TRADITION AND MODERNITY IN VETERINARY MEDICINE, 2025, vol. 10, No 1(18): 112–118

OTITIS EXTERNA IN DOGS – A REVIEW

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(Submitted: 3 July 2024; Accepted: 6 October 2024; Published: 25 June 2025)

ABSTRACT

Ear infections are one of the most common infections in dogs nowadays. Since in practice the isolation of a certain microorganism is tied to additional labor and equipment, the specific therapy necessary for the concrete causative agent is not always prescribed. Long-term treatment with inappropriate medications can lead to the development of antibiotic multi-resistance of the infectious agents. The purpose of our research was to summarize the latest information provided by various sources and present it in an accessible and easily understandable version. The following most frequently isolated pathogens are considered in the article: *Malassezia pachydermatis, Pseudomonas aeruginosa, Staphylococcus pseudintermedius, Escherichia coli, Klebsiella* spp., *Finegoldia magna, Proteus* spp. and other. Their resistance to different types of antibiotics and which are the most effective among them is shown. The clinical signs and some studies related to hereditary breed predisposition to otitis are also indicated.

Key words: otitis, dog, antibiotic resistance.

Introduction

Inflammation of the external ear is one of the most common infectious diseases in dogs. According to Miller et al. (2013) and Barnard and Foster (2017) some of the most frequently isolated microorganisms in otitis in these animals are *Malassezia pachydermatis, Pseudomonas aeruginosa, Staphylococcus pseudintermedius, Escherichia coli* and *Klebsiella* spp. The most often detected Gram-negative species is *Pseudomonas aeruginosa*. Other authors (Tang *et al*., 2020) also reported that *M. pachydermatis, S. pseudintermedius, Staphylococcus schleiferi*, together with some anaerobic bacteria such as *Finegoldia magna, Peptostreptococcus canis* and *Porphyromonas cangingivalis*, are some of the most commonly found microorganisms in otitis media in dogs nowadays.

According to De Martino *et al.* (2016) after examining 122 dogs in the Campania region of Italy, it was found that 31 of them had a fungal infection caused by *M. pachydermatis*, and the rest had a bacterial infection. The most frequently isolated species among them had been *S. pseudintermedius*. Other proved bacterial causes have turned out to be from the families *Staphylococcaceae, Pseudomonadaceae, Enterobacteriaceae, Streptococcaceae* and *Enterococcaceae*. Single isolates had been from *Micrococcus* spp., *Kocuria varians, Aerococcus viridans* and *Pasteurella pneumotropica*. Boone *et al.* (2021) have studied 59 dogs from 2007 to 2018. Ninety one percents of the patients had been affected by therapy, with 87% having problems with only one ear.

Research related to the diagnosis and therapy of these diseases in dogs is current, as the causative agents and their resistance to antimicrobial agents are changing. This prompted us to undertake the present review looking at the clinical signs, microbial causative agents and contemporary therapy of otitis externa in dogs.

Clinical signs

Dogs with long-standing otitis externa present a diagnostic challenge to the veterinary medicians because the same species is usually isolated from chronically affected ears regardless of the underlying cause. In patients with chronic otitis externa, the disease is often caused by various combinations of primary, predisposing and supporting factors. The unique therapeutic needs of each patient can be determined by careful interpretation of previous and current findings, which should be supported by additional diagnostic tests (John, 1998).

The symptoms of otitis externa are most often redness in the earlobe or in the ear canal. With more advanced development of the process, blood or scabs can be observed in the earlobe. Another very common sign is an unpleasant and unusual smell from the ear, as well as itching in the ear area. Also common clinical signs are swelling around the ear or ear canal and presence of black or yellowish discharge in it. Behaviorally, the dog holds one ear lower than the other and rubs it against various surfaces such as carpet, floor, etc. (Griffin, 2023). Inflammation of the external ear can occur as a result of the spread of infection from the external ear canal or after penetration of a foreign body into the eardrum. More than half of dogs with long-term, recurrent inflammation of the outer ear develop otitis media. Clinical signs are similar to those of otitis externa. Shaking of the head, scratching of the ear, rubbing of the affected ear on the floor, turning of the head to the affected side, and loss of balance are often seen. The ear is usually painful and may have discharge and inflammatory changes in the ear canal. Recurrent otitis externa can be indicative of the possible development of otitis media (Moriello, 2018 b).

Etiological agents

The investigations of Lilenbaum *et al.* (2000) performed in 65 affected untreated dogs showed that the most widespread causative agents of otitis media belong to the group of coagulase-negative bacteria. The most commonly isolated staphylococcal species had been *S. epidermidis* and *S. aureus*. Other common members of the family had been *S. simulans, S. haemolyticus, S. saprophyticus* and *S. intermedius.*

The studies of Hariharan *et al.* (2006) showed that the most common isolates from infected ears of dogs are the species *Staphylococcus intermedius* and *Pseudomonas aeruginosa*. The next most frequent causative agents are *Streptococcus* spp., *Proteus* spp., *Escherichia coli* and *Enterococcus* spp. Other less common causes of otitis are *Pasteurella* spp., *Klebsiella* spp., *Citrobacter* spp. and *Enterobacter* spp. According to Jo *et al.* (2012) the most common causes of otitis in dogs are *Enterococcus faecalis, Staphylococcus aureus, S. pseudointermedius, E. faecium, E. aviu* and, *Streptococcus canis*, presented in order of frequency.

According to Hader's (2016) analysis, which included 8,896 ear swab samples from dogs that had been cultured in 2016 as part of routine diagnostics, 19% of the samples did not show any bacterial growth (negative cultures). Microorganisms had been detected in 81% of samples (positive cultures). Of these, pure cultures had been obtained in 32.5% of cases, mixed cultures – in 31.7% and only physiological microbiome – in 16.8% of cases. The most common bacterium in culture-positive samples had been *S. pseudintermedius* (38.7%). Almost half of them had been found in pure culture. Beta-hemolytic streptococci had been found in 12.7% of the cultures, *P. aeruginosa* – in 12.3% and other pathogens – in 11.9% of the examined samples. They are followed by *E. coli* with 6%, *P. mirabilis* with 5.1% and enterococci with 3.8%. Of the total number of samples, 78% had been examined bacteriologically and mycologically and 22% – only bacteriologically. Sixty-two whole and eight percent (62.8%) of mycologically tested samples had been culturally positive and 37.2% have turned out to be negative at cultivation. *M. pachydermatis* has represented the

largest proportion of mycologically positive samples – 98.6%. *Candida* spp. and molds are found only in isolated cases.

Bajwa (2019) reported that the most common causative agents of canine otitis belong to the genus *Staphylococcus*, as in previous decades. Other not infrequently isolated species are representatives of the genera *Pseudomonas, Proteus, Enterococcus, Streptococcus* and *Corynebacterium*. *Malassezia* spp. is also among the most common isolates. It should be borne in mind that the species of the genera *Staphylococcus* and *Pseudomonas* form a biofilm, because of which treatment may not be successful, despite the choice of the correct antibiotic. Álvaro *et al.* (2019) also reported that the most frequently isolated bacteria causing otitis in dogs are *Staphylococcus* spp. (52.3%). *Proteus* spp. are next in order of isolation frequency. (17.2%), as well as *P. aeruginosa* (9.5%).

Recently, Harvey (2022) has conducted a study among 257 dogs, of which 128 healthy and 129 animals suffering from otitis. The purpose of the study had been to determine the bacterial and fungal composition of the microflora in healthy and affected ears by PCR method. The author reported that *Cutibacterium acnes, S. pseudintermedius* and *Streptococcus* spp. dominate in healthy ears. In general, however, a greater microbial diversity is observed in healthy ears than in diseased ones. According to the research of Secker *et al.* (2023) different microorganisms had been isolated from 78.3% of affected dog ears. Of these, 62.78% of the taken samples have shown bacterial growth, 8.5% – fungal and 7% had been with mixed bacterial and fungal infection. The most common microorganisms identified are *M. pachydermatis, S. pseudintermedius, S. schleiferi* and *Finegoldia magna*.

Hereditary predisposition

Otitis is a very common type of inflammation in dogs and if left untreated can lead to complications and deafness. Certain dog breeds are more prone to developing this type of infection due to their physical characteristics, such as long, furry or floppy ears. This is due to the fact that ears with such a morphology create favorable conditions for the development of microorganisms (Griffin, 2023). Some of these anatomically predisposed breeds are the Golden Retriever, Shih Tzu, Bloodhound, Basset Hound, Cocker Spaniel, that have large, long and drooping ears, which often results in moisture retention. The Coonhound is a breed that has an affinity for water activities, which is a major predisposing factor for moisture to enter and retain in the ear canal. For this reason, such breeds should take extra care to keep their ears clean and dry (Griffin, 2023).

O'Neill *et al.* (2021) pointed out that the breeds with predominant otitis are Basset Hound (28.8% of all affected), Char-Pey (17.76%), Labradoodle (17.71%), Beagle (14.72%), Golden Retriever (14.11%) and Cockapoo (12.97%). The breeds with the lowest rate of otitis cases are Jack Russell Terriers (3.53%), Border Collies (2.30%) and Chihuahuas (1.26%). According to Ferreira Júnior *et al.* (2019) of 148 dogs that have developed otitis externa, 51.4% are male and 48.6% are female. Cases are most common among dogs over 7 years of age. The breed with the highest number of affected individuals is the Poodle (14.84%, 22 out of 148).

Therapy and prevention

The five most frequently isolated microorganisms from dogs with otitis according to Barriuso *et al.* (2021) are *Staphylococcus* spp. (in 58.32% of the cases), *Proteus* spp. (14.58%), *E. coli* (9.90%) and *Pseudomonas* spp. (8.33%). The four most effective antibiotics for otitis therapy in affected patients were tobramycin (26.70%), gentamicin (25.52%), neomycin (24.47%) and amikacin (in 13.29% of the cases), although aminoglycosides can be ototoxic and their use in contact with the tympanic membrane should be be restricted. Quinolones also showed significant

antimicrobial activity, although 29.17% of the isolated microorganisms showed resistance to ciprofloxacin and 29.69% – to enrofloxacin. According to Ferreira Júnior *et al.* (2019) resistance to more than three groups of antibiotics occurred most frequently in *P. aeruginosa* (61.9%) and *Proteus* spp. (39.47%). Their study showed that tobramycin and ciprofloxacin rank among the most effective topical agents.

The investigations of Kwon *et al.* (2022) showed that *P. mirabilis* is most often resistant *in vitro* to cefazolin (75%), trimethoprim-sulfamethoxazole (72%), chloramphenicol (72%), amoxicillin-clavulanate (63%), ampicillin (59%), cefepime (56%), ciprofloxacin (53%), aztreonam (50%), ceftazidime avibactam (50%), gentamicin (22%) and amikacin (16%). Among the isolates, 75% are found to be multi-resistant to antibiotics. *P. mirabilis* is found to have very pronounced multiple resistance. Although the exact cause is unknown, long-term antibiotic use is thought to be a major factor in the development of resistance.

According to Murugan (2016) *Staphylococcus* spp. showed the highest sensitivity in antibioticograms to amoxicillin-clavulanic acid (94.23%) and the lowest sensitivity to penicillin G (11.53%). *Pseudomonas* spp. are most sensitive to amoxicillin-clavulanic acid (86.95%), and *Proteus* sp. and *Klebseilla* spp. showed 100% sensitivity to cefotaxime, but complete resistance to penicillin G and amikacin is observed in the Gram-negative bacteria isolated. *E. coli* is found to be most sensitive to cefotaxime (88.88%) and least sensitive to penicillin G. The isolated representatives of the genus *Enterococcus* have demonstrated significant resistance to erythromycin (45.8%), rifampin (34.4%), ciprofloxacin (27.1%), levofloxacin (25.0%), doxycycline (19.8%), linezolid (13.5%) and chloramphenicol (10.4%). A total of 43 *P. aeruginosa* strains are isolated from 170 ear swab samples. They are subjected to disk diffusion susceptibility testing and the resistance profiles of the strains are found to be as follows: 100% to trimethoprim-sulfamethoxazole, 93.02% to doxycycline, 79.06% to neomycin, 58.13% to oxytetracycline, 34.88% to enrofloxacin, 25.58% to tobramycin, 20.93% to gentamicin, 13.95% to ciprofloxacin, 9.3% to amikacin and 4.65% to polymixin.

The results of the study done by Hariharan *et al.* (2006) showed that 90% of the isolated agents are sensitive to gentamicin. Eighty-five percent of *P. aeruginosa* strains are sensitive to gentamicin, and 100% to polymyxin B. Among the other representatives, the greatest sensitivity to amoxicillin-clavulanic acid is observed. The antibiotics amikacin, amoxicillin-clavulanic acid, ampicillin, cephalexin, chloramphenicol, clindamycin and doxycycline are included in the study, as well as enrofloxacin, erythromycin, fusidic acid, gentamicin, penicillin, and trimethoprim-sulfate (TMS). All Gram-positive bacteria tested have shown sensitivity to amoxicillin-clavulanic acid. Conversely, none of these drugs is effective against all Gram-negative isolates tested. The antibiotic amikacin is found to be most effective against most strains of *P. aeruginosa*, with only 11% resistance, and enrofloxacin is effective against *E. coli* and *Proteus* spp., with only 2% resistance.

The analysis by Hader (2016) showed that an increasing percentage of *P. aeruginosa* isolates become resistant to marbofloxacin. Resistance to orbifloxacin has increased in *P. aeruginosa, P. mirabilis* and *E. coli*. Overall, a favorable level of resistance can still be observed for both agents. Gentamicin and neomycin are aminoglycoside antibiotics, therefore both agents have a very similar pattern of resistance develfpment. The level of sensitivity of Gram-negative bacteria to them is still good. However, beta-hemolytic streptococci and enterococci show natural resistance to aminoglycosides. Chloramphenicol, thiamphenicol and florfenicol belong to the group of amfenicol antibiotics. They are bacteriostatic, but have a very broad spectrum of action. However, in addition to *P. aeruginosa* isolates, *S. pseudintermedius* and *P. mirabilis* also show a higher percentage of

resistant to them strains (Hader, 2016). The polypeptide antibiotic polymyxin B is effective against many Gram-negative bacteria. Gram-positive microorganisms are mostly resistant. In an analysis performed by Hader (2016), Gram-negative pathogens have shown a high percentage of resistant isolates (30% and above). All Gram-positive bacterial isolates are resistant.

Lilenbaum *et al.* (2000) performed susceptibility tests for penicillin G, gentamicin, oxacillin, tetracycline, trimethoprim-sulfamethoxazole, streptomycin, ampicillin and rifampin. They reported that antibiotic resistance is common, with 90.9% of isolates showing resistance to at least one medicine. The most active antimicrobial agents against staphylococci isolated from dogs with otitis externa are found to be rifampin and oxacillin. Multidrug resistance is a common problem, and one strain of *S. haemolyticus* had been resistant to all antimicrobial agents tested. Resistance to three or more different drugs is a common finding observed in 16 strains (36.4% of those tested) of both coagulase-positive and coagulase-negative staphylococci. The study highlights the occurrence of cases of otitis externa caused by coagulase-negative strains of staphylococci and points out the need for isolation from ear canal swabs of the causative agents in bacterial culture with species identification and *in vitro* susceptibility testing in order to select the appropriate antimicrobial agents with a view to successful therapy and avoiding the development of resistance.

Henneveld *et al.* (2012) conducted a retrospective study on the role of *Corynebacterium* spp. in canine otitis media and treatment options. The authors have isolated members of this genus from 79 of a total of 81 samples that had a mixed microbiome. The role of corynebacteria in the development of otitis is not yet fully understood, as they usually disappear with treatment against the other pathogens even when it is established that *Corynebacterium* spp. are resistant to the particular antibiotic. Two of the 81 cultures tested had been suspicious for pathogenic corynebacteria. Fifty-four of the isolates are tested for antibiotic susceptibility. Most representatives have shown low resistance to chloramphenicol (98%), amikacin (93%), tetracycline (93%), gentamicin (85%) and enrofloxacin (59%). As a result of their observations, the authors recommended treatment primarily with gentamicin and enrofloxacin.

According to Woodward (2020), *S. intermedius* and *P. aeruginosa* are increasingly causing difficult-to-treat, long-lasting otitis media due to the development of multi-resistance to commonly used antibiotics. These infections are often chronic (lasting more than 2 months) and associated with purulent exudation, severe epithelial lesions, pain and swelling of the ear canal. Successful treatment is multi-component and should include the following steps: determining the primary cause of inflammation and prescribing therapy against it, removing the exudate from the ear canal, diagnosing and treating the accompanying inflammation of the middle ear, if any, choosing an appropriate antibiotic after laboratory examination and its use in effective doses for a sufficient time, as well as not to stop the treatment until the patient is completely cured (weeks or months).

Moriello (2018 a) suggested that as additional procedures to the treatment of ear inflammation, the hair in the animal's ears should be removed so that, when applied topically, the drugs can create a thin film and be more effective. In more severe cases, the combined use of antimicrobials, antifungals, and corticosteroids is recommended to reduce swelling, pain, and glandular secretion. It is emphasized that the treatment should be continued until the infection is completely cured. Prophylactic activities that can be done to prevent such infections are regular cleaning and drying of the ears. Avoiding getting them wet when bathing is important. Prophylactic removal of hairs from the ear canal can also be undertaken, but if there is no indication of a predisposition to inflammation, it is better to avoid this, because if after cutting them they remain in the ear canal, the hairs can lead to irritation of the channel. The sooner measures are taken for

adequate treatment, the better are the prospects for a good outcome. If there is an inner ear infection, long-term antibiotic therapy is necessary, but some neurological problems (lack of coordination, head tilt, deafness, drooping lips, or inability to blink) may remain for life. Antibiotics given orally or by injection may be prescribed for 3 to 6 weeks if an inner ear infection is present. Small eardrum perforations usually heal in 2 to 3 weeks. At the same time, inflammation of the external ear canal will be healed. In addition to antibiotic therapy, anti-inflammatory drugs may be prescribed during the first week of treatment to reduce pain and inflammatory changes in nearby nerves. In case of chronic otitis media, surgery and drainage may be required (Moriello, 2018b).

Conclusion

Otitis (inflammation of the outer ear) is an increasingly common problem in dogs. It has been shown that there is a breed predisposition to it, with floppy-eared and long-eared breeds being more susceptible, as well as those that like to swim. The pathogens *Stphylococcus* spp., *Proteus* spp., *E. coli*, *Pseudomonas* spp. and *Enterococcus* spp. are most often isolated from the studied ear materials. In recent years, treatment with amikacin, neomycin, gentamicin, tobramycin, ciprofloxacin or enrofloxacin has been most effective. To penicillin G and trimethoprim-sulfamethoxazole, resistance can reach even 100% and are not effective for treatment. Amikacin is suitable for the treatment of otitis caused mainly by Gram-positive bacteria. The best results gives the local treatment of the ear.

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