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What's causing this disastrous ear problem?
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PSPP classification
Over the years a variety of classification schemes have been utilized to help understand otitis externa. PSPP divides the etiologic classification of otitis externa into causes and factors. Each cause and factor has a way to determine its presence or assess its response to therapy. They also have possible treatment options and prognosis. The prognosis can be divided into curable in a relatively short term, require lifelong treatment or surgery to correct, or they may be reversible but achieving that will require long term management. The PSPP System© classifies each cause and factor with a likely prognosis and there is an associated client handout that helps the veterinarian identify the components of an ear problem and educate the client about what is needed for their pet. The PSPP System© is available as downloadable pdf files for veterinarians at no cost online at www.animaldermatology.com

Causes are diseases or agents that directly produce inflammation in the ear, otitis externa. Factors are agents or elements of the disease that contribute to ear disease. Factors combine with causes or facilitate the causes to create more severe inflammation or symptoms. Factors may be present prior to or as a result of the ear disease. Factors can inhibit the response to treatment of the causes of ear disease and can cause recrudescence of disease once treatment of causes is completed.

Primary causes
Primary causes are usually the actual inciting agent or etiology that directly causes damage to the ear canal skin. These can occur alone and induce otitis externa without any other cause or factor. The primary cause may result in subtle lesions or signs and remain unrecognized by the owner or even veterinarian until a secondary cause occurs. Once a primary cause alters the aural environment secondary infections often develop. The vast majority of cases will have a primary cause. The exceptions include: when predisposing factors combine with secondary causes to result in disease; the primary cause initiated disease but then was resolved or eliminated but secondary causes or perpetuating factors remain and cause recurrent signs or infections. It is critical too successful long-term management that the primary cause has already resolved or can be determined and either eliminated or controlled.

Key Points Regarding Chronic Primary Causes
Idiopathic or not diagnosed was reported in 32% of otitis cases in a retrospective study[1]. There typically should be or have been a primary diagnosis but they are not always readily apparent. In general practice foreign bodies and ear mites make up a significant number of cases and once they occur they may result in perpetuating factors that result in chronic ear disease. If not seen early in the process they may then present without the primary cause being readily diagnosed. Allergic, most likely atopic, dermatitis is the most frequent cause of otitis externa, especially chronic in the dog.[1] Otitis externa as the only sign of atopic disease was described in 3 to 5% of atopic dogs.[2, 3] The incidence of ear disease in atopic dogs has been reported as low as 17%[4] to as high as 87% having historical or physical evidence of otitis and 73% history of treatment for ear disease.[5] The importance of atopic disease in the pathogenesis of ear disease is even more obvious when one considers that conservatively about 10% of all dogs are atopic. This suggests that about 7.3% of all dogs may develop significant otitis externa as a result of atopic dermatitis. Therefore if the case is recurrent or chronic and perpetuating factors are absent allergy is the most likely cause even if other allergy signs are not readily apparent. The allergic reaction often is mild and may cause erythema, mild edema and with chronicity some increase in scale or lichenification. The concave pinnae are often affected though any part of the ear canal or skin surrounding the external orifice may be affected. A significant exudate rarely occurs with just an allergic reaction. The erythema may be mild, transient or intermittent. Subsequent secondary infections with Malassezia or bacteria will make the inflammation and discharge more marked and persistent. Self-trauma from pruritus may further contribute to inflammation and pathology. It is also important to realize that secondary infections may be unilateral. The primary allergic symptoms may be mild or intermittent and not recognized. These types of cases are then considered as presenting just with unilateral disease. It is also possible to see chronic unilateral otitis or recurrent unilateral otitis due to
the perpetuating factors that occur when that one ear had secondary causes and more severe pathologic changes or disruption in normal otic physiology than the contra-lateral ear. The contra-lateral ear probably did have mild allergic changes but never developed the secondary cause or perpetuating factors. As a result that ear is not considered to be clinically abnormal. Allergic reactions also play an important role in feline otitis externa but the incidence of atopic disease is much less than in dogs and the ears appear to be less commonly affected when cats are atopic.

Pinnal lesions are often confined to the concave pinnae where the hair coat is thinnest. In many cases of atopic otitis, the inflammation will initially be limited to the pinnae, external orifice or vertical portion of the external ear canal. This may partly reflect where airborne allergens are more likely to contact and stick to the skin. Once secondary infections occur where the symptoms tend to extend down the horizontal canal and to the tympanum.

Food allergy is the second most common allergic etiology of ear disease. Over 20% of food allergy dogs start with otitis externa alone and ear disease is present in up to 80% of food allergic dogs.[6] When allergic otitis externa is suspected, and there is no other historical or physical evidence of allergic disease, then food allergy is most likely. Certain breeds, such as cocker spaniels, Chinese shar Pei and Labrador retrievers are more likely to present with food allergy manifested as otitis externa only. Also, allergic appearing otitis in young animals should raise the index of suspicion regarding food allergy. Another clinical finding that suggests food allergy is when the animal appears allergic and the inflammation begins or is more severe in the horizontal ear canal as atopic otitis tends to start more in the vertical canal. Acute severe otitis is more common in food adverse reaction cases than atopic otitis cases. In cats facial disease, pinnal and external orifice of the ear is commonly affected with food allergy. Lesions of the horizontal and deeper vertical canal are infrequent in food allergic and atopic cats. Though otitis externa (depth not described) is reported in as high as 20% of food allergic cats.[7]

Flea allergy dermatitis (FAD) has been reported to cause otitis externa in dogs however the elimination of concurrent atopic dermatitis is not generally complete. Even response to flea control does not eliminate concurrent atopic dermatitis as the flea control may have lowered the dog below its allergic or pruritic threshold. I consider FAD an uncommon cause of otitis externa. The Muse study showed flea allergy dogs have no more otitis requiring treatment than what was reported in normal dogs. The presence of otitis externa is an indication to search for an etiology other than FAD.

Secondary causes
The secondary causes do not create disease in a normal ear, they contribute to or cause pathology only in the abnormal ear. As such they occur in combination with primary causes or predisposing factors. Generally secondary causes of otitis externa are easy to eliminate once identified and when they are chronic or recurrent it is usually because primary causes or perpetuating factors have not been adequately addressed. Secondary causes in the past were often considered as primary causes or the "main" diagnosis of an ear case. (ie. Pseudomonas or Malassezia otitis) Even today many clinicians direct all their efforts at diagnosing and treatment of secondary causes. Although their treatment may be important, other causes and factors must be looked for. In some cases such as malassezia, eliminating the concurrent predisposing factor or primary disease may result in the resolution of the secondary problem.

Key Points Regarding Secondary Cause, Bacteria
Micro-organisms act as opportunists and significantly contribute to the inflammation and pathology in the compromised ear canal. Bacteria are rarely primary causes, so a diagnosis of bacterial otitis externa is rarely complete. Staphylococcus intermedius and the gram negative organisms Pseudomonas spp., Proteus spp., Escherichia coli, and Klebsiella spp. are most commonly isolated as secondary pathogens. Staphylococcus schleiferi subspecies coagulans has been reported as a pathogen in otitis cases.[8] However it is also found in a similar number of normal ears and also if found in pyoderma cases suggesting it may not be predisposed to ears. [9] Methicillin resistance is also becoming a problem in chronic otitis cases. One study showed 7 of 23 Staph. Sp isolated from the vertical ear canal were Methicillin resistant. [10] The four gram negative organisms are not routinely cultured from normal ears. Corynebacteria may also be important most often present in mixed infections and cases may not respond until it is appropriately treated. These agents usually are associated with a creamy white to yellow purulent exudate and ulcerations are common. Mixed infections are frequent occurring in about 50% of the cases based on culture.[11] In my experience it is even more frequent based on cytological findings which is controversial but certainly the initial way secondary microbial involvement is determined. Any otic cytology showing inflammatory cells should be considered abnormal and any microbe seen associated with it should be considered potentially pathogenic.
Perpetuating factors
Perpetuating factors are changes in the anatomy and physiology of the ear that occur in response to otitis externa. These factors may be subtle at first but over time can develop into the most severe component of chronic ear disease. These factors are not disease specific and are most commonly seen in chronic cases. Once present, they accentuate or permit the development of secondary causes by providing environments and microscopic niches that favor their persistence. In many cases perpetuating factors prevent the resolution of otitis externa when treatments are only directed at primary and secondary causes. They cause much frustration to clinicians for several reasons. They often result in animals presenting repetitively with different causes present at each subsequent visit. These factors can become self perpetuating and lead to progressive worsening of disease. They can become severe and end up causing the majority of symptoms exhibited by a pet or be so mild appearing that too many veterinarians as well as owners a pet and its ear canal appear normal. Yet left untreated perpetuating factors, even though primary and secondary causes are controlled or eliminated, result in recrudescence of clinical disease.

In chronic cases often more than one of these factors will be present. Standard treatments of the primary and secondary diseases present often times will not immediately eliminate the perpetuating factors. In early cases, treating the primary cause may be sufficient in controlling a case, but after the establishment of perpetuating factors treatment may need to be directed at them. The treatment for perpetuating factors is often different that what is required to control primary and secondary causes of otitis externa. Their treatment should be continued until they have resolved which may take months of continuous therapy and in some cases they are permanent and will require lifelong therapy or a surgical solution. Perpetuating factors are the most common reasons otitis externa cases require surgery.

Key Points Regarding Perpetuating Factors
In early cases, treating the primary cause may be sufficient in controlling a case, but after the establishment of perpetuating factors treatment may need to be directed at them. Treatment for the perpetuating factors should be continued until they have resolved which may take months of continuous therapy. Perpetuating factors may be the major reason for poor response to therapy, regardless of the predisposing factors and primary causes present.

Progressive pathologic responses occurring from inflammation may affect the epidermis, dermis and subsequently the adnexa and lumen of the ear canal. The epidermis becomes acanthotic and hyperkeratotic which because it is confined to the lumen of the canal and surrounded by a cartilaginous tube results in small epithelial folds. The thickened epidermis and the hyperkeratotic stratum corneum increase the keratin debris that is exfoliated into the canal lumen. The increased secretion and epithelial debris may favor the proliferation of bacteria and yeast. These changes also appear to alter the normal epithelial migration. The abnormal epithelial migration may prevent or impede the removal of the waxes, lipids, and exfoliating corneocytes and associated pathogenic bacteria. The dermis may become edematous, fibrotic and develop nodular pyogranulomas. Fibrosis is more common in end stage otitis in non-cocker breeds.

Tympanic membrane alterations occur in response to the accumulation of inflammatory debris and adjacent infection as well as in response to the buildup of exudate and debris that no longer can migrate out or pass through the occluded lumen. The abnormal tympanic membrane thickens, becomes opaque or slightly colored and loses its transparency. It may appear white, off-white, yellow, brown, or gray. The attachment to the manubrium cannot be seen. Therefore, the abnormal tympanic membrane can appear the same as impacted exudates or keratin plugs. This is a common problem situation where cases referred are diagnosed as having an abnormal tympanic membrane but the referring veterinarian has told the owner the tympanic membrane is intact. Once the tympanum ruptures the material in the external ear will enter the middle ear and otitis media likely results.

Tips for assessing the tympanic membrane
Diagnosis of otitis media is really only confirmed by demonstrating inflammation in the middle ear cavity. It is as easy to determine as otitis externa as many cases present with only symptoms of otitis externa. Evidence of inflammation to the tissues surrounding the middle ear or the inner ear usually indicates that otitis media has occurred. The presence of nerve damage, temporomandibular disease should be interpreted as indicative of otitis media. Even with otoscopic exam many cases of otitis externa may not be detected and in cases with apparently intact diseased tympanic membranes otitis media may be present. Radiology is indicated when otitis media is suspected and especially prior to surgical procedures involving the middle ear. However radiology is only helpful when it demonstrates middle ear pathology, normal radiographs do not rule out the presence of otitis media. This is generally true with computed tomography and magnetic resonance imaging as well though they are more sensitive than radiographs.
A tentative diagnosis of otitis media can be made when a ruptured tympanic membrane is seen or when radiographic changes are present in the middle ear. Otitis media can only be ruled out when a definitive normal appearing tympanic membrane is present. Palpation of the tympanic membrane with a blunt instrument has been shown to be inaccurate and causes a significant incidence of damage to the tympanic membrane. The author utilizes a technique of tube palpation and flushing to aid in the diagnosis of otitis media. This technique also may reveal false middle ear cavities. The soft tube can be used to palpate any material located at the approximate level of the tympanic membrane. The feeding tube is passed under visualization with a surgical otoscope head down the ear canal to the level where the tympanic membrane is expected to be located. In a normal ear the tip of the tube will remain visualized. Several features should be observed for:

1. Depth and location of tip of tube,
2. Loosing the view of the tip
3. Movement and retraction of membrane
4. Bruising pattern of deep tissue
5. Air bubbles that come through a damaged TM

The observation of fluid flushing from the external ear through the nares or failure to retrieve all the fluid infused along with swallowing in awake dogs indicates otitis media. Though this is an uncommon finding but is why cases having the middle ear flushed need to be anesthesized and intubated or have there head always kept angled down to try and prevent inadvertent aspiration of flushing fluids.

Ear loops or buck curettes are also helpful in diagnosing otitis media or tympanic membrane diverticulum. Normally there is a bony point where the tympanic membrane attaches to the ventral wall at the junction of the external ear canal and dorsal lateral wall of the tympanic bulla. The loop when passed over this and pulled back will catch on this bony lip. If this is done then the tympanic membrane is not located in its normal position. In general it is wiser to over diagnose otitis media than miss the diagnosis. An incorrect diagnosis of otitis media results in more aggressive treatment that is generally helpful for treating otitis externa. In contrast a missed diagnosis often leads to treatment failure.

**Predisposing factors**

Predisposing factors alone do not cause otitis externa but increase the risk of development. These factors work in conjunction with either primary causes or secondary causes to become a significant problem. In rare cases a predisposing factor may combine with a secondary cause to create disease even when no primary cause is present. The best example of this is a dog that gets water in its ear that leads to epidermal maceration or damage and then a secondary bacterial or yeast infection occurs. It is possible this is how environment, increased heat and humidity, also contribute to otitis. However in the authors experience these animals often do have a subtle but mild primary disease still present.

**Interaction Of Causes And Factors**

Whenever a case of otitis external presents the best chance for successful treatment and the prognosis is predicated on the recognition of all causes and factors present. Many combinations may be seen and rarely is only one cause present. Most cases will have at least three and often numerous causes and factors present at the same time. It is the combination of the causes and factors that result in how severe a case is and how readily it will respond to treatment. Therefore, it is important that the clinician try to recognize all components present in a case of otitis externa. In addition, the combination of factors often results in more severe symptoms. By combing predisposing or secondary factors, otitis externa may result even without a more classically recognized primary disease being present. On the other hand, primary diseases may not cause clinical signs of otitis until a secondary factor becomes established. This is commonly seen in atopic dogs without apparent clinical otitis until a secondary malassezia or bacterial otitis becomes established or an atopic dog that only develops disease when water also gets into the ear.


