

# The Efficacy of Prophylactic Topical Antibiotics in Preventing Otitis Externa Following Trauma Induced by Cerumen Removal

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## Abstract

Cerumen impaction compels the removal of ear wax which may lead to otitis externa, an infection of the outer ear, due to trauma to the ear canal and loss of cerumen, which has antimicrobial properties. Current treatment guidelines to prevent otitis externa do not include prophylactic topical antibiotics. This review will determine the efficacy of using prophylactic topical antibiotics to prevent otitis externa following trauma induced by cerumen removal for impaction. A comprehensive review of treatment guidelines, existing literature, and clinical trials related to otitis externa, cerumen impaction, and prophylactic antibiotics was done utilizing PubMed and Google Scholar. Data on the effectiveness of the use of topical antibiotics as a preventative measure and the infection rates after cerumen removal were analyzed. Prophylactic topical antibiotics may reduce infection rates following a cerumen removal procedure. Their efficacy has been proven in other ototic procedures, but there is no data revealing effectiveness of prophylactic antibiotics for cerumen removal. Due to the risk of further complications, higher-risk populations such as those who are immunocompromised, may require the extra support of antibiotics. Their use is indicated during prolonged aural irrigation. However, the routine use of antibiotics also raises concerns about adverse effects and antibiotic resistance. The use of prophylactic antibiotics following cerumen removal may offer benefits in preventing otitis externa in vulnerable populations, but further research is needed to establish clear guidelines. Randomized clinical trials are necessary to determine the benefits and risks of using preventative antibiotics in medical practice.

## 1. INTRODUCTION

Acute otitis externa, commonly referred to as "swimmer's ear," is often the result of acute bacterial infections. Common causative pathogens include *Pseudomonas aeruginosa* and *Staphylococcus aureus*<sup>1</sup>. It commonly presents with pruritis, edema, drainage and discomfort. This pathologic process can occur at any time in a person's lifetime, yet incidence is highest in the pediatric population. An estimated 19% incidence in ambulatory visits for ages 5 to 91. There are several risk factors that increase the chance of otitis externa occurring. These include increased moisture in the ear, seen in swimmers, trauma to the ear canal, use of hearing aids, and loss of protective cerumen<sup>2</sup>. This reveals that cerumen has important physiologic functions against otitis externa that need to be explored

further. There are many ways to approach treating acute otitis externa depending on the severity of infection. These include antibiotic drops as well as non-antibiotic antiseptic recommendations. Topical antibiotics, such as fluoroquinolones with broad coverage, remain the recommendation for moderate cases of otitis externa. Ear drops or topical agents were seen to target the ear canal best and as effective as oral antibiotic treatment<sup>3</sup>. In mild cases, antiseptics like acetic acid were as efficacious as antibiotics<sup>4</sup>. Severe cases of otitis externa are best treated with combination therapy of an antibiotic topical and a steroid. The combination has been shown to reduce swelling and improve patient comfort<sup>5</sup>.

With several options for treatment, clinical judgement plays an important role in patient care

and management of otitis externa. If not adequately treated, this condition can become chronic, therefore early management and preventative measures are necessary.

## **2. CERUMEN FUNCTION**

Cerumen, commonly referred to as “earwax,” has some important functions within the ear and canal, but if overproduced it is also known to cause obstruction. Cerumen is a mixture of ceruminous and sebaceous gland secretions, along with sloughed off squamous epithelium<sup>6</sup>. This is a normal part of the external auditory ear canal. It functions to lubricate, provide a barrier, and trap dirt or debris before entering the internal ear<sup>7</sup>. Cerumen further protects against infection, not only as a physical barrier, but also by lowering the pH of the canal and making the environment too acidic for bacterial growth<sup>8</sup>. In a laboratory study, cerumen showed a decrease in growth of *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Candida albicans* on nutrient agar, proving to have some antimicrobial and antifungal properties<sup>9</sup>. With the use of immunochemistry studies, antimicrobial proteins such as lysosomes and beta-defensins have been found in ceruminous glands, composing part of the secretory function of cerumen<sup>10</sup>. All this information points to the importance of cerumen in the protection of the ear against infections and if the normal processes outlined here are disrupted, the development of otitis externa may occur.

## **3. CERUMEN IMPACTION AND TREATMENT**

Cerumen impaction occurs when there is an accumulation of cerumen that causes symptoms such as pain or discomfort, dizziness, tinnitus, or cough. Impaction can also lead to hearing impairment especially in the elderly or those with cognitive difficulties<sup>11</sup>. Any of these symptoms can cause a decreased quality of life especially if the impaction is severe enough to cause conductive hearing loss, which can lead to difficulties communicating with others. Other symptoms such as the feeling of fullness in the ear, itching, discharge, and odor are also possible<sup>12</sup>. The discharge or odor may be due to the buildup of earwax or a possible infection. Impaction can also alter hearing aid function, which in turn can cause hearing loss<sup>12</sup>. This occurs when ear wax clogs the devices. A patient can also be diagnosed with cerumen impaction if the accumulation prevents completion of an otoscopic examination, which includes the visualization of the external auditory meatus,

tympanic membrane, and the vestibulocochlear system<sup>8</sup>. Delay of thorough examination of the ear can lead to the potential misdiagnosis of other problems such as a tumor, tympanic membrane perforation, or infection.

When there is a failure of the ear’s self-cleaning mechanism, cerumen buildup or impaction occurs. Normally, cerumen is removed from the external auditory meatus through the migration of the epithelial lining, which is aided by the movement of the jaw<sup>13</sup>. This process, however, can be disrupted due to the packing of cerumen deep into the ear canal<sup>14</sup>. Hearing aids, ear plugs, headphones, and the use of cotton tipped swabs can cause further obstruction. The variations in the anatomy of the auditory meatus can also block the migration of cerumen<sup>14</sup>. The size and shape of the canal may block expulsion. The composition of the cerumen itself is also important to note. Age related changes such as the atrophy of cerumen glands, can result in drier cerumen, which leads to a decreased ability of the ear’s normal self-cleaning mechanism to remove ear wax<sup>15</sup>. These factors put the elderly population at higher risk for cerumen impaction. Cerumen impaction commonly affects older adults, especially those living in nursing homes, those with intellectual disabilities, and children<sup>16</sup>. Removal of an impaction by a physician is more likely to be required in an individual who cannot communicate that there is a problem. An individual with dementia or someone who is non-verbal may not be able to relay the fact that they are experiencing otalgia or hearing loss<sup>16</sup>. In fact, their dementia may be misdiagnosed due to their reduced ability to communicate. A study done on the Special Olympics, found that a third of the athletes who failed their hearing screening test had conductive hearing loss, which is most commonly caused by cerumen impaction<sup>17</sup>. Hearing loss can disrupt normal speech development in children with Down Syndrome<sup>17</sup>. These children are more prone to cerumen impaction due to differences in the anatomy of the nasopharynx, weakness of the tensor veli palatini muscles, and the decreased size of the Eustachian tube<sup>17, 18</sup>. Cerumen impaction can decrease the quality of life in these individuals, especially when undiagnosed.

Impaction can be treated with cerumenolytic agents, irrigation or manual removal. Cerumenolytic agents are topical therapies that are either water-based, oil-based, or neither<sup>8</sup>. The use of this treatment is more cost effective for the patient and is less invasive leading to fewer side

effects. Aural irrigation is an effective way to remove cerumen and is done using a large syringe with water that has a temperature close to body temperature<sup>8</sup>. Electronic irrigators may also be used; however, it is important to keep them at a lower pressure setting to avoid perforating the tympanic membrane. Irrigation can also lead to trauma of the epithelial lining of the ear canal, which increases the risk of bacterial infection<sup>19</sup>. It is important that the irrigation be done by a trained individual to reduce risk of trauma and infection. Manual removal is done on a cooperative patient with a cerumen curette and an otoscope for direct visualization<sup>20</sup>. It is important that the patient holds still during this procedure to avoid potential injury presenting as bleeding, pain, trauma, or hearing loss<sup>20</sup>.

The removal of cerumen typically begins with the application of cerumenolytic agents to soften or dissolve the earwax, followed by irrigation to aid its extraction. The final option that can be used is manual removal, and since the ear canal is not exposed to moisture during this procedure, there is a decreased risk of infection when compared with irrigation<sup>20</sup>. However, there is a risk of trauma, which can predispose the ear canal to infection.

#### **4. OTITIS EXTERNA FOLLOWING CERUMEN REMOVAL**

Although cerumen removal is a generally routine and safe procedure, it certainly can pose a risk for the development of otitis externa (OE). It is estimated that the incidence of OE following cerumen removal is approximately 3% which can translate to around 69,000 cases annually in England and Wales<sup>21</sup>. Aural irrigation or manual removal can cause trauma to the external auditory canal, which when coupled with the absence of the protective cerumen, allows for an environment that is susceptible to bacterial infection<sup>14</sup>. The extent of the susceptibility, however, depends on patient-specific factors such as pre-existing dermatological conditions or history of OE that may compromise the skin barrier.

The mechanism of injury depends on the method of cerumen removal used. Aural irrigation involves flushing the ear canal using water or saline to dislodge the cerumen. However, if increased water pressure or non-sterile fluids are employed, this can lead to microscopic tears or abrasions to the epithelial lining of the ear<sup>14</sup>. pH is a protective measure of the ear canal that can also be manipulated. If the naturally acidic

environment is disrupted due to added moisture, the ear can be left vulnerable to bacterial or fungal colonization<sup>22</sup>. Manual removal of cerumen using forceps of a curette can also cause injury if excess force by the practitioner is used or due to unanticipated movements by the patient<sup>23</sup>. This, too, can cause abrasions to the epithelial lining of the ear leaving it susceptible to OE by *Pseudomonas aeruginosa* or *Staphylococcus aureus*<sup>24</sup>. Furthermore, practitioners without proper training can exacerbate the possibility of injuries.

An inflammatory response results due to the damage done to the epithelial lining leading to erythema, edema, and increased vascular permeability<sup>25</sup>. The loss of cerumen, as mentioned, and the local inflammation allow pathogens to attach, colonize, and proliferate. Through the progression of the infection, patients may describe pain, purulent discharge, muffled hearing, and sensitivity to touch<sup>26</sup>. Most cases of OE infections are resolved promptly with treatment; however, if untreated, the infection may advance, leading to complications such as chronic OE or cellulitis<sup>27</sup>. Early intervention proves to be essential in preventing such complications and recurrent infections, especially in vulnerable groups, such as children.

Many prophylactic strategies have been studied to diminish the risk of OE following cerumen removal. One of the most effective preventative methods is using 2% acetic acid drops to reacidify the ear post-cerumen removal<sup>27</sup>. As discussed, the external auditory canal's naturally acidic environment works to limit bacterial or fungal colonization, so medical practitioners can use the acidic drops to provide a protective barrier to minimize the risk of OE after cerumen removal. Another standard prophylactic measure that continues to be studied is the use of fluoroquinolone and combination ear drops. Chu et al. studied the effectiveness of an otic solution containing ciprofloxacin (0.3%) plus fluocinolone acetonide (0.025%) finding that the combination was superior at attacking pathogens in acute OE than ciprofloxacin or fluocinolone alone ( $P = 0.04$  and  $P = 0.01$ , respectively)<sup>28</sup>. Therefore, a combination antibiotic solution may be a potential method for the prevention and treatment of OE following cerumen removal<sup>29</sup>. A potential obstacle to consider is the increasing antibiotic resistance due to frequent use of fluoroquinolones, prompting researchers to find alternative combinations with equivalent efficacy.

Preventative methods are also key in minimizing trauma and risk of infection. Aural irrigation should be performed using controlled pressure as well as body temperature, and sterile water<sup>14</sup>. If manual removal will be conducted, the practitioner should use an otoscope to have direct visualization and they should educate the patient to remain still to avoid injury to the ear canal<sup>11</sup>. Other strategies include advising patients to avoid using foreign objects such as cotton swabs to remove cerumen as it can increase the risk of impaction and microscopic tears which ultimately enhance the risk of OE<sup>30</sup>. Proper patient education by practitioners in out-patient clinics may help to further reduce many preventable cases of otitis externa.

### **5. PROPHYLACTIC ANTIBIOTIC TREATMENT FOR CERUMEN REMOVAL**

Prophylactic antimicrobial therapy refers to the use of antimicrobial agents before sterile anatomy becomes contaminated, with the goal of minimizing the microbial load during surgery<sup>31</sup>. This can similarly be applied to outpatient procedures such as cerumen removal. While clinicians utilize aseptic technique for cerumen removal procedures, there is always the risk of the introduction of trauma as seen in a randomized trial comparing aural irrigation and manual removal<sup>32</sup>. Individuals who are at a higher risk for otitis externa or malignant otitis externa may benefit from prophylactic antibiotics for cerumen removal.

Those at risk include the immunocompromised or diabetic<sup>29</sup>. Medical practitioners should use their best judgement before deciding if prophylaxis with antibiotics is necessary by considering the following: determine if there was trauma or a potential route of infection such as trapped moisture following aural irrigation or significant disruption to microbial flora, the immunocompetence of the patient, and the risk of antibiotic resistance<sup>33</sup>. Currently, no clinical trials exist that show the effectiveness or necessity of using these antibiotics. However, with the possibility of trauma to the ear canal, those with a weakened immune system may require extra support.

During prolonged aural irrigation, it is recommended that patients be given topical steroid drops with ciprofloxacin, a fluoroquinolone antibiotic, or dexamethasone. These can be given for a few days after the procedure<sup>33</sup>. This is especially important to consider for high-risk patients as defined in the

paragraph above. These antibiotics may be given due to suspected perforation or retained fluid; acetic acid ear drops may also be helpful for immunocompromised patients<sup>34</sup>. The patient must also be advised to avoid the entry of water into the ear canal<sup>34</sup>. The combination of injury, water, and a weakened immune system can allow for pathogenesis of bacteria. If left untreated, this can lead to complications such as otitis externa or, in severe cases, malignant otitis externa, which may require systemic antibiotic therapy<sup>35</sup>. Proper post-procedural care is essential to minimizing the risk of infection and ensuring optimal healing.

### **6. CLINICAL IMPLICATIONS AND OUTCOMES**

It is important to recognize the clinical implications that may arise from using antibiotics prophylactically. Consider that a retrospective analysis found no evidence of otitis externa as a complication of manual cerumen removal when performed by otolaryngologists using clean technique<sup>23</sup>. This implies that routine prophylactic use of topical antibiotics may not be necessary and also suggests that the use of clean and aseptic techniques are effective in preventing infections. Furthermore, the clinical practice guidelines from both the The American Academy of Family Physicians and the American Academy of Otolaryngology-Head and Neck Surgery do not specifically address the use of prophylactic antibiotics for this purpose<sup>8</sup>. However, there have been studies noting that both prophylactic use as well as systemic antibiotics are indicated and are effective.

A systematic review by Di Traglia et al found that antiseptic, steroid, and antibiotic agents are all effective for the management of acute otitis externa<sup>4</sup>. Further, the clinical outcomes and implications of using topical antibiotics specifically, are well documented. Topical antibiotics are highly effective, as shown with clinical cure rates ranging from 65-90% within 7 to 10 days of initiating therapy<sup>36, 5</sup>. The current conclusions show that using topical antibiotics is effective for treatment of OE, yet, they have not shown how prophylactic use may benefit higher-risk populations.

In similar cases, prophylactic use of topical antibiotics has been found to be useful. For example, when managing the insertion of tympanostomy tubes in children, a Cochrane review noted that the use of prophylactic antibiotics reduced postoperative ear discharge<sup>37</sup>. Another review noted that topical antimicrobials

reduced the relative risk of a surgical site infection in head and neck surgery by 0.44 (95% CI, 0.28-0.68; I<sup>2</sup> = 0.0%)<sup>38</sup>. Finally, another review showed that a reduction in surgical site infection was appreciated when using topical antibiotics on surgical sites that were closed by primary intention (RR 0.61, 95% CI 0.42 to 0.87)<sup>39</sup>. These studies illustrate that prophylactic use may still be indicated in select instances of otitis externa.

Since reduced infection rates are appreciated in similar prophylactic cases, it is important to recognize the benefit that low-cost prophylactic antibiotic use may provide. Improvement of quality of life is noted in numerous studies of both otitis media and otitis externa. There was a positive correlation between reported levels of anxiety, depression, and stress in patients with chronic otitis media<sup>40</sup>. Furthermore, caregivers and children with OM also experienced significant reductions in health-related quality of life<sup>41</sup>. The improvement in quality of life that includes the emotional wellbeing of the patient and caregivers highlights the broader impact that chronic infections can have on a patient. Understanding these outcomes emphasizes the importance of preventative strategies in reducing overall quality of life and burden of disease.

In terms of patient populations to receive prophylactic use of antibiotics, patients who are immunocompromised and have conditions that impair host defenses such as diabetes or HIV infection would seem to benefit the most. The patients within these populations are at a higher risk for complications and may have increased morbidity if the infection spreads beyond the ear canal<sup>42</sup>. Moreover, HIV-infected populations have increased risk of OE and other severe infections, especially those who have low CD4 counts<sup>43</sup>. Patients with diabetes are another group that may benefit from prophylactic treatment, as well as systemic antibiotics for OE, given the higher risk of complications<sup>44</sup>. Thus it is very important to identify these individuals within these populations and treat them according to current clinical guidelines. This tailored approach aims to prevent severe infections and improve clinical outcomes in these high-risk groups.

## **7. CHALLENGES AND LIMITATIONS**

Ear drop antibiotics are used as the front line defense in treating bacterial otitis externa. Oral antibiotics are also recommended for patients with diabetes, HIV/AIDS, malignant otitis

externa, or otitis media co-infection<sup>45</sup>. Antibiotics are necessary for the adequate and effective removal of dysbiosis of pathogenic bacterial overgrowth, allowing the normal flora to heal the infection. However, the overuse of these medications can lead to the generation of antibiotic resistance. A study done by Nawaz et al. showed isolated bacteria from the outer ear increasing in resistance over the last 10 years.

The two most common pathogenic agents, *S. aureus* and *P. aeruginosa* became over 70% and 40% resistant to penicillin and amoxicillin respectively during the time period analyzed<sup>46</sup>. Overprescription of drugs exacerbates this problem, allowing resistance to spread and resistant bacteria to thrive. Increased antibiotic resistance of these two pathogens would disrupt the balance of bacteria in the inner ear which could lead to increased susceptibility to otitis externa infections and make it more difficult to treat these infections in the future. However, oral antibiotics have been shown to be necessary to control the infection in vulnerable populations.

The biggest potential harm of utilizing prophylactic antibiotics after a cerumen removal is antibiotic resistance and disruption of normal flora after antibiotic use. Antibiotics nonspecifically kill bacteria and allow other, possibly antibiotic resistant bacteria to replicate. Additionally, there is very limited data on prophylactic antibiotic treatment following a traumatic cerumen removal and the guidelines do not indicate any benefit of such treatment<sup>24</sup>. However, this may be due to the small number of such incidents reported. In such cases, physicians use their best judgement and may recommend continuation of antibiotic ear drops as well as follow the guidelines for otitis externa but further research and conclusions ought to be met to determine best practices for this specific condition.

## **8. FUTURE DIRECTIONS**

Around 1 in every 1000 cerumen impaction removals face major complications, such as tympanic membrane rupture or vertigo<sup>47</sup>. Manipulating the ear and introducing non-sterile foreign tools into the areas could lead to formation of otitis externa, especially in immunocompromised or diabetic populations. Randomized controlled trials could address this by comparing outcomes between immunocompetent and immunocompromised patients who follow current guidelines and those who receive prophylactic antibiotics post-

procedure. However, in the immunocompetent population, there is limited evidence supporting an increased likelihood of otitis externa following a cerumen disimpaction when proper sterilization and technique is employed<sup>23</sup>. Observational studies of current treatment involving immunocompromised individuals could also give guidance for future studies, specifically looking at which situations preventative antibiotics are used after cerumen removal. The studies mentioned above would elucidate a standard of care for prophylactic antibiotics for at risk individuals, which could greatly aid in improving patient outcomes and quality of life.

## 9. CONCLUSION

Cerumen plays a critical protective role in the ear, acting as a barrier against infections. However, its overproduction can lead to impaction, which can cause symptoms such as pain and hearing loss. The removal of cerumen, whether through irrigation or manual extraction, can increase the risk of otitis externa by disrupting the ear canal's natural defenses. Although routine cerumen removal is a safe and clean procedure, improper technique or excessive trauma can predispose patients to otitis externa, particularly those in high-risk populations such as the elderly, immunocompromised individuals, and children with anatomical differences.

Prophylactic antibiotics following cerumen removal remains a debated topic, with limited clinical evidence supporting their routine use, though they may be beneficial in certain high-risk groups. Prophylactic antibiotics have been found useful in other ototic procedures such as the insertion of tympanostomy tubes, which may indicate effectiveness after cerumen removal. Overuse of antibiotics raises concerns about resistance, highlighting the need for considerations regarding their use. Preventative strategies, such as maintaining proper technique during cerumen removal, using acidifying ear drops post-procedure, and educating patients on proper ear hygiene, are crucial in minimizing infection risk. Future research should focus on high-risk populations to determine whether prophylactic antibiotic use is warranted and standardized guidelines should be implemented for specific cases. Ultimately, a balanced approach that prioritizes evidence-based interventions and individualized patient care will optimize outcomes and reduce unnecessary complications associated with cerumen removal.

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