media fails, it is usually the result of inability of the antibiotic to get to the bacteria. For example, there may be sequestration of bacteria within folds or pockets of granulation tissue unexposed to the topical antibiotic. Antibiotic sensitivity patterns are important for treating otitis media when systemic antibiotics alone are used to get levels within the bulla. Unlike topical antibiotics, which can achieve many times the blood MIC, systemic antibacterial therapy for otitis media relies on lower levels of antibiotics arriving in the middle ear hematogenously or through inflammatory cells. Because of the poor blood supply in the external ear canal and middle ear, there is limited diffusion of antibiotic from the serum into the lumen of the ear canal or tympanic bulla.

The choice of antimicrobial agents becomes more complicated when otitis media is involved. It is preferred to avoid the topical use of fluoroquinolones completely unless a systemic form of the same drug is used concurrently because of the potential for sub-therapeutic concentrations of the topical drug to reach the middle ear via the ruptured tympanum. Development of fluoroquinolone resistance is documented to occur in vitro with a single exposure to the drug. Many veterinary dermatologists recommend starting an oral fluoroquinolone pending culture/susceptibility results. Systemic antimicrobial therapy based on culture/susceptibility testing of samples retrieved from the middle ear is indicated whenever possible. In fact, it has been stated that otitis media cannot be resolved with topical therapy alone. Many chronic cases of otitis media involve *P aeruginosa*, however, and an oral drug is not always available because of broad-spectrum resistance. Several systemic antipseudomonal drugs intended for intravenous use can also be used subcutaneously, allowing therapy by the client at home. Examples include meropenem (8 mg/kg every 12 hours), ticarcillin (40–80 mg/kg every 6 hours), and ceftazidime (30 mg/kg every 4 hours). The downfall of these systemic injectable drugs is their extremely high cost. In cases of *Pseudomonas* otitis media in which an oral antibiotic is unavailable and the cost of subcutaneous therapy is prohibitive to the client, success with thorough bulla lavage followed by high-throughput topical therapy has been shown. The later entails application of large volumes (1–2 mL) of topical drug (most often, an SSD solution) twice daily and regular (daily or every other day) at-home flushing of the canals using a cleanser (Epiotic Advanced, Virbac). It is our contention that high-volume application of low-viscosity antimicrobial preparations and cleansers promotes a continued ‘‘flushing’’ of the bullae as long as the tympani remain open.

Methicillin-resistant *Staphylococcus* spp also present a dilemma in selecting a systemic antibiotic. Methicillin resistance (indicated by resistance to oxacillin in most susceptibility profiles) confers resistance to all β-lactam antibiotics, and many of these strains also show broad fluoroquinolone resistance patterns. Most strains isolated from patients presenting to the dermatology service at the University of Pennsylvania have been susceptible to chloramphenicol or macrolide antibiotics (erythromycin, azithromycin, and clarithromycin).The methicillin resistance status in South African companion animal practice is unknown at this stage although methicillin resistant *Staphylococcus* spp. have been isolated from dermatology cases at the Onderstepoort Veterinary Academic Hospital.

Regardless, the successful therapy of bacterial or fungal otitis media relies on an initial thorough cleansing of the bulla, aggressive targeted antimicrobial therapy for an absolute minimum of 6 to 8 weeks, and consistent cleansing/flushing of the external canal by the client at home. Therapy can only be discontinued when the ear canals are negative for microorganisms on cytologic examination, the external canals have no residual oedema, and the epithelium has normalized. In some cases, the tympanic membrane may not regenerate, although most do. In cases in which these criteria cannot be achieved, a prophylaxis program that incorporates regular use of cleansers must be instituted. The level of commitment on the part of the client cannot be overly stressed. In one report, the mean time to resolution of chronic otitis media in 44 dogs was 117 +- 86.7 days (range: 30-360 days)

Rechecks

With successive recheck visits, the eardrum and the horizontal canal should be examined for fluid, mucus, and pus. If there is fluid within the bulla, it should be flushed out and the bulla suctioned to prepare it for re-infusion. When the weekly examination reveals a dry canal and little liquid within the bulla, the inflammation and infection within the bulla have subsided. At this point, bulla infusion treatments can be discontinued. Subsequent 2-week recheck intervals should reveal a healing eardrum.

Chronic otitis externa

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