Management of childhood ear infections

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Childhood ear infections consist of acute otitis media (AOM), otitis media with effusion (OME), and otitis externa (OE). AOM and OME have been defined in a clinical practice guideline developed by the American Academy of Pediatrics (AAP) and American Academy of Family Physicians.

In order to have a diagnosis of AOM, the patient must have a history of acute onset of signs and symptoms, middle ear effusion, and middle ear inflammation. OME is defined by the presence of middle ear effusion without acute signs and symptoms. OE is characterized by inflammation of the external ear canal.

Epidemiology

AOM is the most common diagnosis associated with antimicrobial therapy for children in the United States. The peak incidence occurs during the first two years of life. AOM occurs more frequently during the winter months. About 50% of children will have had one episode of AOM by six months of age, and, by three years of age, the incidence increases to 75%. Almost 100% of children will experience at least one middle ear effusion in their lifetime.

Risk factors associated with the development of AOM include day care attendance, lack of breast-feeding, presence of siblings, lower socioeconomic status, exposure to cigarette smoke, and allergies.

Complications following AOM include hearing loss, perforation of the tympanic membrane, otorrhea, recurrent otitis media, persistent middle ear effusion, and mastoiditis. Recurrent otitis media (ROM) is defined as three or more episodes of AOM within a six-month period or six episodes in a year. Chronic suppurative otitis media (CSOM) can also develop secondary to chronic bacterial infection within the middle ear. It is defined by at least six weeks of middle ear drainage and a nonintact tympanic membrane (secondary to perforation or placement of tympanostomy tubes). It most often occurs following an untreated otitis media (OM) infection.

More than 50% of children will experience one episode of OME in their first year of life, increasing to 90% of children by school age. Recurrence is common...
in children who experience OME with an approximate incidence of 35%.

Otitis externa or “swimmer’s ear” peaks in children between seven to 12 years of age. Approximately 10% of the population will develop OE at some point during their lifetime. Approximately 80% of all cases occur during the summer months. OE was first noted in the 1800s. However, research interest peaked during World War II, when it became epidemic with the hot and humid conditions in the South Pacific. Research in the 1940s proved that OE was most likely caused by bacteria and not fungi.

Pathophysiology

Otitis media is defined as inflammation of the middle ear. It develops following an upper respiratory infection, which can be due to viral and/or bacterial causes. OM’s pathophysiology involves infection and congestion of the upper respiratory tract, including the nasopharynx and eustachian tube. The eustachian tubes connect the middle ear to the nasopharynx. The function of the eustachian tubes is to protect the middle ear from nasopharynx secretions, drain middle ear fluid into the nasopharynx, and maintain equilibrium within the middle ear.

Following an upper respiratory infection, the eustachian tubes develop impairment in pressure regulation and clearance of the congestion. Due to these disruptions, pathogens can travel from the nasopharynx into the middle ear. In addition, a transudative middle ear effusion develops and cannot be properly drained, potentially leading to persistent infection.

Children are much more susceptible to ear infections than adults because their ear canals are short and horizontal, which facilitates easier access of bacteria into the middle ear. In addition, children are more susceptible to recurrent upper respiratory infections due to an immature immune system, and they have the presence of adenoids in the nasopharynx, which may become edematous during infections and lead to further eustachian tube dysfunction.

OE can develop because of environmental changes in a patient’s external auditory canal. In a healthy ear, the external auditory canal has hair and cerumen that push debris away from the eardrum. Cerumen or “earwax” has lipid-rich properties that prevent water from damaging the thin epithelial layer of skin in the ear canal. In addition to these defenses, the ear canal maintains an acidic pH that provides a chemical barrier against infection. Essentially, anything that interferes with the ear canal’s natural drainage and cleaning system can put a patient at risk for developing acute OE.

Children often develop OE because of impacted cerumen, moisture in the environment, or the insertion of foreign objects in their ears. If children have impacted cerumen in their outer ear canal, an obstruction is created, thus trapping water and bacteria. Any entrapment of the water and bacteria can lead to maceration of the epithelial lining of the canal. A similar phenomenon can occur when water is trapped in one’s ear secondary to swimming, bathing, or perspiration and humidity. When an attempt is made to cleanse a cerumen-filled ear, the use of an astringent or soap may change the acidic environment in the canal to alkaline. If foreign objects such as cotton swabs, earplugs, or pencils are inserted into the ear, they can cause damage to the lining of the ear canal, thus predisposing it to infection.

Inflammation in OE can develop from an allergic reaction, chronic disease, or anatomic abnormalities. Patients can develop contact dermatitis of the ear with...
certain sprays, shampoos, and objects inserted into the ear. Chronic diseases such as eczema and acne can affect the outer portion of the ear canal. Finally, anatomic abnormalities such as narrowing of the ear canal or a small canal associated with disorders such as Down syndrome can predispose patients to develop OE.

Clinical presentation

Common signs and symptoms seen in AOM, OME, and OE are listed in Table 1. The diagnosis of middle ear effusion is made via pneumatic otoscopy. This technique involves the use of an otoscope with a rubber bulb attached that can introduce air into the middle ear to assess tympanic membrane mobility. A bulging tympanic membrane, decreased mobility of the tympanic membrane, and an air-fluid level behind the tympanic membrane all confirm the presence of middle ear effusion.

The important distinction between AOM and OME is based on the presence (AOM) or absence (OME) of acute signs and symptoms. Unfortunately, many of the symptoms seen in AOM are nonspecific and can be indicative of other respiratory infections. Because infants cannot verbalize their pain, it is often difficult to determine the severity of the pain. Infants will typically pull on their ears repeatedly when they have otalgia.

As with OM, OE patients may have otalgia, but in OE the pain is usually more isolated to the outer ear canal in the tragus and the pinna. In bacterial acute OE (the most common type), patients usually have an itching sensation and edema in the ear during the pre-inflammatory phase. During the actual inflammatory phase, all of the traditional symptoms occur with varying degrees. Patients may even develop a lymphadenopathy anterior to the tragus. Acute OE is typically diagnosed through an evaluation of a patient’s signs and symptoms, erythema and inflammation seen during ear examination, and environmental history.

In complicated OE, the pain can be severe and is usually accompanied with copious drainage. Patients with such symptoms as fever, intractable headache, pain extending to the temporomandibular joint, or development of neurological palsies should be evaluated for malignant (necrotizing) OE. Diagnosis of malignant OE is usually made through a combination of clinical, laboratory, and radiological tests.

Microbiology

There have been many studies on the bacteriology of AOM. The majority of bacteria are isolated from cultures of middle ear fluid. The results consistently demonstrate Streptococcus pneumoniae as the most common pathogen, followed by Haemophilus influenzae and Moraxella catarrhalis. Recent consensus guidelines estimated the frequency of bacterial isolates in AOM as follows: S. pneumoniae 39% (27%-52%), H. influenzae 27% (16%-52%), M. catarrhalis 10% (2%-27%), and other pathogens 3% (0%-11%). These other pathogens included S. pyogenes, Staphylococcus aureus, and Pseudomonas aeruginosa.

S. pneumoniae is the most important bacterial cause of otitis media; however, only a few types are responsible for most disease. The prevalence does not seem to vary with patient ages. S. pneumoniae is the least likely to resolve without treatment compared with H. influenzae, which tends to resolve spontaneously. H. influenzae is associated with nontypable strains in the vast majority of patients. Approximately 10% is due to H. influenzae type B, which can be prevented by immunization. M. catarrhalis has greater frequency in the autumn and winter. Beta-lactamase is found in approximately 25%-45% of H. influenzae and 70%-100% of M. catarrhalis isolated.

Microbial flora isolated in OME are the same as in AOM. There are some differences between the presentation of OME and AOM. First, the inflammatory process has clearly resolved and the number of bacteria has decreased.

### Table 1

<table>
<thead>
<tr>
<th>Signs and symptoms of childhood ear infections</th>
<th>Acute otitis media</th>
<th>Otitis media with effusion</th>
<th>Otitis externa</th>
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</thead>
<tbody>
<tr>
<td><strong>Signs and symptoms</strong></td>
<td>Tympanic membrane: bulging, erythema, otorrhea</td>
<td>Cloudy appearance of tympanic membrane with decreased mobility, Air-fluid level in middle ear, Possible hearing loss</td>
<td>External ear canal (bacterial): edema, erythema, pruritus, possible otorrhea, pain on tragus (Fungal): itching, sensation of fullness ± symptoms listed for bacterial</td>
</tr>
<tr>
<td><strong>Nonspecific symptoms:</strong> otalgia (pulling of ear), fever, irritability, nasal stuffiness</td>
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decreased in OME versus AOM. Second,  S. pneumoniae is less frequent, whereas  H. influenzae and  M. catarrhalis are more common pathogens.

Although AOM is generally considered a bacterial infection, viruses play a significant role in the etiology of this condition. The respiratory viruses normally co-incide with bacterial pathogens in most patients. The concomitant viral infection can lead to persistent symptoms or interfere with bacterial clearance despite antimicrobial therapy. These respiratory viruses include respiratory syncytial, parainfluenza, and influenza virus.

OE is primarily a bacterial infection. The most common cause of OE is  P. aeruginosa followed by staphylococci species. Investigators evaluated 2,039 ear canal specimens from patients with acute OE, finding 53% gram-negative bacteria with 71%  P. aeruginosa. Among the gram-positive organisms identified, staphylococci species accounted for the largest percentage, followed by coryneform (diphtheroids).  S. epidermidis was the most common staphylococci species, followed by  S. aureus. In patients with OE plus otorrhea,  S. aureus is the most common organism. As with other infections, the development of community-associated methicillin-resistant  S. aureus is increasing in OE patients.

Fungi in OE occur in 1%-10% of patients and are usually a result of change in the microbial flora of the ear canal after the use of topical antibiotics.  Aspergillus and  Candida species are the most prominent fungi in OE. The signs and symptoms of fungal OE often are unique from bacterial OE in that patients primarily develop pruritus and have a sensation of “fullness” in the ear.

**Treatment**

**Acute otitis media:** Because clinical practice guidelines exist for the management of AOM, clinicians should make every effort to be familiar with the guidelines and use them to determine the appropriate treatment strategy for each patient based on the patient’s history, clinical presentation, physical exam, and presence of risk factors. Unfortunately, the condition is often overdiagnosed and unnecessary antibiotic treatment is prescribed. The treatment of AOM is associated with significant healthcare costs estimated at $5 billion per year in the United States.

The current AAP guidelines address the management of infection in patients two months to 12 years of age. It is important to note that pediatric doses of medications are based on the patient’s weight. Pharmacists should make every effort to determine a child’s weight upon filling a prescription and to verify that the weight-based dose is appropriate prior to dispensing.

While several different classes of antibiotics have been found to be clinically effective for the treatment of AOM, amoxicillin remains the agent of choice because of its low cost, excellent safety profile, and palatability. Patients who present with the first confirmed episode of AOM should be managed with amoxicillin 80-90 mg/kg/day in two or three divided doses. Patients with persistent high fever, severe otalgia, or those at risk of resistant infections should be managed initially with amoxicillin-clavulanate 80-90 mg/kg/day (of amoxicillin component) divided twice daily. Addition of clavulanate to amoxicillin provides coverage against beta-lactamase-producing strains of  H. influenzae and  M. catarrhalis. Amoxicillin-clavulanate is associated with more diarrhea and gastrointestinal upset compared with amoxicillin. In order to minimize the side effects, clinicians should ensure that only twice-daily formulations or extended-release formulations of amoxicillin-clavulanate are dispensed.

Only patients who are allergic to penicillin or cannot tolerate oral medications should be managed with alternative antibiotics. Cephalosporins such as cefuroxime axetil, cefpodoxime, or cefdinir (Omnicef) can be used if a patient does not exhibit a type I hypersensitivity reac-

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**Table 2**

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<thead>
<tr>
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<th>Recommended</th>
<th>Alternative if type I allergy</th>
<th>Alternative if non-type I allergy</th>
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<tbody>
<tr>
<td><strong>Mild</strong></td>
<td>Amoxicillin 80-90 mg/kg/day ÷ b.i.d.-t.i.d.</td>
<td>Azithromycin 10 mg/kg once daily × 1, then 5 mg/kg/day once daily × 4 days</td>
<td>Cefdinir 14 mg/kg/day ÷ once daily-b.i.d.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clarithromycin 15 mg/kg/day ÷ b.i.d.</td>
<td>Cefpodoxime 10 mg/kg/day once daily</td>
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<td></td>
<td></td>
<td></td>
<td>Cefuroxime axetil 30 mg/kg/day ÷ b.i.d.</td>
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<tr>
<td><strong>Severe</strong></td>
<td>Amoxicillin-clavulanate 80-90 mg/kg/day of amoxicillin ÷ 6.4 mg/kg/day of clavulanate ÷ b.i.d.</td>
<td>Same as above</td>
<td>Ceftriaxone 50 mg/kg IV or IM once daily × 1-3 days</td>
</tr>
</tbody>
</table>

Source: Adapted from American Academy of Pediatrics, Subcommittee on Management of Acute Otitis Media. Diagnosis and management of acute otitis media. Pediatrics 2004
tion to penicillin antibiotics (i.e., anaphylaxis or urticaria). A macrolide antibiotic, azithromycin or clarithromycin, should be the drug of choice in patients who do have a type I hypersensitivity reaction to penicillins. A single 50 mg/kg IV or intramuscular (IM) dose of ceftriaxone can be used in patients unable to tolerate oral antibiotics. Antibiotic selections along with doses are listed in Table 2.

The duration of antibiotic therapy is controversial. The guideline recommends a 10-day course for children less than six years of age and those with severe symptoms. A seven-day course can be used in all other patients.

Patients who fail to respond to initial antimicrobial therapy within 48 to 72 hours should be reassessed and changed to a different antibiotic. Amoxicillin should be changed to amoxicillin-clavulanate if no improvement is seen with first-line therapy. Parenteral ceftriaxone for three days is recommended in patients who initially received amoxicillin-clavulanate with no improvement.

Patients with recurrent otitis media or chronic suppurative otitis media may be candidates for fluoroquinolone therapy. Recently, gatifloxacin (Tequin) has been found to be safe and effective for the management of recurrent/resistant AOM in patients six months of age and over. Gatifloxacin has activity against multidrug-resistant pneumococci and beta-lactamase-producing strains of *H. influenzae* and *M. catarrhalis*. Despite the excellent in vitro activity, antibiotic resistance is developing rapidly to the fluoroquinolones. Therefore, until further research is conducted, the fluoroquinolones should be used cautiously as last-line therapy in patients who have failed amoxicillin-clavulanate or ceftriaxone.

Appropriate management of pain is essential to the management of AOM. Clinicians should assess the severity of otalgia during the physical assessment and recommend strategies to reduce the pain. Agents used for managing pain include both oral and topical agents. Acetaminophen (10-15 mg/kg/dose) or ibuprofen (5-10 mg/kg/dose) can be used for mild to moderate pain. Patients should initially be managed with a scheduled dose to ensure adequate pain management. Acetaminophen with codeine is appropriate for patients with moderate to severe pain. Ototopical agents containing benzocaine and/or antipyrine have been found to be effective for the management of ear pain associated with AOM.

Complementary and alternative medicine strategies (such as homeopathy, herbal remedies, and naturopathy) for the treatment of ear pain have gained popularity in recent years. However, the AAP guideline does not recommend alternative medicine until further research has been conducted.

Two commonly recommended over-the-counter homeopathic agents for ear pain include sweet oil (olive oil) and Similasan Earache Relief. Similasan contains extracts of chamomilla, sulphur, and mercurius solubilis. Chamomilla and sulphur act as pain relievers, while mercurius solubilis has anti-inflammatory properties. These products should be avoided in patients with tympanostomy tubes, ear drainage, or damaged eardrums.

Another approach to the treatment of AOM includes initial observation without antibiotic therapy for 48 to 72 hours following diagnosis. Because AOM resolves spontaneously in most patients, deferring antibiotics can help decrease patient cost, antimicrobial resistance, and unwanted side effects. Evidence has shown that only one out of every seven to 20 children with AOM who is treated with antibiotics will show a clinical benefit. Deferred antibiotic treatment should only be considered for children two years of age or older or in children six months to two years with mild illness at presentation.

### Prevention of AOM

Preventive strategies to reduce the incidence/recurrence of AOM in patients include modification of risk factors and vaccination. Clinicians should encourage parents to breast-feed infants for the first six to 12 months of life, avoid infant exposure to cigarette smoke, avoid pacifier use beyond six months of age, and, if possible, limit exposure to day care centers. While these strategies are recommended, their effectiveness has not been proven.

Vaccinations for children that may help prevent AOM include influenza vaccine, pneumococcal conjugate vaccine, and *H. influenzae* type b (Hib) vaccine. The influenza vaccine should be given annually to all children six months of age and over. Patients under five years should not receive the intranasal influenza vaccine (FluMist). Both the Hib vaccine and Prevnar (7-valent pneumococcal conjugate vaccine) should be administered at two, four, six, and 12 to 18 months for a total of four shots. These vaccines are included in the *Recommended Childhood and Adolescent Immunization Schedule* published annually by the Centers for Disease Control & Prevention. Studies have shown a minimal reduction in the incidence of AOM in patients receiving these vaccines.

### Otitis media with effusion

The clinical practice guideline published by AAP provides evidence-based recommendations on the management of OME in children aged two months to 12 years. Unlike therapy for AOM, therapy for OME is recommended only if symptoms persist and significant clinical benefits can be achieved beyond spontaneous resolution.

First-line management of OME includes watchful waiting for three months following diagnosis. Antimicrobial therapy is not recommended due to lack of efficacy data in long-term resolution of OME. There are randomized trials that have shown modest short-term benefits; however, adverse events such as rashes, allergy,
and resistance outweigh the benefits. There is also lack of evidence for long-term benefit to support the use of antimicrobial therapy with or without steroids. A single course of therapy for 10 to 14 days is an option for those who are averse to surgical options for their children. However, long-term resolution is meager and repetitive therapy with or without steroids is not recommended.

Oral steroid therapy is not recommended in the treatment of OME in children. A recent meta-analysis showed no benefit of oral steroids versus placebo. Additionally, oral steroids produce unwanted adverse events such as weight gain, altered behavior, increased appetite, and adrenal suppression.

In addition, the guideline does not recommend utilizing antihistamine-decongestant combinations in treating OME. A meta-analysis in 1994 showed no benefit versus placebo, and no further studies have been conducted. Adverse events from antihistamines and decongestants, such as drowsiness, excitability, or behavioral changes, could worsen and complicate the situation.

One risk of persistent OME is hearing loss. The guideline recommends surgical placement of tympanostomy tubes in patients with persistent effusions and/or hearing loss. Randomized trials have demonstrated a decrease in effusion prevalence of around 60% following tube placement. However, up to half of the patients who have tubes will have a relapse of OME, which may require additional surgery. This usually

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Prescription and OTC otic preparations</th>
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<tbody>
<tr>
<td><strong>Category of topical otic preparation</strong></td>
<td><strong>Brand name(s)</strong></td>
</tr>
<tr>
<td><strong>PRESCRIPTION PRODUCTS</strong></td>
<td></td>
</tr>
<tr>
<td>Astringents</td>
<td>VoSol Otic; Acetasol</td>
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<tr>
<td></td>
<td>VoSol HC; Acetasol HC</td>
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<tr>
<td></td>
<td>Burow’s Otic; Otic Domeboro</td>
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<tr>
<td>Analgesic/Anesthetic</td>
<td>Auralgan; Allergen</td>
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<tr>
<td></td>
<td>Americaine; Otocaine</td>
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<tr>
<td></td>
<td>Zoto HC</td>
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<tr>
<td>Aminoglycoside-based products</td>
<td>Cortisporin Otic; Antibiotic; Otosporin</td>
</tr>
<tr>
<td>Fluoroquinolone-based products</td>
<td>Cipro HC Otic</td>
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<tr>
<td></td>
<td>CiproDex</td>
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<tr>
<td></td>
<td>Floxin Otic</td>
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<tr>
<td><strong>OTC PRODUCTS</strong></td>
<td></td>
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<tr>
<td>Earwax removal</td>
<td>Murine Ear</td>
</tr>
<tr>
<td></td>
<td>Debrox, Auro Ear Drops</td>
</tr>
<tr>
<td>Drying agents</td>
<td>Swim-Ear, Auro-Dri</td>
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</tbody>
</table>

*Note: This is not an all-inclusive list. Source: Adapted from Facts and Comparisons 4.0, 2005.
Otitis externa

Initial treatment goals in acute OE include pain reduction, eradicating the pathogens responsible for infection, and reestablishing the integrity of the lining of the ear canal. Depending on the severity of acute OE, different therapies may be employed. Controversy exists in the treatment of early- or new-onset acute OE over whether to use astringents or to proceed immediately to topical antibiotics. In acute OE of suspected bacterial origin, consensus exists to employ topical antibiotics.

If a patient has significant otorrhea or impacted cerumen, most literature recommends a gentle cleansing of the external auditory canal and suctioning of debris under instrumentation. This is recommended only for patients who have an intact tympanic membrane. If ear debris is crusted, hydrogen peroxide may be instilled into the ear canal to soften it. In addition, a wick or gauze strip can be placed in the canal to relieve canal edema or facilitate the passage of antibiotic therapy. Ear wicks or ribbon gauze should be left in only for a maximum of three days and may be used in conjunction with topical antibiotics. Once the wick or gauze is removed, topical antibiotics should be continued for seven to 10 days.

As mentioned previously, some clinicians endorse the use of astringents or pH-modifying agents in early, acute OE. One technique involves flushing the ear canal with 3% hypertonic saline several times daily. Another recommended technique is acidifying the canal with 2% acetic acid preparations with or without the use of ear wicks. Some acetic acid products have additional astringents, such as boric acid, or mild antimicrobial agents, such as aluminum acetate, added. Combination products based with peroxides or alcohols may be used as well. Table 3 lists ototopical preparations along with dosing recommendations.

Several disadvantages exist with the utilization of acidifying agents that have contributed to their declining use. Such disadvantages include increased canal irritation, ototoxic potential with exposure to the inner ear, and change in the balance of normal microflora of the canal. Finally, the majority of these agents need to be administered three or more times daily.

Topical antibiotics are most commonly employed for acute OE. Current antimicrobial therapy includes combination products with either aminoglycosides or fluoroquinolones as the active constituents. Due to fluoroquinolone resistance issues, many clinicians initiate topical antibiotic therapy with aminoglycoside products in acute OE. Topical fluoroquinolones should be reserved for moderate to severe cases of OE or those patients who did not respond to the initial therapy.

Historically, topical aminoglycosides such as neomycin were used to treat acute OE caused by gram-negative bacteria. Neomycin exhibits activity against both gram-negative organisms and staphylococci species. Neomycin is usually combined with polymyxin, a polypeptide antibiotic with activity against gram-negative organisms, and hydrocortisone. Polymyxin adds no additional antimicrobial coverage, but it decreases the potential for neomycin sensitization. In the 1990s, studies with polymyxin/neomycin/hydrocortisone (PNH) demonstrated cure rates ranging from 87% to 97%.

According to a recent national survey, neomycin-based products were still the most commonly prescribed topical antibiotics. PNH products are relatively inexpensive and efficacious in mild acute OE; however, specific considerations must be taken into account. Aminoglycoside-based products should not be used in patients with a perforated tympanic membrane due to the increased risk for vestibulotoxicity and hearing loss. Second, patient compliance is an issue as PNH drops need to be instilled three to four times daily.

There has been an increase in prescribing of topical fluoroquinolones such as ciprofloxacin and ofloxacin for OE. These fluoroquinolones work effectively against both gram-positive and gram-negative bacteria. Unlike neomycin-based products, they lack ototoxic properties and may be used in patients with perforated tympanic membranes. Quinolone otic drops are simpler to use than PNH as they are dosed twice daily, but they are considerably more expensive. Studies show mixed results regarding differences in clinical cure rate between PNH and ciprofloxacin products.

Both the acidifying agents and the topical antibiotics may be combined with steroids. The steroids will decrease the inflammation, but they may cause immunologic suppression and topical sensitization. Due to this fact and the varying results in studies, controversy exists as to whether or not a steroid in combination with other topical agents is necessary.

Recommendations regarding the duration of topical antibiotic therapy differ based on the severity of OE. Most clinicians treat mild cases of acute OE for seven days. For moderate to severe OE cases, treatment duration ranges from 10 to 14 days.

Systemic antibiotics should not be prescribed for patients with mild to moderate OE; they should be reserved for patients with persistent or refractory OE. If a patient develops a fever or infection has spread locally into cellulitis or lymphadenitis, initiation of systemic antibiotics may be appropriate. Oral antibiotics may be considered for immunocompromised patients with mild OE. IV antibiotics such as vancomycin are usually reserved for
severe infections such as necrotizing external otitis.

Systemic antibiotics should provide empiric coverage for *Pseudomonas* and *Staphylococcus* species. Oral fluoroquinolones should be used with caution in children. Ciprofloxacin is the only fluoroquinolone that has been approved for children one to 17 years of age. Alternatives to fluoroquinolones may include penicillinase-resistant penicillins and second- or third-generation cephalosporins. If *Staphylococcus* alone is suspected, one may consider dicloxacillin or an antistaphylococcal cephalosporin.

Acute, infectious OE can be prevented if patients avoid ear trauma and select environmental conditions and situations. Patients should avoid inserting any objects such as pencils or cotton swabs that may scratch or damage the lining of the canal. Nontraumatic drying of the ear canal should be considered after water exposure. Topical acidifying or drying agents such as Swim-Ear (95% isopropyl alcohol, anhydrous glycerin) may be preventive as well.

**Bacterial resistance**

Antimicrobial use is a major contributor to the emergence of resistance in the respiratory pathogens. Antimicrobial resistance is a concern in OM, since it is the most common microbial infection in early childhood and the leading reason for antimicrobial use in children in most industrialized countries. As previously noted, the two most common pathogens isolated from AOM patients are *S. pneumoniae* and *H. influenzae*. Pneumococcal resistance to penicillin was first observed in the 1960s. Recently, emergence and spread of penicillin-resistant *S. pneumoniae* strains have been observed and tracked worldwide. Both penicillin-intermediate and penicillin-resistant *S. pneumoniae* are common causes of AOM in the United States.

A steadily increasing number of *H. influenzae* and nearly all *M. catarrhalis* strains are beta-lactamase producers. These resistant pathogens are most commonly isolated during the winter months from children in day care, children younger than two years, children recently treated with antimicrobials, and children who have not responded to treatment.

With the wide use of beta-lactams, increasing levels of penicillin-resistant *S. pneumoniae* were thought to have greater potential clinical importance than the emergence of macrolide-resistant *S. pneumoniae* strains. Increasing macrolide use has also been associated with an increase in pneumococcal resistance to these agents. Macrolide-resistant *S. pneumoniae* are now more common than penicillin-resistant *S. pneumoniae* in many parts of the world. Factors contributing to this development are inappropriate use of antimicrobial drugs, using antimicrobial drugs to treat nonmicrobial or self-limiting infections (i.e., often AOM), using agents with a spectrum of activity that either does not cover the appropriate causative pathogen(s) or has too broad a spectrum of activity, and inappropriate dose or duration of treatment.

Because most resistant strains of *S. pneumoniae* are also resistant to other classes of antimicrobials—such as macrolides, trimethoprim-sulfamethoxazole, and clindamycin—options become limited and the potential for treatment failure increases. This has motivated a search for newer drugs that are effective against resistant strains.

The most important consideration in selecting an antimicrobial for managing AOM is efficacy against *S. pneumoniae*. Although this pathogen as a cause of AOM is decreasing in the wake of widespread use of the 7-valent pneumococcal conjugated vaccine, it is also the least likely of the three main pathogens to resolve spontaneously without treatment. In addition, selected antibiotics that have efficacy against beta-lactamase-producing strains of *H. influenzae* and *M. catarrhalis* are recommended. *S. pneumoniae* with reduced susceptibility to penicillin, and *H. influenzae* that produce beta-lactamase are significantly more prevalent among children than adults. This is especially true among children who attend day care or who have had prior treatment within the month.

Antimicrobial agents chosen empirically must not only have activity against the major pathogens, they must also achieve peak concentrations in the middle-ear fluid sufficient to eradicate *S. pneumoniae* with reduced susceptibility to penicillin and retain activity if beta-lactamase is produced by a gram-negative organism.

Controversy over resistance to ototopical medications exists when evaluating the treatment of OE. In the majority of OE studies, the eradication of the offending organism was 85% or higher. However, the clinical cure rate was often high due to the fact that some resistant organisms can be overcome with high, localized drug concentrations in the ear. This is the reason that ototopical antibiotics are recommended in the management of OE. Organisms are becoming more resistant to traditional ototopical medications such as PNH. One theory is that the increasing use of fluoroquinolone ear drops has led to the increase in resistance.

**Conclusion**

Ear infections occur frequently throughout childhood and are associated with significant healthcare costs. An appropriate understanding of the presentation, causes, treatment, and prevention strategies is necessary in order to counsel patients. Pharmacists need to understand the rationale for different treatment strategies based on each type of ear infection and be familiar with pharmacologic agents used to treat the infection and its symptoms.

*References are available upon request.*
1. Which of the following statements is true regarding acute otitis media (AOM)?
   a. OM develops when bacteria or viruses travel from the eustachian tubes into the nasopharynx.
   b. Children are more susceptible to ear infections because their ear canals are short and horizontal.
   c. The incidence of OM increases with age.
   d. The presence of adenoids in children allows easier clearance of bacteria and/or viruses that cause ear infections.

2. Symptoms consistent with a clinical presentation of AOM include which of the following?
   a. Hearing loss and otorrhea
   b. Otalgia and fever
   c. External ear inflammation
   d. Fullness of ear and fever

3. Which of the following factors increases a patient’s risk of developing otitis externa (OE)?
   a. An alkaline environment in the ear canal
   b. Living in a dry climate
   c. Low-set ears
   d. A history of OM

4. Signs and symptoms of OE may include all of the following except:
   a. Pruritus
   b. Otorrhea
   c. Nasal stuffiness
   d. Otalgia

5. The most common organism isolated in AOM is:
   a. Pseudomonas aeruginosa
   b. Candida albicans
   c. Staphylococcus aureus
   d. Streptococcus pneumoniae

6. Which organisms are more frequently isolated in otitis media with effusion (OME)?
   a. S. epidermidis and S. pneumoniae
   b. Haemophilus influenzae and Moraxella catarrhalis
   c. S. aureus and H. influenzae
   d. M. catarrhalis and S. pneumoniae

7. Which of the following organisms is a beta-lactamase producer?
   a. M. catarrhalis
   b. S. aureus
   c. P. aeruginosa
   d. S. pneumoniae

8. The most common infectious cause of OE is:
   a. S. epidermidis
   b. P. aeruginosa
   c. C. albicans
   d. H. influenzae

9. Which of the following is first-line therapy for a two-year-old female with an initial episode of AOM?
   a. Ceftriaxone
   b. Amoxicillin-clavulanate
   c. Amoxicillin
   d. Azithromycin

10. If a patient has a type I allergy to penicillin (i.e., anaphylaxis), which agent should be recommended for the treatment of AOM?
    a. Ceftriaxone
    b. Cefdinir
    c. Azithromycin
    d. Amoxicillin-clavulanate

11. The clinical practice AAP guideline recommends which of the following agents for first-line treatment of otalgia in patients with mild AOM?
    a. Acetaminophen with codeine
    b. Sweet oil
    c. Ibuprofen
    d. Auralgan

12. Prevention of recurrent AOM can be achieved with which of the following strategies?
    a. Breast-feeding for the first six to 12 months of life
    b. Repeated courses of prophylactic antibiotics
    c. Attendance in day care
    d. Chronic use of antibacterial ototopical preparations

13. Which of the following is recommended by the clinical practice guideline for the treatment of OME?
    a. Antimicrobial therapy
    b. Oral steroid therapy
    c. Surgery
    d. Antihistamine and decongestant combinations

14. Initial therapy for acute OE should always include:
    a. Ear wicks or ribbons
    b. Thorough cleansing of the ear canal
    c. Oral antibiotics
    d. Astringents or topical antibiotics

15. Regarding topical antibiotic use, which of the following statements is correct?
    a. Ciprofloxacin otic drops are considered first-line therapy for most patients.
    b. Polymyxin/neomycin/hydrocortisone combination should be used only in patients with perforated tympanic membranes.
    c. When considering daily dosing of medications, topical fluoroquinolone drops need to be administered less frequently than aminoglycoside combination products.
    d. Regardless of topical antibiotic used, otic drops should be administered for three days.

16. When counseling a parent on preventing the recurrence of OE, one may suggest:
    a. Frequent cleaning of ears with cotton swabs
    b. Use of topical acidifying or drying agents after swimming
    c. Wax earplugs while showering
    d. Oral antibiotics in the summer

17. The initial treatment of otitis externa includes which of the following?
    a. Removal of earwax with a Q-tip and antibiotics
    b. Systemic antibiotics and analgesics
    c. Alcohol lavage and analgesics
    d. Eradication of pathogen and relief of pain

18. When contained in otic preparations, antipyrine acts as an:
    a. Antibacterial
    b. Analgesic
    c. Earwax remover
    d. Astringent
19. Swim-Ear contains which of the following ingredients?
   a. Carbamide and glycerin
   b. Antipyrine and benzocaine
   c. Isopropyl alcohol and glycerin
   d. Pramoxine and chloroxylenol

20. Which resistant organism is the primary cause of treatment failure in OM?
   a. Macrolide-resistant S. pneumoniae
   b. Vancomycin-resistant S. aureus
   c. Penicillin-resistant S. pneumoniae
   d. Vancomycin-resistant enterococci

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