Earache

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OBJECTIVES

This article is designed to assist emergency physicians and other emergency department providers understand the following:

- The wide variety of conditions that may cause earache
- The principles of diagnosis of acute otitis media (AOM) and otitis media with effusion (OME)

KEYWORDS

- Earache
- Otitis
- Mastoiditis
- Tympanic membrane rupture
- Cerumen impaction
- Foreign body

KEY POINTS

- A great variety of conditions, including some distant from the ear itself, may cause earache.
- Acute otitis media is diagnosed by a combination of signs and symptoms of acute otitis media (eg, fever, earache); and evidence of a middle ear effusion (fluid seen behind tympanic membrane, decreased mobility with insufflation by pneumatic otoscopy, opacity or discoloration of tympanic membrane not because of scarring, or evidence from tympanometry or spectral gradient acoustic reflectometry) but not simple redness of the tympanic membrane.
- Treating acute otitis media with antibiotics is controversial, with greatly varying yet prestigious guidelines of which patients to treat.
- Despite resistant organisms, high-dose amoxicillin, because of high concentrations in the middle ear, is still the drug of choice for acute otitis media.
- Malignant otitis externa is suspected in immunosuppressed patients with external ear erosions with visible bone, pain out of proportion to the physical examination, or an elevated erythrocyte sedimentation rate or an elevated white blood cell count, and may be confirmed by MRI.
- Perichondritis (infection of the external ear cartilage) is increasingly common because of upper ear piercing, may require incision and drainage, and requires systemic antibiotics covering Pseudomonas and methicillin-resistant Staphylococcus aureus.
- Ear candles should never be used.
• Emergency department treatment of AOM and OME
• Emergency department treatment of those with AOM and OME complicated by tympanostomy tubes or a ruptured tympanic membrane
• Recognition of the otitis media complications of mastoiditis and petrositis
• Treatment of acute traumatic tympanic membrane rupture
• Emergency department treatment of otitis externa and related conditions, including malignant otitis externa and cholesteatoma
• The increasing incidence and treatment of perichondritis
• Appropriate treatment of cerumen impaction, with attention to those with diabetes mellitus or other immunocompromise and anticoagulation
• Issues in the removal of foreign bodies from the external ear

EARACHE

Earache is very common. For example, 80% of children in Boston have otitis media before age 3 years.1 In 1990, there were 25 million medical visits for AOM.2 In 1986, the indirect cost of otitis media was estimated at $3.5 billion.3

An immunization for Haemophilus influenzae type B has been used throughout the developed world since about 1980; however, most of the H influenzae found in AOM cannot be typed, meaning that the H influenzae type B vaccine has not affected the incidence of AOM. However, pediatric visits to primary care offices, urgent care centers, and emergency departments for otitis media decreased by a third after the introduction and widespread use of a pneumonia (Streptococcus pneumoniae [pneumococcus]) vaccine in 2000.4,5 Still, that leaves a lot of visits, and this does not count otitis externa or all the other causes of earache. In one study, two-thirds of earache was caused by ear problems, such as AOM or otitis externa, but one-third were referred pain, and given the complex innervation of the ear this pain was referred from a variety of sources.6

Some of the more common causes for earache other than otitis media, otitis externa, or barotrauma (incidence >100/100,000)7 in order of frequency include the following.8,9 Additional lists of even less common causes of ear pain may be found in the literature.9

• Carious or abscessed teeth
• Temporomandibular joint (TMJ) pain, either from an acute posttraumatic TMJ capsulitis (contusion of the cartilage of the jaw joint) or chronic TMJ pain
• Cervical spine pain
• Cervical lymphadenitis (swollen infected lymph nodes in the neck)
• Tonsillitis
• Posttonsillectomy pain
• Acute parotitis (inflammation of the parotid salivary gland in the cheek from viral, bacterial, or noninfectious causes)

Assume one looks at the outside of the ear, and then looks at the inside of the ear with an otoscope, and everything looks normal. The earache is worse with range of motion of the jaw, or with biting down. There is tenderness just anterior to the tragus of the ear, where one can feel the TMJ, especially with range of motion of the jaw. If after a blow to the jaw, even on the other side, it is likely acute posttraumatic TMJ capsulitis, or perhaps a tear of the cartilage meniscus in the TMJ; if more chronic, it may be TMJ syndrome.

If the ear looks normal, but on oral examination there is tap tenderness of a nearby tooth, especially if there is visual evidence of caries or abscess, then that is likely the
cause of the earache. Earache with a normal ear examination but tender cervical lymph nodes below the ear indicates cervical lymphadenitis, which may cause pain interpreted as earache.

It is very common for people to have sore throat and earache. If the ear examination is normal, it is likely tonsillar pain radiating to the ears. Sometimes people present primarily with an earache, but a normal ear examination and with only minor throat pain, but with tonsillitis on oral examination. Even a lingual tonsillitis, hard or impossible to see on examination of the oropharynx, may cause pain referred to the ear. Peritonsillar cellulitis or abscess may cause severe unilateral ear pain with a normal ear examination.

Posttonsillectomy pain commonly radiates to the ears. Serous middle ear effusions are common after tonsillectomy. Ear pain with a normal examination, but with swelling and pain in the distribution of the parotid salivary gland, suggests parotitis. Parotitis may be a viral or bacterial infection or noninfectious, including such problems as an obstructive stone in Stensen duct.

OTITIS MEDIA

AOM (Acute Suppurative Otitis Media)

AOM is distinguished from other forms of otitis media, including OME (otitis media with effusion, secretory otitis media, serous otitis, “glue ear”) and chronic otitis media (chronic suppurative otitis media). Chronic otitis media is now rare in developed countries, thanks to the introduction of antibiotics in the 1930s. Some also define other types of otitis media, such as persistent and recurrent AOM and recurrent OME. AOM often occurs coincident with, or subsequent to, an episode of acute viral rhinosinusitis (a cold). Although now generally regarded as a relatively benign condition, in the era before antibiotics sequelae and complications were common.

Diagnosis of AOM

AOM is defined as the presence of fluid in the middle ear in association with signs or symptoms of acute local or systemic illness. Accompanying signs and symptoms may be specific for AOM, such as otalgia or otorrhea; or nonspecific, such as fever. With this general statement, the diagnosis of AOM is clearly defined and agreed on, but the specific diagnostic criteria remain elusive. One survey of 165 pediatricians resulted in 147 different sets of criteria, and in 26 clinical trials 18 different sets of criteria were used.

Diagnosing a middle ear effusion is relatively straightforward. Pneumatic otoscopy is recommended, looking for position, color, translucency, and mobility. In one study, as confirmed by myringotomy, pneumatic otoscopy was 93% sensitive and 58% specific, which compares favorably with tympanometry, which was 90% sensitive and 86% specific.

A 2004 clinical guideline on OME states: “Distinct redness of the tympanic membrane should not be a criterion for antibiotic prescribing because it has poor predictive value for AOM and is present in about 5% of ears with OME.” A red tympanic membrane may also be a result of crying or irritation from removing cerumen. A retracted tympanic membrane, which may be painful, is caused by negative middle ear pressure, likely the result of eustachian tube dysfunction and not of a bacterial infection.

One recent study used the following definition of middle ear effusion: two or more of decreased or absent tympanic membrane mobility, yellow or white discoloration of the tympanic membrane, opacification of the tympanic membrane not caused by scarring, and visible bubbles or air-fluid levels.
Pelton\textsuperscript{18} tabulates a multivariate analysis of how three findings (color, position, and mobility) correlate with AOM determined by myringotomy. The combination of a cloudy tympanic membrane, a bulging tympanic membrane, and a tympanic membrane with slightly or distinctly impaired mobility correlated highly with AOM (99%). The full predictive values and associated findings are reproduced in Table 1, sorted by predictive value. Note that pneumatic otoscopy to determine mobility adds significantly to the predictive value of the examination.

The development of machines that assess for middle ear effusion without a prolonged fight with a squirming, screaming infant to perform pneumatic otoscopy, or worse, digging wax out of the ear of a squirming, screaming infant before performing pneumatic otoscopy, seemed to be attractive to many physicians. Tympanometry uses a mechanical device to measure features of the tympanic membrane and middle ear, and can assess for middle ear effusion. Tympanometry has been available since the early 1970s. Tympanometers are simple to use, although results are a bit complex to interpret. They are found in many otolaryngology offices and some pediatric offices and emergency departments.

First-generation tympanometers assess the tympanic membrane and middle ear by measuring the quantity of a 226-Hz musical tone reflected back from the tympanic membrane as a function of how the air pressure in the external canal is varied above and below ambient air pressure. Second-generation tympanometers use a pair of musical tones. The tympanometer plots a pressure-versus-compliance curve on a graph known as a tympanogram. Different curves strongly suggest certain anatomic correlates in the middle ear, such as tympanic membrane thinning (eg, healed postrupture) or ossicular disarticulation; middle ear effusion versus ossicular fixation; middle ear effusion; sclerosis; cerumen impaction; or retracted tympanic membrane. The interpretation of tympanograms is described in the medical literature and in other sources but is beyond the scope of this article.\textsuperscript{19,20} There is no evidence

Table 1
Predictive values of physical examination findings for acute otitis media

<table>
<thead>
<tr>
<th>Predictive Value (%)</th>
<th>Color</th>
<th>Position</th>
<th>Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>99</td>
<td>Cloudy</td>
<td>Bulging</td>
<td>Distinctly impaired</td>
</tr>
<tr>
<td>99</td>
<td>Cloudy</td>
<td>Bulging</td>
<td>Slightly impaired</td>
</tr>
<tr>
<td>97</td>
<td>Cloudy</td>
<td>Normal</td>
<td>Distinctly impaired</td>
</tr>
<tr>
<td>94</td>
<td>Distinctly red</td>
<td>Bulging</td>
<td>Distinctly impaired</td>
</tr>
<tr>
<td>94</td>
<td>Cloudy</td>
<td>Normal</td>
<td>Distinctly impaired</td>
</tr>
<tr>
<td>93</td>
<td>Slightly red</td>
<td>Bulging</td>
<td>Slightly impaired</td>
</tr>
<tr>
<td>89</td>
<td>Distinctly red</td>
<td>Normal</td>
<td>Distinctly impaired</td>
</tr>
<tr>
<td>85</td>
<td>Slightly red</td>
<td>Bulging</td>
<td>Distinctly impaired</td>
</tr>
<tr>
<td>83</td>
<td>Distinctly red</td>
<td>Bulging</td>
<td>Slightly impaired</td>
</tr>
<tr>
<td>47</td>
<td>Distinctly red</td>
<td>Normal</td>
<td>Slightly impaired</td>
</tr>
<tr>
<td>41</td>
<td>Slightly red</td>
<td>Normal</td>
<td>Slightly impaired</td>
</tr>
<tr>
<td>37</td>
<td>Cloudy</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>29</td>
<td>Normal</td>
<td>Retracted</td>
<td>Distinctly impaired</td>
</tr>
<tr>
<td>15</td>
<td>Distinctly red</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>7</td>
<td>Slightly red</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>3</td>
<td>Normal</td>
<td>Retracted</td>
<td>Slightly impaired</td>
</tr>
<tr>
<td>0.1</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
</tr>
</tbody>
</table>
that tympanometry is superior to pneumatic otoscopy for diagnosing middle ear effusion.

Tympanometry requires an airtight seal between the instrument and the external ear canal; however, a newer related technique, spectral gradient acoustic reflectometry (SGAR), does not require such a seal. SGAR machines emit a series of tones in a spectrum from 1.8 to 4.4 kHz, and measure the reflectance of the different frequency tones. The patterns may be mapped to curves known to be characteristic of certain middle ear conditions, including middle ear effusion. As with tympanometry, accuracy is dependent on user technique.21

A 1999 article provides a detailed and critical review of studies of tympanometry and SGAR up to that point, and concluded that although tympanometry and SGAR might be useful tools in certain settings, they do not supplant history, physical examination, and pneumatic otoscopy for the diagnosis of AOM.22 A 2007 study found SGAR almost as good as tympanometry at distinguishing middle ear effusion, and pointed out the advantages of SGAR over tympanometry: “unlike tympanometry, SGAR can be performed in relatively uncooperative children and its successful performance does not depend, as does that of tympanometry, on achieving an airtight seal between the instrument and the walls of the external auditory canal.”17 Acoustic reflectometry can distinguish a middle ear effusion, but cannot distinguish OME from AOM.23 The accuracy of reflectometry depends on the design of the reflectometer, with more recent designs being superior to older ones.24

Thus, despite problems dealing with cerumen in the canal obscuring the tympanic membrane, and uncooperative infants, pneumatic otoscopy is still slightly superior to tympanometry and SGAR for diagnosing middle ear effusion, one of the requirements for diagnosing AOM. As Combs25 writes: “No technology can replace the careful history and otoscopic examination by an experienced physician.”

Parents often present with a child and concerns about AOM. Although physicians are unable to diagnosis AOM by symptoms alone, parents are able to do so with a sensitivity of 71% and specificity of 80%.26

Antibiotics for AOM?

In the 1980s, it was said that “any child with an earache has an acute amoxicillin deficiency until proven otherwise.” Tradition is powerful, and the tradition in the United States (and Australia) is that if parents bring in a child with an earache, the clinician will prescribe antibiotics. However, in parts of Europe, AOM is not treated with antibiotics as often.27,28 In the Netherlands, antibiotics are prescribed for 31% to 56% of children with AOM29,30; in the United States the rate is 95%.31

It used to be taught that antibiotics were appropriate, at least in younger children, to decrease the incidence of deafness, known to be caused by otitis media. However, permanent deafness comes primarily from chronic suppurative otitis media (2 or more weeks of otitis media with discharge), which is quite rare in developed countries. AOM does not cause such deafness, although lingering effusions may cause temporary partial deafness.32 More serious complications of otitis media, such as permanent deafness or death from brain infection by contiguous spread, are also primarily a problem of the developing world, particularly of eastern Asia and the western Pacific, where it represents a significant medical burden.33 However, chronic suppurative otitis media and its complications are quite rare in developed countries.34 The reason for this difference is unclear.33

In the developed world, the past four decades has seen the traditional antibiotic treatment of AOM increasingly called into question. There are concerns about creating resistant bacteria, and questions about the efficacy of antibiotics for AOM.35
In recent years in the United States has it been acceptable to delay treating pediatric AOM with antibiotics, at least for some patients, opting to treat with analgesics instead (delayed antibiotics or observation). The clinician provides a prescription for an antibiotic (a safety-net antibiotic prescription), but also gives instructions to not fill it unless the pain continues for more than a day or so. Frequently, the earache ceases, and then there is no perceived need to fill the prescription. This has been shown to provide parent satisfaction and decrease the number of prescriptions filled, which it is hoped will delay the emergence of resistant bacteria, not to mention preventing adverse effects from the antibiotics. Some parents are convinced that their child needs antibiotics and fill the prescription right away. However, in most pediatric studies satisfaction is the same whether the parents are given a prescription or told to call back or return if their child is not better in 2 to 3 days, and fewer children get antibiotics if the patient is discharged without a prescription. A large 2001 study found that an immediate antibiotic reduces crying during the day and sleep disturbances at night the first day, and decreases acetaminophen use. This occurs after the first day, when symptoms are already diminishing. However, some argue that such a minimal benefit may not outweigh adverse effects of the antibiotic nor the risk of creating resistant bacterial strains. For adult patients with AOM, delayed prescribing has not been studied.

The medical literature is filled with articles debating the merits of antibiotics for children with otitis media in general, and the subset of those who should receive antibiotics, and in particular, whether antibiotics are indicated for those younger than 2 years of age. However, a recent (March 2008) international conference of experts was unable to achieve a consensus on when antibiotics are appropriate for otitis media.

There are presently two competing prestigious recommendations for how to treat AOM. The American Academy of Pediatrics (AAP) and the American Academy of Family Physicians (AAFP) released a joint clinical practice guideline on the management of AOM in 2004. It has had limited impact on prescribing practices. The primary recommendations of this guideline are as follows:

- To diagnose AOM the clinician should confirm a history of acute onset, identify signs of middle ear effusion, and evaluate for the presence of signs and symptoms of middle ear inflammation.
- The management of AOM should include an assessment of pain. If pain is present, the clinician should recommend treatment to reduce pain.
- Observation without use of antibacterial agents in a child with uncomplicated AOM is an option for selected children based on diagnostic certainty, age, illness severity, and assurance of follow-up. (The guideline recommends that those younger than 6 months of age, with a certain or uncertain diagnosis of AOM, be treated with antibiotics immediately; from 6 months to 2 years of age, that immediate antibiotics be started if the diagnosis is certain, or if the diagnosis is uncertain and there is severe illness; and that for those older than 2 years age, observation is an option, whether diagnosis is certain or uncertain, as long as there is no severe illness.)
- If a decision is made to treat with an antibacterial agent, the clinician should prescribe amoxicillin for most children. When amoxicillin is used, the dose should be 80 to 90 mg/kg/d (high dose). In patients who have severe illness (moderate to severe otalgia or fever of $\geq 39^\circ$C) and in those for whom additional coverage for $\beta$-lactamase–positive $H$ influenzae and Moraxella catarrhalis is desired, therapy should be initiated with high-dose amoxicillin-clavulanate (90 mg/kg/d of
amoxicillin component, with 6.4 mg/kg/d of clavulanate in two divided doses. If the patient is allergic to amoxicillin and the allergic reaction was not a type I hypersensitivity reaction (urticaria or anaphylaxis), cefdinir (14 mg/kg/d in one or two doses), cefpodoxime (10 mg/kg/d, once daily), or cefuroxime (30 mg/kg/d in two divided doses) can be used. In cases of type I reactions, azithromycin (10 mg/kg/d on Day 1 followed by 5 mg/kg/d for 4 days as a single daily dose) or clarithromycin (15 mg/kg/d in two divided doses) can be used to select an antibacterial agent of an entirely different class. Other possibilities include erythromycin-sulfisoxazole (50 mg/kg/d of erythromycin) or sulfamethoxazole-trimethoprim (6–10 mg/kg/d of trimethoprim). Alternative therapy in the penicillin-allergic patient who is being treated for infection that is known or presumed to be caused by penicillin-resistant *S pneumoniae* is clindamycin at 30 to 40 mg/kg/d in three divided doses. In the patient who is vomiting or cannot otherwise tolerate oral medication, a single dose of parenteral ceftriaxone (50 mg/kg) has been shown to be effective for the initial treatment of AOM.

- If the patient fails to respond to the initial management option within 48 to 72 hours, the clinician must reassess the patient to confirm AOM and exclude other causes of illness. If AOM is confirmed in the patient initially managed with observation, the clinician should begin antibacterial therapy. If the patient was initially managed with an antibacterial agent, the clinician should change the antibacterial agent.

The respected Cochrane Review of antibiotics for AOM in children, however, representing a more cosmopolitan perspective than the United States-only AAP-AAFP guideline, was updated in 2010. It notes that antibiotics slightly decrease pain at 24 hours and for a few days following, and that delayed antibiotic prescribing worked as well as immediate antibiotics. It notes that antibiotics made no difference in recurrence or more severe complications, such as temporary deafness, rupture of the tympanic membrane, or mastoiditis. However, complications from the antibiotic (vomiting, diarrhea, and rash) were common (37%). The Cochrane Review concludes that antibiotics should not be used for most cases of AOM, and are appropriate only if there is bilateral AOM or there is AOM with otorrhea (discharge from the ear).

The Cochrane review and the AAP-AAFP guidelines are based on essentially the same evidence, which is primarily from developed countries. They do take into account different traditions and public expectations, and interpret the balance of risks and benefits differently. In essence, both recommend only treating severe AOM with antibiotics; the 2010 Cochrane review considers severe to be restricted to bilateral AOM or AOM with otorrhea, whereas the 2004 AAP-AAFP guideline takes a much more inclusive view of what is severe, including any patient younger than age 2, or especially younger than 6 months of age. It is hard to see how one could be accused of practicing bad medicine if one follows either of these two prestigious guidelines.

Even though many bacteria isolated from ears with AOM are resistant to amoxicillin, amoxicillin is still recommended as first-line treatment because it is as clinically effective as other antibiotics. A single dose of intramuscular ceftriaxone and 5 days of oral azithromycin are as effective as amoxicillin. There has been an increasing incidence of multidrug-resistant *S pneumoniae* (pneumococcus) in AOM. There are many recommendations, therefore, to switch from standard-dose amoxicillin (25–50 mg/kg/d divided twice a day or three times a day, maximum 30 mg/kg/day if child is <3 months old) to high-dose amoxicillin (80–90 mg/kg/d divided twice a day). This achieves high concentrations in the middle ear, which is not the case for oral cephalosporins, which is one reason that amoxicillin is still recommended as first-line treatment of AOM. The AAP-AAFP guideline summarized previously provides guidance for cases
of penicillin allergy. Although twice-a-day dosing is often used, a Cochrane Review concluded that there is not enough evidence to support twice-a-day dosing instead of three times a day.\textsuperscript{55} Courses of antibiotics shorter than 7 days have been reviewed by the Cochrane Collaboration, and because of a higher failure rate, are not recommended.\textsuperscript{56}

Resistant AOM (persistence of fever, otalgia, and red, bulging tympanic membranes or persistent otorrhea after 3 or more days of antibiotic therapy) should be treated with high-dose amoxicillin–clavulanate, cefuroxime axetil, or intramuscular ceftriaxone for 3 days, according to one expert panel.\textsuperscript{57} No evidence-based recommendations for resistant AOM are yet available. Patients with resistant AOM should be encouraged to follow-up with a primary care physician as soon as possible.

Recurent AOM (a repeat episode occurring a month after the initial episode) is almost always (>90%) from a new pathogen.\textsuperscript{58} There are some recommendations in the literature to suggest that amoxicillin-clavulanate is the appropriate first choice for such episodes. Having an episode of AOM before age 6 months is associated with recurrent episodes of AOM. However, there seems to be no association with day care, gender, familial history of allergy, duration of breast-feeding, or domestic environment.\textsuperscript{59} Recurrent AOM tends to resolve as children grow older.\textsuperscript{60} There is some evidence that prophylactic antibiotics, either throughout the cold season or with onset of a viral upper respiratory infection, may help prevent AOM in children with a history of recurrent episodes.\textsuperscript{61}

One final note about antibiotics. When a parent or guardian says “amoxicillin never works for his/her ear infections!” I believe them. Some kids are probably colonized with amoxicillin-resistant bacteria. Scientific studies are not good enough yet to tease out these outliers. So, I prescribe something else, and call it the art of medicine.

**Other Treatments for AOM**

Oral decongestants and antihistamines have been studied for AOM, and based on multiple studies a Cochrane review recommends against them. There was slight benefit with a combination of oral decongestants and antihistamines, but the side effects outweigh the minimal benefit.\textsuperscript{62} A recent study finds no benefits at all from antihistamines, decongestants, or both combined.\textsuperscript{63} One older study found that a combination of antihistamine and decongestant taken during acute viral rhinosinusitis (a cold) did not prevent subsequent AOM.\textsuperscript{64}

Interestingly, a recent study showed a trend toward benefit, not from oral decongestants or antihistamines, but from a topical decongestant (nasal spray): approximately 27% resolution of effusion at 1 month as opposed to 19% resolution for decongestants, antihistamines, or controls.\textsuperscript{63} A short course of oxymetazoline (Afrin) nasal spray (<10 days to avoid rhinitis medicamentosa, which one can describe to patients as “being addicted to nasal spray so you have to use it to breathe through your nose”) seems appropriate.\textsuperscript{65,66} For otitis media or OME, I tell patients to spray into both nostrils, then lie flat on their backs for a few minutes, so that they can taste the spray getting back to where the eustachian tubes drain out in the back of the nose and throat.

One study showed a modest amount of pain control from an ear drop consisting of glycerin, antipyrine, and benzocaine (Auralgan).\textsuperscript{67} A Cochrane review of various types of analgesic ear drops concluded that there was not enough evidence to know if they are effective.\textsuperscript{68}

**Otitis-Conjunctivitis Syndrome**

Conjunctivitis and otitis media are sometimes found together, and the combination is highly likely to be caused by \textit{H influenzae}.\textsuperscript{69} \textit{H influenzae} tends to be resistant to
antibiotics commonly used for ear infections, such as amoxicillin and azithromycin (Zithromax); therefore, it is important to look for conjunctivitis that might indicate a need for a different antibiotic.70–73 Amoxicillin-clavulanate (Augmentin), cefuroxime (Ceftin), and cefdinir (Omnicef) are commonly prescribed antibiotics that cover resistant H influenzae.74

If examining a patient with purulent conjunctivitis, it is worthwhile examining the ears; roughly two-thirds also have AOM, and thus should be prescribed an oral antibiotic rather than eyedrops.75 If one is prescribing oral antibiotics, there is generally no need to prescribe antibiotic eye drops for uncomplicated conjunctivitis; the tears are thought to contain adequate amounts of the systemic antibiotics, lasting much longer than eyedrops between doses, and serve the same purpose adequately.76

**Otitis Media with Effusion (Glue Ear, Serous Otitis, Middle Ear Effusion)**

Sometimes in the emergency department one sees a patient with a complaint solely of decreased hearing. When one looks in the ear, rather than a cerumen impaction, one sees an ear that has a clear effusion, fluid behind the tympanic membrane. Or, one may routinely examine an ear and see some fluid behind the tympanic membrane.

It is common for a middle ear effusion to persist after AOM. At 2 weeks after AOM, about three-fourth of children have a persistent effusion; a month after, half do; and 3 months later, 10% to 25% do. This is not an indication for additional antibiotics.1,12,77

OME may also less commonly result from eustachian tube dysfunction from other causes, such chronic eustachian tube deformity, environmental allergies,78 tobacco smoking, and esophageal reflux.79 OME may cause discomfort, decreased hearing, or a feeling of “water in the ear.” OME is defined as fluid in the middle ear without signs or symptoms of acute ear infection, and as with AOM, is primarily a problem of children.15 OME may cause significantly decreased hearing, resulting in decreased scores in tests of speech and cognitive abilities, which is why it is a particular focus for pediatric primary care.80

In the emergency department, a cloudy TM, a visible effusion with an air-fluid level, or bubbles behind the tympanic membrane without symptoms of acute infection is also sufficient to tentatively establish the diagnosis and refer for outpatient follow-up. A 2004 clinical guideline of The AAP, AAFP, and American Academy of Otolaryngology–Head and Neck Surgery recommends pneumatic otoscopy to identify OME. Although optional in the emergency department, decreased mobility with insufflation confirms the diagnosis.50

Unfortunately, for patients in the emergency department with OME, there is little that can be done. Studies show that autoinflation with a Politzer device, antihistamines, decongestants, steroids, and antibiotics are all essentially useless.15,81–84 One mucolytic proved worse than useless.85 The AAP, AAFP, and American Academy of Otolaryngology–Head and Neck Surgery guideline recommends as initial management for children (2 months to 12 years of age) with OME a 3-month period of “watchful waiting,” checking hearing tests, and considering tympanostomy tubes.15

OME, although primarily a disease of children, also occurs in adults. Causative factors of cases referred to otolaryngologists include chronic sinus disease (particularly of the ethmoids); tobacco smoking; adenoidal hyperplasia; sequelae of AOM; and rarely head and neck tumors (<5% of cases).86 There is strong suspicion that many cases of OME are caused by allergy, but controlled treatment studies are lacking.87 Emergency department management consists primarily of referral to an otolaryngologist. In cases where allergy seems a likely cause, it is reasonable to treat for this with a nonsedating antihistamine and a steroid nasal spray. For those with OME after AOM, or from acute viral rhinosinusitis, given the findings for AOM a short course of
oxymetazoline (Afrin) nasal spray (<10 days to avoid rhinitis medicamentosa) is appropriate.\textsuperscript{65,66} Simple anatomic considerations lead to a recommendation for patients to lie supine for a few minutes after using a nasal spray for OME.

**AOM with Tympanostomy Tube or Ruptured Tympanic Membrane**

Tympanostomy tubes (myringotomy tubes, ventilation tubes, “grommets”) are sometimes surgically inserted in the tympanic membranes of children with recurrent AOM or, particularly in children older than 3 years, chronic OME. It is common to have otorrhea for days to a few weeks after insertion of tympanostomy tubes, and this is considered a normal consequence of the surgical procedure.

There may be a question as to whether a patient who has had tympanostomy tubes in the past, or who has otorrhea and one cannot see the tympanic membrane, might have a perforation in the tympanic membrane. Any patient who can taste ear drops when administered, or who can expel air out their ear canal with pinched-nose blowing, should be assumed to have a perforation.\textsuperscript{88}

About 5% of children with tubes develop chronic otorrhea (drainage from the ear), usually caused by skin flora, such as *Pseudomonas aeruginosa* and *Staphylococcus aureus*.\textsuperscript{89} Infants and children with tympanostomy tubes not uncommonly present to the emergency department with acute otorrhea. This occurs in roughly half of children with tubes.\textsuperscript{90} From the otorrhea, the external ear canal may acquire an eczematous appearance.\textsuperscript{88} Usually there are minimal associated symptoms: low-grade temperature and fatigue, but seldom pain.

In one study, approximately 30% of children with AOM had a spontaneous rupture of the tympanic membrane during an episode of AOM; this was more common if they had a history of prior AOM. Almost always there is a sudden decrease in pain. Eighty-five percent of the ruptures were in the anteroinferior portion, with smooth margins, and provided adequate drainage. In the other 15% the rupture was in the posterosuperior portion of the TM, and was small and nipple-like. Ninety-four percent of the perforations were spontaneously healed within a month. Children who have had a perforation are twice as likely to have recurrent AOM.\textsuperscript{91}

The bacteriology of intermittent otorrhea with tubes in those younger than age 3 is essentially the same as that for AOM in this group: a mixture of viruses and airway-derived bacteria.\textsuperscript{92,93} In older children, it is usually skin flora including *P aeruginosa* and *S aureus*.\textsuperscript{94}

There are a wide range of treatments of such otorrhea, from simple observation without treatment, to topical antibiotics (ear drops), to systemic antibiotics. In children younger than 3 years old with acute tube-associated otorrhea, one study found ear drops as effective as oral antibiotics; however, oral antibiotics were provided for those with fever or significant ear pain or failure of ear drops.\textsuperscript{92} One study found ofloxacin ear drops (Floxin) as effective as oral amoxicillin-clavulanate.\textsuperscript{95} Given that ear drops are effective for tube-associated otorrhea in all ages of infants and children, it seems prudent to use ear drops as the initial treatment for all such children, unless there is severe ear pain or high fever, in which case ear drops (to cover skin flora) and oral antibiotics should be prescribed.\textsuperscript{96}

At times ear drops go through tympanostomy tubes into the middle ear, depending on a variety of factors. There is enough concern for ototoxicity that it is recommended that only nonototoxic eardrops be used when there are tympanostomy tubes or a possible tympanic membrane perforation.\textsuperscript{97} Aminoglycoside antibiotics and propylene glycol have been found to be ototoxic in animal studies.\textsuperscript{98,99} It is also recommended that ear drops with alcohol or with a low pH be avoided in such cases, because of concerns about pain and ototoxicity.\textsuperscript{88} Chloramphenicol ear drops with
propylene glycol are not readily available in the United States; however, they may be available from foreign countries, and if patients enquire about their use, it is best to recommend against them and prescribe an alternative. Neomycin and polymyxin B and hydrocortisone otic suspension (Cortisporin) contains an aminoglycoside (neomycin) and propylene glycol,98 and acetic acid ear drops (Vosol, Acetasol; Vosol-HC, Acetasol-HC) also contain propylene glycol, so they should not be used for tube-associated otorrhea (or perforated tympanic membranes) unless the risks outweigh the benefits.

Ciprofloxacin-dexamethasone (Ciprodex) has been found to be nonototoxic in an animal model.100 In company-supported research, it has been shown to result in somewhat faster resolution of tube-associated otorrhea than ofloxacin ear drops (Floxin).101 There is some independent evidence that adding a steroid to an antibiotic results in faster resolution of external otitis, and a steroid alone is effective even without an antibiotic.102,103

In the rare case of a child with tubes presenting to the emergency department with ongoing otorrhea refractory to appropriate ear drops, it is appropriate to obtain a culture, allowing the follow-up provider to use culture results to guide treatment, but not change treatment in the emergency department. If the patient is now having significant ear pain or fever, it is appropriate to start oral antibiotics after culturing.92

**Mastoiditis and Petrositis**

A hundred years ago, mastoiditis and petrositis were common and dreaded complications of otitis media: 20% of patients with otitis media got mastoiditis or petrositis. However, these complications became much less common (2%), and especially rare in the developed world (<1%), after antibiotics became available in the 1930s.104 The incidence is somewhat higher in the Netherlands, where antibiotics are much less commonly prescribed for AOM.28

Mastoiditis is best described as symptomatic infection of the air cells in the bony mastoid process behind the ear. It is most common in those younger than 2 years old.105 The classic presentation of mastoiditis, swelling and perhaps warmth or redness over the mastoid, with anterior and inferior displacement of the pinna, is now seldom seen. Antibiotics may obscure the usual symptoms of mastoiditis; there are reports of “masked mastoiditis” where patients develop further complications of mastoiditis, such as brain abscess, without classic signs of mastoiditis.106 Masked mastoiditis reports date back to 1941, soon after initial use of antibiotics for otitis media.107 The most common findings are now an abnormality of the tympanic membrane and sagging of the posterior wall of the external ear canal.10 Beers and coworkers108 also suggest looking behind the ear, because sometimes in mastoiditis the postauricular fold is obliterated; compare with the unaffected side.

The diagnostic criteria for mastoiditis are poorly defined.109 As with fluid in the sinuses on computed tomography (CT) that occurs with most any viral upper respiratory infection,110–112 fluid in the mastoid air cells on CT is nondiagnostic, found in many cases of otitis media.113 High-resolution CT findings of bony resorption in the mastoid, combined with some clinical signs of mastoiditis, permits a diagnosis of “coalescent” mastoiditis, which is simply another way of saying the bony septae between the mastoid air cells are being destroyed.114 Suspected cases of mastoiditis should be imaged (CT or magnetic resonance imaging [MRI]) because findings of “coalescent” mastoiditis may be diagnostic. However, there are no other accepted criteria for CT or MRI diagnosis of mastoiditis.109 A visual review of the CT findings of mastoiditis and related conditions is available in print and online.115

Patients with mastoiditis are generally admitted for further work-up and treatment. Myringotomy is usually performed and tympanostomy tubes are generally placed. If
there are neither subperiosteal abscess nor central nervous system involvement, a period of 48 hours of observation and broad-spectrum intravenous (IV) antibiotics is recommended before considering mastoidectomy. Subperiosteal abscesses are surgically drained.

Petrositis (infection of the petrous portion of the temporal bone, Gradenigo syndrome) was classically described as presenting with the triad of deep facial pain, otitis media, and ipsilateral abducens nerve paralysis. However, such classic presentations are rare today; a history of chronic otitis media or surgery for mastoiditis with ongoing symptoms of infection, and deep facial pain, which is the single unifying symptom in a series of eight modern cases, should increase one’s suspicion for petrositis.

Suspected cases of petrositis should be imaged (CT or MRI), and are generally admitted for further work-up and treatment. CT findings of bony changes in the petrous area are diagnostic. Although mastoidectomy is a common treatment, there are case reports of successful conservative management of adults and children with just antibiotics.

Facial Nerve Paralysis

Facial nerve paralysis is a rare complication of AOM in adults and in children. The causes are unclear. There are recommendations in the literature that this should be managed conservatively with antibiotics and steroids, and that the time course for the paralysis is generally 2 weeks to 3 months.

Bullous Myringitis

Bullous myringitis used to be thought to indicate infection with mycoplasma. More recently it has been found that, except for a slight increase in *S. pneumoniae*, the pathogens in those with bullous myringitis are the same as for any case of AOM. Bullous myringitis is associated with worse AOM and more severe pain. As one review put it, bullous myringitis is just AOM with blisters on the eardrum.

BAROTRAUMA AND TRAUMATIC TYMPANIC PERFORATION

Traumatic perforation of the tympanic membrane may occur secondary to a blow to the ear (the most common cause in one series, mostly from domestic violence or street fights); blast injury (including fireworks); barotrauma from diving or altitude exposure; or direct trauma to the tympanic membrane. Symptoms of tympanic membrane perforations are generally fullness, tinnitus, or hearing loss. Any patient with severe vertigo after a ruptured tympanic membrane may have a perilymphatic fistula or rupture of the round window, and an otolaryngologist should be consulted urgently for such patients. Approximately 90% of civilian perforations heal in a month with no specific treatment. Explosion-related blast injuries from war tend to be larger; to be similarly symptomatic (83%); and not to heal spontaneously as frequently (48%). There is evidence from the 1974 Birmingham bombings that very large perforations (80% or more of the TM) do not heal spontaneously, and that smaller perforations (<80%) tend to heal spontaneously; there is a recommendation to allow a month for healing of each 10% of the tympanic membrane that is lost.

For at least 2 weeks after a perforation, it is strongly recommended that there be no cleaning or instrumentation of the external ear canal, unless there is visible contamination or evidence of infection, in which case it is recommended to use gentle suction and mopping to remove debris. There is no evidence that ear drops improve healing of traumatic tympanic membrane perforations. There are opinions, based on large observational series where healing occurred at a high rate despite the lack of such
ear drops, that they are not needed. There are also expert opinions in the literature that ear drops are not helpful and may well be harmful. There is some evidence, albeit with small numbers, that worse healing is associated with the use of ear drops (2 of 9 with ear drops healed at 4 weeks vs 29 of 33 healed at 4 weeks with no ear drops), and ear irrigation and antibiotic ear drops seem to be associated with increased infection rates. Because moisture in the ear seems to make infection more likely, it is recommended that patients be carefully instructed to keep the ear dry. There are a few recommendations that an infected ruptured tympanic membrane be treated with oral antibiotics, but this is not evidence-based and there is neither evidence nor expert recommendations as to the appropriate antibiotics. Given the experience with otorrhea with tympanostomy tubes (see later), coverage for \( P. aeruginosa \) and methicillin-resistant \( S. aureus \) (MRSA) is appropriate.

Advice from a Canadian otolaryngologist from World War II still seems to the point. The correct treatment of recent rupture of a drum in the forward areas is important and the following are approved principles:

1. It is essential that no drops or no powder be instilled in the ear. No syringing should be done and no peroxide used.
2. If there is reason to suspect that the drum may be ruptured, but there is still some doubt because of blood or wax in the canal, leave the ear strictly alone.
3. The soldier should be warned to keep water out of the ear and avoid violent blowing of the nose.
4. A plug of sterile cotton should be placed in the canal and evacuation arranged to the nearest otologist.

The only exception to this is that a referral to an otolaryngologist is not urgent, because no additional treatment is appropriate for at least 3 months. Otolaryngologists generally wait 3 to 6 months for healing to occur before considering surgical repair. There is good evidence that observation of tympanic membrane ruptures, with appropriate attention to preventing infection, provides superior healing compared with early surgical repair.

## EXTERNAL EAR

### Otitis Externa

Otitis externa (swimmer’s ear, tropical ear) refers to inflammation of the external ear canal. It tends to present with first itching, then serous discharge, later pain (sometimes severe) and tenderness, particularly when the tragus is pressed (Box 1). Patients often complain of partial deafness from edema of the tympanic membrane, or mechanical blockage of the edematous external ear canal or from purulent drainage.

Otitis externa is more common in warm months in temperate climates, and in tropical or subtropical climates, likely related to increased humidity and sweating. Otitis externa occurs at all ages, although there is a bit of a peak from 7 to 12 years, and it tapers off after age 50. Ten percent of people experience otitis externa at least once in their lives. Otitis externa is usually unilateral: only 10% of cases are bilateral.

The external ear canal is protected by cerumen (ear wax). Cerumen is a combination of desquamated cells from the squamous epithelium of the external ear canal and secretions from glands in the canal. It is acidic and contains lysozyme, and it is thought to help prevent bacterial and fungal infection. However, this has been recently challenged.

Numerous factors are thought to predispose to otitis externa. Moisture in the external ear canal and a break in the normal protection of skin and cerumen (earwax)
are thought to be key. This is often a result of extended or repetitive swimming without
drying the external ear canal afterward; from sweating profusely for a prolonged
period; from hearing aids; or from the occlusive effect of earplugs or earbuds (in-ear
speakers for mobile devices). Water in the external ear canal that is contaminated
with large amounts of bacteria, or local trauma, perhaps from cleaning the canal
with cotton swabs or other objects, is also thought to contribute.139

Otitis externa is classed into preinflammatory, acute inflammatory, and chronic
stages. The preinflammatory stage is when dampness in the external ear canal causes
swelling of the skin of the canal. This weakens the skin and obstructs glands that
secrete cerumen. On examination with an otoscope, one sees the lining of the external
ear canal turned whitish from the effects of moisture, and sometimes cerumen that is,
rather than the characteristic medium yellow or brown, soft and quite pale, and some-
times whitish, again from the effects of moisture.108

On examining mild acute inflammatory otitis externa with an otoscope, one sees
redness and mild swelling of the lining of the external ear canal, and perhaps some
mild serous discharge. Moderate cases present with worsening pain, and on exami-
nation, one sees purulent discharge and enough edema that it is hard to see the
tympanic membrane. Tenderness on pressing on the tragus or pulling on the pinna
is a hallmark sign of otitis externa.88 If the tympanic membrane is red, and there is
suspicion of AOM, pneumatic otoscopy may show normal mobility, which rules out
AOM.88 Severe cases are so edematous, and with so much in the way of purulent
discharge, that the lumen of the external ear canal is completely occluded, and the
tympanic membrane is invisible. One may find swelling and redness even outside
the external ear canal, visible without an otoscope, or adenopathy, particularly below
and anterior to the ear. If the infection spreads to tissues outside the ear, particularly
osteomyelitis of the temporal bone, this is termed malignant otitis externa (necrotizing
otitis externa). Some say that “malignant” is a misnomer and “necrotizing” should be
used instead because the process is infectious and not neoplastic.140 Chronic otitis
externa is defined by lasting more than a month, or recurring four or more times in
1 year.136

When because of severe otitis externa one is unable to see the tympanic membrane,
it is hard to tell if one is dealing with isolated otitis externa or otitis media with tympanic

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**Box 1**

**Elements of the diagnosis of diffuse acute otitis externa**

1. Rapid onset (generally within 48 hours) in the past 3 weeks, AND
2. Symptoms of ear canal inflammation that include:
   a. Otalgia (often severe), itching, or fullness,
   b. WITH OR WITHOUT hearing loss or jaw pain, AND
3. Signs of ear canal inflammation that include:
   a. Tenderness of the tragus, pinna, or both
   b. OR diffuse ear canal edema, erythema, or both
   c. WITH OR WITHOUT otorrhea, regional lymphadenitis, tympanic membrane erythema, or
cellulitis of the pinna and adjacent skin

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From Rosenfeld RM, Brown L, Cannon CR, et al. Clinical practice guideline: acute otitis ex-
rupture. However, the evidence suggests that appropriate treatment of moderate to severe otitis externa and of otitis media with a ruptured tympanic membrane are essentially the same.\textsuperscript{88,141} To guide the topical antibiotic into the inner portion of the external ear canal, one may insert an expanding ear wick.\textsuperscript{108}

A furuncle (abscess), an infected hair follicle, may appear in the outer third of the external ear canal. Pain and tenderness are focal, and as with any abscess, there may be purulent drainage, or, particularly in the era of MRSA, overlying cellulitis. This is sometimes termed focal otitis externa, but is a very different process from the more common otitis externa. Treatment is the same as for any abscess: local heat, and when clinically appropriate, incision and drainage; if there is significant overlying cellulitis, oral antibiotics that cover MRSA.\textsuperscript{88}

Those who are immunocompromised (including diabetes mellitus) or who live in humid tropical environments are at risk for otomycosis, fungal infection of the outer ear. Drainage may be colorful: black, gray, bluish green, yellow, or white. Fungal hyphae may even be visible with an otoscope.\textsuperscript{88,142}

The most common bacterium isolated from otitis externa is \textit{P aeruginosa} (in roughly one-third of cases), \textit{Staphylococcus epidermis} and \textit{S aureus} (about 10% each), and a variety of other less-common bacteria in smaller frequencies. Fungi accounted for less than 2% (Aspergillus and Candida). \textit{S epidermisis}, \textit{Corynebacterium}, and \textit{\alpha-}hemolytic \textit{Streptococcus} are normal flora, but may be implicated in infection when normal protective barriers in the external ear canal are breached.\textsuperscript{135} Rare precipitants for otitis externa include infections from herpes simplex or varicella zoster virus (shingles) or eczema, which damage the squamous epithelium.\textsuperscript{108}

Over the past two millennium a great variety of agents other than antibiotics have been used to treat otitis externa.\textsuperscript{143,144} Steroids alone have been shown to be as effective as antibiotics.\textsuperscript{102,103,145} Aluminum acetate, acetic acid, boric acid, and glycerine-ichthammol are all still used in the developing world, although good studies of their efficacy are not available except as described later.\textsuperscript{146}

Because of its acid nature, vinegar has been used as a traditional medicine for infections, such as otitis externa, for thousands of years.\textsuperscript{147} Two percent acetic acid has a pH of 3.\textsuperscript{148} Commercial table vinegar, based on an inspection of a selection of material safety data sheets, has a pH of 2.2 to 2.6. Combinations of alcohol (for its drying effect) and acetic acid (or vinegar or lemon juice) to acidify, with or without hydrocortisone, have been traditionally used to prevent and treat otitis externa.\textsuperscript{142} Prescription acetic acid drops with hydrocortisone (Vosol-HC, Actasol) or without hydrocortisone (Vosol, Acetasol) are available in the United States. These are probably effective for mild cases; however, they may be painful to an irritated ear canal, must be used multiple times a day, and should not be used with tympanostomy tubes or a tympanic membrane perforation because there are concerns about ototoxicity of acetic acid.\textsuperscript{149}

In vitro studies show that aluminum acetate and acetic acid are effective against common bacteria causing otitis externa.\textsuperscript{150} One study showed aluminum acetate drops clinically effective in chronic otitis with otorrhea (including those with perforated tympanic membranes).\textsuperscript{151} Aluminum acetate is available quite inexpensively over-the-counter as Burow Solution (13% aluminum acetate; domeboro) with a pH of 3.06.

Given their high concentrations and persistence and lack of systemic side effects, and concerns about rising antibiotic resistance, a consensus panel recommends that ear drops should be used instead of systemic antibiotics as the primary treatment of otitis externa and otorrhea with tympanostomy tubes.\textsuperscript{152} Oral antibiotics may be added to ear drops (not substituted for ear drops) when the patient is immunocompromised by such conditions as diabetes mellitus, local radiotherapy, or HIV-AIDS, or when the infection extends outside the ear canal (malignant otitis externa).\textsuperscript{88,142} There
is some evidence that treating otitis externa with common antibiotics used for AOM actually interferes with resolution of the otitis externa and, in the case of cephalosporins, increases recurrence rates.88

The natural history of otitis externa shows that without treatment, only 15% of patients experience a clinical cure at 10 days. Antimicrobial ear drops, whether antiseptic or antibiotic (or, surprisingly, steroid drops alone), are highly effective, raising this 10-day cure rate to 65% to 80%.153

A combination of the aminoglycoside neomycin with the polypeptide antibiotic polymyxin, for additional coverage of *P aeruginosa*, and hydrocortisone, to decrease swelling (Cortisporin) is quite commonly prescribed. However, neomycin is well-known to dermatologists as a common skin allergen,154–156 which may complicate the otitis externa with a severe local reaction, making these drops undesirable as a first-line treatment of otitis externa. If one is seeing a patient with persistent or worsening otitis externa despite being on neomycin drops, changing to a quinolone antibiotic combined with a steroid is appropriate. Seeing a pattern of eczematous eruption on the lower portion of the external ear where ear drops tend to run may be a clue to such an allergic reaction.142 Ten percent to 15% of the normal population is hypersensitive to neomycin.88

Neomycin is also an aminoglycoside, and aminoglycosides are considered ototoxic.98,99 They should only be used in cases of potential tympanic membrane perforation (eg, severe otitis externa where the tympanic membrane cannot be visualized) or when there are tympanostomy tubes when the benefits clearly outweigh the risks.

Topical fluoroquinolones first became available to treat otitis externa in 1997 and 1998 in the form of ciprofloxacin and ofloxacin. With excellent coverage of gram-positive and -negative bacteria including *P aeruginosa*, and without the ototoxicity or allergy concerns of neomycin,157,158 quinolones seem an ideal antibiotic for otitis externa. In addition to ciprofloxacin (Ciprodex, Cipro-HC), ofloxacin ear drops (Floxin) are available. These have been specifically studied in one study of hundreds of patients and found to be more effective than prior treatments and safe with tympanostomy tubes (and, by a reasonable extension, in those with ruptured tympanic membranes).159

Multiple studies have shown that ciprofloxacin (with or without hydrocortisone or dexamethasone) and ofloxacin drops are as effective as neomycin-polymyxin-hydrocortisone ear drops.160–163 In one study, once-daily ofloxacin ear drops were as effective as neomycin-polymyxin-hydrocortisone ear drops four times a day.157 Beers and Abramo108 pointed out that ciprofloxacin-hydrocortisone ear drops had not been studied for safety in the setting of tympanostomy tubes or a ruptured tympanic membrane, and thus recommended ofloxacin ear drops for this particular setting. However, there seems to be no solid evidence for ototoxicity of the combination of ciprofloxacin and dexamethasone, and there is now literature that suggests its use in otorrhea with tympanostomy tubes is safe and effective, and may be more effective than ofloxacin.158 Ciprofloxacin and particularly ofloxacin have some activity against MRSA,164–166 and quinolone antibiotics stay at very high concentrations in the external ear, making efficacy against MRSA and even quinolone-resistant *S aureus* quite likely; quinolone ear drops also have no significant systemic absorption, making emergence of ciprofloxacin resistance unlikely.149

The evidence seems to favor ofloxacin (Floxin) or ciprofloxacin-dexamethasone (Ciprodex) drops as the first choice for treating otitis externa or otorrhea with tubes (and by a reasonable generalization, AOM with tympanic rupture), and once-a-day dosing of ofloxacin is likely appropriate.167 Cost of quinolone antibiotic ear drops used to be a major concern (on the order of $100 per prescription). However, inexpensive generic ofloxacin ear drops are now available; for example, the MedExpress chain
of urgent care centers currently (2012) charges patients $15 for a bottle, and the Massachusetts Department of Health currently lists it having a charge of $10.92. There are recommendations against using benzocaine-containing analgesic ear drops for otitis externa (eg, Auralgan), given the concerns for potential allergic reactions to the benzocaine complicating ongoing assessment of the efficacy of treatment.88

The technique for instilling ear drops may make a significant difference in how they work. When prescribing ear drops for otitis externa, gently cleanse secretions and wax out of the ear. Instruct the patient to gently cleanse the ear at home before instilling the drops. Warm the ear drops to body temperature, perhaps by keeping in a shirt or pants pocket for 5 to 10 minutes before use. This prevents dizziness from caloric stimulation (difference in temperature causing circulation in the semicircular canal). Have the patient lie on the unaffected side; instill the drops (gently pulling on the pinna may open the ear canal a bit to allow the drops in); and then gently press on the tragus a few times to pump the drops deeper into the ear. Have the patient stay lying on the side for a few minutes after instilling. Placing a cotton ball in the ear before arising may prevent the drops from draining out of the ear onto the patient’s clothes; this may be removed after the danger of such external drainage has ceased.142

Patients with otitis externa should be instructed to abstain from water sports for 7 to 10 days after treatment starts. Competitive swimmers may return to swimming 2 to 3 days after treatment, or immediately if they wear well-fitting ear plugs after the pain has resolved. Hearing aids and ear buds (in-ear speakers) should remain out until pain and discharge have resolved.88

Patients should be told to expect a significant improvement in their pain and discharge in 2 to 3 days. If not improving by then, patients should be instructed to have their ears reassessed. The possibility of AOM with ruptured tympanic membrane may be entertained, and if there is ongoing pain or fever, an appropriate oral antibiotic for AOM might be appropriate. The patient must be reassessed for the possibility of malignant otitis media (see next). The ear may need to be cleaned of debris to ensure that the topical antibiotic is delivered to the entire ear canal. This may require IV analgesia or even moderate sedation. A culture for bacterial and fungal pathogens is appropriate. It may also be necessary to consult an otolaryngologist for urgent follow-up, because failure to improve may be an indication of something other than simple otitis externa, such as cancer.88

**Malignant Otitis Externa**

Malignant otitis externa is primarily a problem of those with immunosuppression, most commonly from diabetes mellitus or HIV-AIDS. The mortality of 50% before antibiotics is now much lower, estimated to be 0% to 15%. Examination of the ear canal may show exposed bone or granulation tissue, particularly in the inferior portion of the canal, although the tympanic membrane usually appears normal. Pain out of proportion to examination findings, history of immunosuppression, and an elevated erythrocyte sedimentation rate in the face of normal temperature and white blood cell count tend to suggest malignant otitis externa. MRI is superior to CT in confirming the diagnosis, and may show dural enhancement and involvement of medullary bone spaces. However, a technetium or gallium scan is the preferred diagnostic test, although it is positive in other local inflammatory conditions, including cancer. A culture of the exudate should be sent before IV antibiotics are started. Because carcinoma and other conditions may present similarly, a biopsy is usually performed.140

It has been shown that cerumen in diabetic ears has an alkaline pH rather than a normal acidic pH, and this may be one of the reasons why malignant otitis externa is most common in people with diabetes (65%–90% of cases). Elderly people with
diabetes also tend to have endarteritis, microangiopathy, and small vessel obliteration, which is thought to contribute.\textsuperscript{168} The ability of \textit{P aeruginosa} to invade tissues and cause septic thrombophlebitis makes it by far the most common bacterium implicated in malignant otitis externa. It is considered an opportunistic pathogen.\textsuperscript{169} Fungi, such as \textit{Aspergillus}, are uncommon as a cause of malignant otitis externa except in patients with HIV with CD4 counts less than 50 cells/mm\textsuperscript{3}.\textsuperscript{169}

Complications of malignant otitis externa include damage to the facial nerve, necrosis of the tympanic membrane, stenosis of the external ear canal (EAC), auricular deformity, and sensorineural and conductive hearing loss. Treatment consists of several weeks of IV antibiotics; in children, fluoroquinolones are used only if the benefits outweigh the risks of joint damage. Given the increasing resistance of \textit{P aeruginosa} to fluoroquinolones, antipseudomonal penicillins and cephalosporins are now generally the treatment of choice combined with an antibiotic appropriate for MRSA until cultures are available.\textsuperscript{88,140} Rare cases of malignant otitis externa caused by the fungus \textit{Aspergillus} are treated with IV antifungals.\textsuperscript{170}

\textbf{Cholesteatoma}

Cholesteatomas are epidermal inclusion cysts of the middle ear or mastoid. Early investigators thought these “pearly tumors” contained cholesterol crystals\textsuperscript{171} but it is now known that they are filled with desquamated keratinaceous material, similar to the “sebaceous” epidermal cysts found on the skin. As with epidermal cysts of the skin, they may become infected, causing drainage. Cholesteatomas may also, by either direct extension or becoming infected, result in bone destruction or even intracranial infection. Frequently they may become infected with anaerobic bacteria, resulting in otorrhea with a characteristic and almost feculent odor.\textsuperscript{172} Cholesteatomas may also present with a variety of symptoms, depending on the location and extent: vertigo, hearing loss, facial nerve paralysis, or intracranial infection. The classic location for a cholesteatoma is adjacent to the posterosuperior portion of the tympanic membrane, but they may appear in other portions of the external ear canal, or perforating through the tympanic membrane.\textsuperscript{173}

If infected, cholesteatomas should be treated with appropriate topical antibiotics. If suspicious of osteomyelitis, CT or MRI is appropriate; as with any suspected infection or tumor, IV contrast improves the diagnostic quality of CT and MRI. Patients with cholesteatomas should generally be referred to an otolaryngologist for ongoing care.

\textbf{Perichondritis}

Perichondritis of the ear, specifically infectious perichondritis, is becoming more common because of the popularity of piercing of the upper portion of the pinna. Piercing of the upper portion of the ear, through the less infection-resistant cartilage, exposes those subjected to it to a higher likelihood of more serious infections, but this seems to be widely unknown by those performing or receiving such piercings. The goals of treatment include healing without permanent deformity. \textit{P aeruginosa} and \textit{S aureus} are common pathogens. Surgical drainage is sometimes required, and systemic antibiotic coverage for both of the previously mentioned pathogens is recommended.\textsuperscript{174}

\textbf{CERUMEN IMPACTION}

A 2008 American Academy of Otolaryngology–Head and Neck Surgery Foundation clinical practice guideline\textsuperscript{175} is currently the definitive reference for managing cerumen
impactions. The following represents a distillation of the portions of this guideline relevant to the practice of emergency medicine.

Cerumen impaction (defined by the 2008 clinical guideline as either complete or partial occlusion of the external ear canal with excess cerumen) is found in 1 of every 10 children, 1 of every 20 adults, in a third of the elderly, and in a third of those with developmental delay. If asymptomatic, cerumen need not be removed. However, cerumen impaction may diminish cognitive function in the elderly, and may interfere with visualization of the tympanic membrane during otoscopy. Cerumen impaction may also cause hearing loss, tinnitus, vertigo, fullness, itching, otalgia, discharge, odor, or cough; however, these may be a symptom of another process coincident with cerumen impaction. Cerumen removal may help achieve a diagnosis, either by relieving the symptoms or by allowing visualization of the external ear canal and tympanic membrane.

Cerumen removal has risks and benefits; it may result in external ear canal pain, abrasions or lacerations, vertigo, syncope, or otitis externa. Tympanic membrane perforation or hearing loss are rare complications. However, one study showed a 0.2% incidence of tympanic membrane perforation from irrigation, and a similar 0.2% incidence of vertigo. One should also consider confounding conditions that might change one’s choice of methods for cerumen removal, such as nonintact tympanic membrane (perforation or tympanostomy tube); ear canal stenosis; exostoses; diabetes mellitus; immunocompromised state; or anticoagulant therapy.

In some of these cases, safe removal in the emergency department may not be possible, and cerumen removal may have to be deferred, to be performed later by an otolaryngologist using a binocular microscope and microinstrumentation. There are three main methods used to remove cerumen: (1) cerumenolytic agents; (2) irrigation; and (3) manual removal, using ear curettes, probes, hooks, forceps, or microsuction. There is no evidence as to which of these, or which combination of them, is best.

There is some evidence that cerumenolytic agents may aid in removal of cerumen, but no evidence that any one agent is superior to the others. The guideline recommends that cerumenolytic agents not be used in patients with otitis externa, because otitis externa is an exclusion for studies of such agents. There are also concerns about a reported 1% skin allergy incidence to 10% triethanolamine polypeptide oleate (Cerumenex) drops. There is some evidence that cerumenolytic agents used before irrigation may improve the efficacy of irrigation. Even water or normal saline used as a cerumenolytic drop 15 minutes before irrigation improved efficacy.

When the tympanic membrane is not intact, mechanical removal might be attempted in the emergency department, but irrigation should be avoided because of concerns about pain, infection, caloric vertigo, and ototoxic hearing loss.

Atrophy of the tympanic membrane from prior surgery, including tympanostomy tubes, is a risk for tympanic membrane rupture, so irrigation is not recommended for those who have had such surgery in the past. When the patient is immunocompromised, for example by diabetes mellitus or HIV-AIDS, concerns about causing malignant otitis externa should prevent routine tap water irrigation unless great care is taken to avoid abrasions, and one considers prescribing acidifying ear drops, such as 2% acetic acid (Vosol, Acetasol) two drops in each ear twice a day, or recommending over-the-counter drops, such as aluminum acetate (Burow solution, Domeboro).

Mechanical removal of cerumen may be faster than irrigation; allows a direct view of the external ear canal; and does not make the external ear canal wet, which is thought to be a risk for otitis externa. Mechanical removal is preferred over irrigation or cerumenolytic agents for patients with a nonintact tympanic membrane or the potential for it, or prior ear surgery. Manual removal, with or without cerumenolytic agents, is
preferred over irrigation for those with immunosuppression caused by such conditions as diabetes mellitus or HIV-AIDS, or who may be immunosuppressed because of systemic illness.

There are many devices available for mechanical removal of cerumen. Perhaps the most effective tool is the binocular microscope often used by otolaryngologists, which is seldom available in the emergency department; those with abnormal external ear canals may benefit from a referral to an otolaryngologist for removal using such a device. Barring such abnormalities, removal in the emergency department under direct visualization with the combination of a headlight, an otoscope speculum, and either a metal or plastic curette may be effective. Those who are on anticoagulants should have cerumen removed by instrumentation only with the greatest care, and the use of cerumenolytics and irrigation may be a better option for them.

There are consensus opinions that certain methods of home removal are not appropriate. These include the use of oral jet irrigators, which may cause ear trauma, and cotton-tip swabs, which may also cause ear trauma, including a ruptured tympanic membrane. There is even a case report of a fatal brain abscess from retained cotton in the ear.

Those with dermatologic diseases of the ear canal, recurrent otitis externa, keratosis obturans, prior radiation therapy affecting the ear, previous tympanoplasty or myringoplasty, or canal wall down mastoidectomy should have their cerumen impactions managed by an otolaryngologist.

Patients with cerumen impactions may be counseled on recommended home care. This includes not using bobby pins or cotton swabs to attempt to remove wax, because this may traumatize the ear and tends to pack cerumen up against the tympanic membrane. Weekly use of a topical ear emollient may significantly (61% vs 23%) decrease future cerumen impactions.

FOREIGN BODIES IN EARS

Foreign body in the ear is a common presentation to primary care offices, emergency departments, and urgent care centers. However, there is little literature on the topic except for case reports and case reviews, and there are no controlled studies to allow one to conclude that one method is superior, either in terms of efficacy or in terms of complications, such as tympanic membrane perforation or external ear canal laceration. Therefore, the following provides an overview of the literature and expert opinion expressed in this literature.

One retrospective case review, which focused solely on those patients referred to otolaryngologists, and thus does not likely reflect most cases, found that about half of those cases referred to an ear, nose, and throat physician after attempted removal by an emergency physician or primary care physician had lacerations of the external canal; however, there is no information on the corresponding number of foreign bodies that were successfully removed by an emergency physician or primary care physician. The article also notes that otolaryngologists tend to use a microscope to remove foreign bodies (91% of the time). The most common foreign body in this study was a cockroach (43 of 98) followed by beads (15 of 98). The study recommends lidocaine instillation (provided the tympanic membrane is intact), which in their series rather than paralyzing the cockroaches, caused them to quickly back out. The recommendations from this case series are as follows:

- Preremoval hearing assessment for patients in who damage to the hearing is suspected
- Removal under direct vision, using a microscope if appropriate
• Patients with objects not readily removed by the primary care physician may require referral to an otolaryngologist
• Mineral oil or lidocaine aural instillation may be useful adjuncts during the removal of live cockroaches

A prospective review from an otolaryngology service in Brazil found that beans were the most common foreign body in the ear. A different retrospective review of 141 cases presenting to primary care offices and the emergency department of an eye and ear hospital found cockroaches to be less common (“insects” 21 of 141), and beads (31 of 141), plastic toys (29 of 141), and pebbles (21 of 141) to be the most common. This study mentioned common instruments available for removal: Frazier tip suction, alligator forceps, Hartman forceps, cerumen loops, and right-angle ball hooks.

Right-angle ball hooks have a thin (few millimeter) rod that makes a right angle at the end, with a blunted end, sufficient to slip into the central hole of a bead. These have been improvised by straightening and then bending the very tip of a paper clip; this has the disadvantage that it is not smooth at the tip, which makes it harder to slip into the hold in the bead. The paper also mentions the Schuknecht foreign body remover, a commercially available 22-gauge angled suction catheter. This study makes a recommendation to avoid any attempts at irrigation if the foreign body could be a small button battery, because of the possibility of damage from short-circuiting the battery with resultant burns to the ear. It goes on to make specific recommendations for referral to an otolaryngologist:

• Lack of proper instrumentation
• Lack of staff to adequately restrain uncooperative child
• Failure to remove foreign body on initial attempts
• Existent injury to the external auditory canal or tympanic membrane
• Object wedged in the medial external auditory canal or up against tympanic membrane
• Glass or other sharp-edged foreign body
• Special circumstances, such as insects, putty, and disk batteries

One retrospective pediatric emergency department study found only 4 of 58 ear foreign bodies were successfully removed in their Australian emergency department. Another pediatric emergency department study, a retrospective chart review of 36 cases over a 1-year period, found a better success ratio (53%) but found a higher complication rate in rounded objects that were hard to grasp, and concluded “certain foreign bodies (graspable type) of the EAC in pediatric patients can be successfully managed by skilled emergency department personnel with low complication rates, whereas other foreign bodies (nongraspable types) may be better managed by early referral to an otolaryngologist.”

A literature review from 2000 notes that the literature frequently recommends restraining children before attempts at removal, but that modern emergency medicine capability makes moderate sedation a more humane option. It also notes that irrigation is contraindicated if there is a tympanostomy tube or ruptured tympanic membrane, or if there is vegetable matter that may swell.

A variety of methods have been reported successful in isolated case reports to remove foreign bodies from the ear, and a listing of these might make one more likely to find a method appropriate for a particular instance. These include the following:

• Killing an insect with vinegar then removing with a probe (recommendation from the era of the Roman Empire)
- Binding the patient to a table with the affected ear down and then pounding on the table (another Roman recommendation)\textsuperscript{180}
- Cyanoacrylate glue on the end of an instrument to remove a bead\textsuperscript{181}
- A Jobson Horne probe (a steel probe with a circle of steel on the end, used sometimes for removing cerumen) or steel wire loop\textsuperscript{180}
- Impression materials: pouring a fast-setting flexible material into the ear canal, and then removing the resulting plug including the foreign body\textsuperscript{182}
- A paper clip bent into an appropriately shaped loop\textsuperscript{182,183}
- Tiny magnets\textsuperscript{184}
- Using ethyl chloride to dissolve Styrofoam beads\textsuperscript{185}

Sticking a hollow candle in the ear and lighting it is a traditional “holistic” remedy for a variety of ear conditions, including the impacted cerumen. It does not remove cerumen, and causes many complications, including occlusions of the external ear canal with candle wax, tympanic perforation, otitis externa, and burns of the auricle. There are strong recommendations in the medical literature that ear candles should never be used by anyone for any reason whatsoever.\textsuperscript{175,186,187}

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