NCC Pediatrics Continuity Clinic Curriculum:
Otitis Media
Faculty Guide

Goals & Objectives:

Goal: Increase your knowledge and skill in the diagnosis of otitis media and options for treatment in children

Objectives: At the end of this module, the pediatric resident should be able to:

- Describe the current recommendations for the diagnosis and treatment of otitis media with effusion.
- Describe ways to position a child for examination and use of the proper size speculum
- State the 3 most common bacteria that cause AOM
- Describe the guidelines regarding whether or not to use antibiotics by age and presentation
- Recognize normal vs abnormal TMs on an ear simulator (optional)

Pre-Meeting Preparation:

- Read: "Otitis Media: To Treat, To refer, To Do Nothing" (*Peds In Review 2015*)
- Review the **JOB AID** card and all the tables from *Contemporary Pediatrics 2015*
- Complete quiz questions prior to clinic
- Review the otitis media cases

Conference Agenda:

- Review the otitis media quiz answers
- Complete the otitis media cases if time allows **OR**
- Use the Oto-Sim simulator if available to identify normal vs abnormal TMs

Extra Credit:

- **Wisconsin Med Otoscopy Library**
- **CHOP Clinical Pathway for AOM**

- Otitis Media Quiz#1
- Otitis Media Quiz#2
- **"Otitis Media"** (*Nature Reviews Disease Primers, 2016*)
- **"Otitis Media: Rapid Evidence Review"** (*American Family Physician, 2019*)
- **AAP Otitis Media Clinical Practice Guidelines** *(2013)*
- **"Clinical practice guidelines for acute otitis media in children: a systematic review..."** (*BMJ, 2019*)
- **"Watchful Waiting for Acute Otitis Media"** *(Pediatrics 2022)*
- **"Improving Adherence to AAP Acute Otitis Media Guidelines. . .)** *(Pediatric Quality and Safety, 2022)*
- **"Rethinking Our Approach to Management of Acute Otitis Media"** *(JAMA Peds, 2022)*
- **"Antibiotics for acute otitis media in children"** *(Cochrane Review, 2023)*

- **Acute Otitis Media** *(JAMA Pediatrics Patient Page, 2020)*
- **Ear Infections (Beyond the Basics)** (*Up To Date, 2024*)

<-Patient Education

Adapted from published materials and from original work by J. Lopreiato, MD January 2018, updates Feb 2024.

Otitis Media: To Treat, To Refer, To Do Nothing: A Review for the Practitioner

Jose Rosa-Olivares, MD,* Amanda Porro, MD,* Marielys Rodriguez-Varela, MD,* Gloria Riefkohl, MD,* Iran Niroomand-Rad, DO*

Nicklaus Children's Hospital, Pediatric Care Center, Miami, FL.

Practice Gap

Acute otitis media is the most common bacterial illness in children and the most common medical condition for which antibiotics are recommended. A significant part of the financial burden resides in frequent antibiotic prescriptions, despite published evidence showing that antibiotics often are not indicated for treatment. This and other factors suggest the need for a review of the management of otitis media.

Objectives

After completing the article, the reader should be able to:

1. Provide a review of the current recommendations for the recognition and treatment of acute otitis media.
2. Describe the current recommendations for the diagnosis and treatment of otitis media with effusion.
3. Delineate the complications related to chronic suppurative otitis media.

INTRODUCTION AND EPIDEMIOLOGY

Otitis media (OM) is one of the most common clinical complaints in the pediatrician's office, accounting for more than 30 million clinic visits per year. (1) It is the second leading diagnosis in pediatric emergency department visits, comprising approximately 13% of all emergency department visits in any given year. Costs are estimated at more than $100 per episode of OM, with up to $5 billion spent in diagnosis and treatment annually. Most cases occur in children between 6 and 24 months of age, with a peak incidence between 9 and 15 months. In fact, as many as 62% of children have an episode of OM by the time they are 12 months old, and up to 83% of children are affected by their third birthday. (1) Acute OM (AOM) is uncommon in the first 6 postnatal months, and if identified, further evaluation is warranted. OM can be clinically identified as one of three entities: otitis media with effusion (OME), AOM, and chronic suppurative otitis media (CSOM).

AUTHOR DISCLOSURE Drs Rosa-Olivares, Porro, Rodriguez-Varela, Riefkohl, and Niroomand-Rad have disclosed no financial relationships relevant to this article. This commentary does not contain a discussion of an unapproved/investigative use of a commercial product/device.

PATHOGENESIS OF ACUTE OTITIS MEDIA AND OTITIS MEDIA WITH EFFUSION

Eustachian tube dysfunction is usually triggered by a viral process. Such dysfunction is further complicated in early infancy by the horizontal anatomy of the tube, which makes middle ear fluid flow more challenging. Usually a viral upper respiratory tract infection precedes the onset of middle ear effusion (MEE). A viral process increases mucus production in the nasopharyngeal region, creating inflammation in the area. This eventually results in closure of the eustachian tube and buildup of fluid behind the tympanic membrane (TM). When OME develops, the middle ear fluid is sterile, but secretions from the nasopharyngeal area are not. Microorganisms present in the nasopharynx reflux into the middle ear space when the eustachian tube temporarily relaxes. This can result in bacterial adherence and colonization, which eventually can develop into the inflammatory process of AOM.

Eustachian tube function can be further compromised by factors such as bottle-feeding. Compared to breastfeeding infants, the child drinking from the bottle typically does not need to exert strong negative pressure to suck and swallow with breathing efforts. Because of pressure gradients and positioning during feeding, bottle-fed infants are more prone to develop milk pooling and pressure differentials between the middle ear and the nasopharynx, thereby reducing eustachian tube drainage. (2) Thus, exclusive breastfeeding for the first 6 months after birth protects against AOM and continues to be the recommendation of the American Academy of Pediatrics (AAP).

In addition to age and eustachian tube dysfunction, other factors contribute to the development of AOM and OME. The most common are listed in the Table.

Bacterial pathogens that most commonly trigger the inflammatory changes of AOM are *Streptococcus pneumoniae* (12%), nontypeable *Haemophilus influenzae* (56%), and *Moraxella catarrhalis* (22%). These bacteria are prevalent at all ages, including neonates. In addition, Gram-negative bacilli have been implicated in 10% of cases reported during the neonatal period. Of note, the incidence of *S pneumoniae*-related infections has significantly decreased since the implementation of universal vaccination with pneumococcal conjugate vaccine (PCV)7 and is projected to decrease further with the use of the PCV13 vaccine. Currently, nontypeable *H influenzae* strains are becoming the primary otopathogen in AOM, particularly in older children. During the first months after birth, diagnosing OM can be difficult due to limited examination and improper instrumentation. If AOM is diagnosed in the neonatal period, careful evaluation and follow-up is necessary because OM may be an isolated local infection or part of a septicemia. Depending on the presence or absence of fever, a partial or full sepsis evaluation and tympanocentesis for culture of the middle ear should be considered for the neonate.

TABLE. **Risk Factors for the Development of Acute Otitis Media and Otitis Media With Effusion**

• Secondhand smoke	• Suboptimal breastfeeding rates
• Preterm birth	• Male gender
• Propped bottles/ supine feeding position	• Poor parental education
• Lack of pneumococcal vaccination	• Young age
• Siblings at home	• Day care participation
• Poor maternal health during pregnancy	• Allergic rhinitis
• Congenital facial or nasal anomalies	• Adenoid hypertrophy
• Family history of recurrent acute otitis media	• Obesity
• Gastroesophageal reflux	• Immunodeficiencies
• Pacifier use	• Ethnicity
• Fall and winter season	

CLINICAL MANIFESTATIONS OF ACUTE OTITIS MEDIA AND OTITIS MEDIA WITH EFFUSION

Patients with AOM often present with rapid onset of fever and ear pain as well as nonspecific signs, such as ear pulling/rubbing, irritability, decreased sleep, and other behavioral changes. Of these, ear pain is usually the most prominent symptom. Combinations of these clinical manifestations along with physical findings are key for diagnosing AOM. Differentiating between AOM and OME on physical examination depends on a combination of factors:

- Moderate-to-severe bulging of the TM (Fig 1) or new-onset otorrhea that is not related to otitis externa
- Mild bulging of the TM combined with sudden recent onset of ear pain or intense erythema of the TM

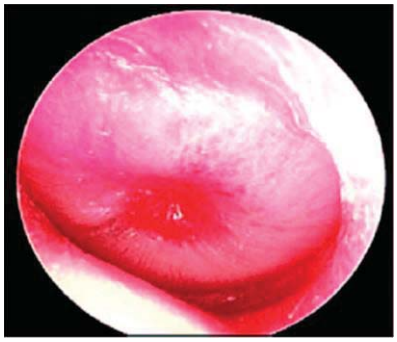


Figure 1. Acute otitis media. Reprinted with permission from Siegel RM, Bien JP. Acute otitis media in children: a continuing story. *Pediatr Rev*. 2004;25:187–193.

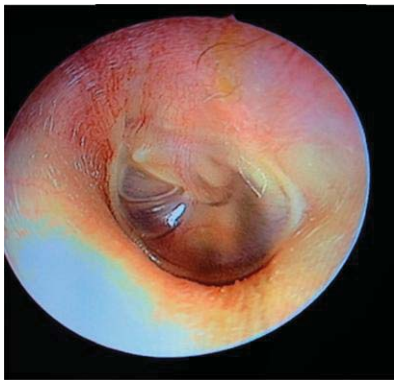


Figure 2. Otitis media with effusion. Courtesy of Yadiel A. Alameda, MD, Caribbean Sinus and Ear Institute, Puerto Rico.

- Presence of MEE

Bullous myringitis may occur in association with AOM in fewer than 10% of cases. In the past, *Mycoplasma* was believed to be the causative agent, but researchers have determined that the pathogens causing bullous myringitis and AOM are the same. Bullous myringitis is simply an extension of AOM and is not an indication for macrolide therapy.

OME is defined as the presence of middle ear fluid in the absence of acute symptoms such as TM bulging or erythema, otorrhea, pain, or fever. OME is the most prevalent ear disease in children. Between 80% and 90% of children have at least one confirmed episode of OME before school age and many develop recurrent (30%–40%) or persistent (5%–10%) effusion. Up to 50% of patients have OME 1 month after initial diagnosis of AOM, one third have OME 2 months after AOM, and 10% have OME 3 months after AOM. Tympanocentesis is the preferred method for detecting the presence of MEE, but it is rarely performed in the primary care setting. Otoscopy usually shows a translucent, gray or pink TM in a neutral or retracted position and visible fluid behind it (Fig 2). OME is the most common cause of conductive hearing loss in children. Children at high risk for language delay, learning problems, or evidence of significant hearing loss should be monitored at 3-month intervals to ensure resolution of the effusion. Intervention is necessary if hearing loss or structural abnormalities to the TM or middle ear are suspected. Pediatricians should consider otolaryngology (ENT) evaluation for patients whose OME persists longer than 3 months and is accompanied by speech delay and/or conductive hearing loss.

The AAP, American Academy of Family Physicians, and American Academy of Otolaryngology-Head and Neck Surgery all agree that the best tool to differentiate AOM from OME is pneumatic otoscopy. Reduced mobility of the TM or response to negative pressure on pneumatic otoscopy is pathognomonic for OME. As an adjunct to otoscopy, tympanometry and acoustic reflectometry may be used to obtain a diagnosis. There is no evidence that these modalities are superior to pneumatic otoscopy. Tympanometry measures sound transmission by evaluating TM compliance, with more fluid in the middle ear creating less compliance of the membrane and less sound transmission. Acoustic reflectometry measures sound intensity when reflected back from the TM, with more fluid in the middle ear resulting in less mobility of the TM and, therefore, louder reflected sound captured by the instrument.

MANAGEMENT OF ACUTE OTITIS MEDIA

When choosing a treatment plan for AOM, clinicians must consider both patient age and illness severity. The primary decision is whether observation without antibiotics (watchful waiting) is appropriate.

Observation with pain control (acetaminophen, ibuprofen, or topical anesthetics such as antipyrine-benzocaine drops) is a management option for children between 6 and 24 months of age who have unilateral nonsevere illness and for children older than 24 months who have unilateral or bilateral nonsevere disease. When feasible, observation without antibiotics is preferred because any reduction in antibiotic use is associated with decreased costs, fewer adverse effects, and diminished microbial resistance.

Pain with AOM may cause significant distress during the first few days of illness that often persists longer in younger children. Analgesics can provide pain relief within 24 hours, allowing some time for symptomatic alleviation

while the patient's natural immunity begins to respond. It is important to inform parents that symptomatic relief without the use of analgesics occurs 3 to 5 days into treatment for children who require antibiotic treatment. Follow-up should be arranged within 48 to 72 hours for reevaluation, whether in person or by phone, and if there is no improvement or symptoms have worsened, medical management should be instituted.

The justification for withholding antibiotic treatment from selected children with AOM is based upon analysis of numerous clinical trials conducted over the past 30 years. Review of these trials suggests most children with AOM do well without antimicrobial therapy. Observing children with AOM who are likely to improve on their own without initial antibiotic therapy reduces common adverse effects of antibiotics, such as diarrhea and diaper dermatitis. In two trials, antibiotic therapy significantly increased the absolute rates of diarrhea by 10% to 20% and of diaper rash or dermatitis by 6% to 16%. In addition, reduced antibiotic use decreases the prevalence of resistant bacterial pathogens. (3) Providing a good analgesic plan for parents, explaining what to expect in terms of pain control, and discussing the need for follow-up, especially if the signs and symptoms worsen, is an appropriate evidence-based approach.

Current guidelines from the AAP recommend immediate treatment for children younger than 6 months of age, those with severe illness, and children younger than 24 months of age with bilateral AOM. Once the decision is made to start antibiotic therapy, medication choice depends on when the child was treated last:

- If it has been more than 30 days from the last infection and the patient does not have purulent conjunctivitis (which can indicate infection by beta-lactam-resistant nontypeable *H influenzae),* amoxicillin is the antibiotic of choice dosed at 90 mg/kg per day divided in two doses. This higher dosing allows for better drug penetration into the middle ear as well as increased minimal inhibitory concentration. High-dose amoxicillin may also overcome the mechanism of penicillin resistance associated with PBP2x (penicillin-binding protein) in *S pneumoniae.*
- If it has been fewer than 30 days from the last infection or there is concomitant purulent conjunctivitis, amoxicillin plus clavulanate should be used, with the amoxicillin component at 90 mg/kg per day divided in two doses.

In cases of penicillin allergy, cefdinir, cefuroxime, cefpodoxime, and ceftriaxone are acceptable alternatives. If there is no improvement after treatment with amoxicillin for 48 to 72 hours, amoxicillin-clavulanate should be administered. Alternative drug choices for those with penicillin allergy in this situation are ceftriaxone and clindamycin. The length of treatment with oral antibiotics should be 10 days for children younger than 2 years of age, 7 days for children ages 2 to 5 years, and 5 to 7 days for children 6 years and older. If using ceftriaxone intramuscularly, the treatment duration is 3 days.

Close follow-up evaluation for patients with AOM is important because persistent treatment failure may necessitate further evaluation by an otolaryngologist or infectious disease specialist. In these cases, tympanocentesis or myringotomy tube placement may be indicated. This allows for culturing of the fluid specimen from the middle ear for bacteriologic diagnosis as well as drainage of the infection. Identifying the causative agent may also be necessary in immunocompromised patients and in those who are seriously ill or who have suppurative complications. The algorithm in Figure 3 describes the evaluation and management of AOM.

MANAGEMENT OF OTITIS MEDIA WITH EFFUSION

The aim of treatment for OME is to prevent its two major complications: transient hearing loss potentially associated with language delay or behavioral problems and chronic anatomic injury to the TM that usually leads to surgery. As with AOM, the initial modality is watchful waiting. There is little harm in observing the child who is not at risk for speech, language, or learning difficulties compared to medical or surgical intervention. Parents should be informed that the child may have reduced hearing until the effusion resolves, but a short-lived effusion has minimal effect on the child's language development. About 70% to 90% of OME cases that result from AOM resolve spontaneously by 3 months. Documented bilateral OME of 3 months' duration or longer resolves spontaneously after 6 to 12 months in about 30% of children who are older than 2 years of age. In the absence of hearing loss, damage to the ossicular structure, or other middle ear pathology, all children with OME should be clinically reevaluated at 12-week intervals until the effusion clears or other complications are identified. As recommended by the AAP, screening for speech delays should be undertaken at all health supervision visits as well as at these clinical reevaluations. If speech delay is a concern, the child should be referred for further evaluation. On the other hand, if complications such as atelectasis of the TM, retraction pockets, persistent perforation with discharge, or cholesteatoma are identified, the

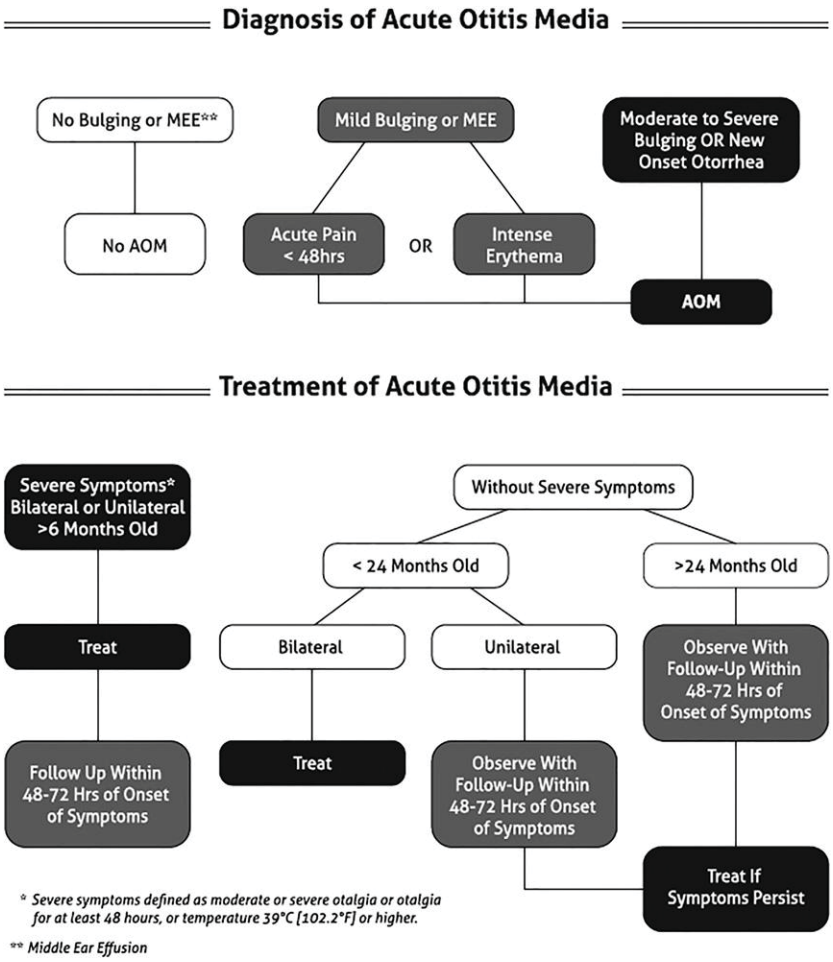


Figure 3. Algorithm created by Claudette Gonzales, MD, and Gabriela Saca, MD, based on information from: Lieberthal AS, et al. The diagnosis and management of acute otitis media. *Pediatrics*. 2013;131(3):e964–e999 and Leibovitz E, et al. Bacteriologic and clinical efficacy of one day vs. three day intramuscular ceftriaxone for treatment of nonresponsive acute otitis media in children. *Pediatr Infect Dis J*. 2000;19(11):1040–1045.

patient should be seen promptly (4 weeks or less) by the ENT specialist.

Medical treatment for OME is appropriate only if persistent and significant clinical benefits can be obtained clinically beyond spontaneous resolution. Studies in the past have shown a mild improvement following antibiotic therapy, but the benefits were only transient. New studies are focusing on the characteristics of the middle ear mucosa with chronic OME. A biofilm structure has been identified that could protect bacteria from medications and would argue against the benefit of antibiotic use in the management of OME. A biofilm is a complex community of microorganisms attached to a surface and protected by an extracellular polysaccharide matrix. Biofilms have been implicated in the failure of antimicrobials, reduction of their efficacy, and survival of residual organisms following drug therapy. Macrolides have known antibiofilm and anti-inflammatory properties and have been tested with promising results. Chen et al (4) showed that macrolides, specifically clarithromycin, can decrease recovery time for OME (effective rates 88.7%–92.5%, $P < 0.01$) if used in full doses for 1 week and then decreased to a low dose until after 1 week of documented resolution of MEE, typically for a total of 8 to 12 weeks. This research suggests that surgical intervention could be delayed or even avoided if macrolides clear the middle ear fluid, but further studies are needed to prove this hypothesis. Studies in which patients used antihistamines and decongestants, alone or in combination, found no benefit for any of the short- or long-term outcomes, including resolution of the fluid, hearing problems, or the necessity of additional referral to specialists. (5) Of interest, even children with allergic rhinitis and OME do not benefit from these medications. Therefore, antihistamines and decongestants are not recommended. Studies evaluating the efficacy of complementary and alternative medicine therapies have also failed to prove their efficacy in the treatment of AOM or OME.

ENT referral for evaluation of tympanostomy tubes is recommended if OME persists for more than 6 months

in one ear or 3 months in both ears in association with a 30-dB hearing loss in the speech range (500–2,000 Hz). Myringotomy alone is not recommended for OME treatment because 20% to 50% of children may relapse and need additional surgical intervention. Similarly, tonsillectom and adenoidectomy are not routinely performed unless there are concomitant disease processes warranting such interventions. ENT evaluation is also encouraged in patients who have developed structural damage to the TM, such as retraction pockets, tympanosclerosis, and cholesteatoma (the latter usually is associated with dizziness, facial nerve weakness, or visible keratin debris in the ear canal). Children with craniofacial abnormalities and immunodeficiencies warrant an earlier evaluation by ENT to avoid further complications.

CHRONIC SUPPURATIVE OTITIS MEDIA PATHOGENESIS AND CLINICAL DESCRIPTION

CSOM is the most severe form of OM, and despite well-designed longitudinal studies, it is the type of OM most likely to persist if untreated. CSOM is characterized by a perforated TM, with persistent drainage from the middle ear lasting more than 6 weeks. A large central perforation of the TM is most common (Fig 4).

The pathogenesis of CSOM is multifactorial. Children with immunodeficiencies, structural anomalies/malformations, and some living in native (indigenous) areas are at increased risk compared to the general population. The range of bacterial pathogens associated with CSOM is considerably broader when compared with AOM. Presently, methicillin-resistant *Staphylococcus aureus* (MRSA) is most common isolate. Methicillin-sensitive *S aureus* (MSSA), *Pseudomonas*, *Proteus*, anaerobes such as *Peptostreptococcus* and *Fusobacterium*, and fungi also have been reported. The diagnosis is based upon consistent clinical findings; cultures are reserved for unresponsive disease. Chronic suppuration can occur with or without cholesteatoma, and the clinical history of both conditions can be similar. Dizziness, facial nerve weakness, or keratin debris should prompt consideration of cholesteatoma. CSOM should be distinguished from chronic OME, in which no perforation or active infection is present. CSOM is uncommon in the developed world, but in the developing world, it has up to a 45% prevalence rate.

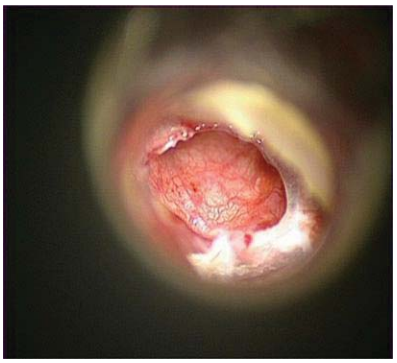


Figure 4. Large perforation in chronic suppurative otitis media. Courtesy of Yadiel A. Alameda, MD, Caribbean Sinus and Ear Institute, Puerto Rico.

Risk factors for the development of CSOM are similar to those for the development of AOM and OME. CSOM most often occurs in the first 5 years after birth. A recent risk factor study found that most cases of CSOM in the developed world now occur as a complication of tympanostomy tube insertion. (6) Early diagnosis is key to minimizing complications such as facial paralysis, subperiosteal abscess, mastoiditis, labyrinthitis, meningitis, cerebral abscess, lateral sinus thrombosis, extradural abscess, hydrocephalus, and encephalitis. The overall mortality rate is 7% to 15%. The incidence of CSOM complications is higher in the pediatric population.

CHRONIC SUPPURATIVE OTITIS MEDIA COMPLICATIONS AND TREATMENT PLAN

The most common sequela of CSOM is conductive or sensorineural hearing loss. Normal hearing is in the range of 0 to 25 dB. Chronic infection of the middle ear that causes lining inflammation and discharge, TM perforation, and ossicular chain disruption can result in conductive hearing loss in the 30- to 60-dB range. This level of hearing loss is mild to moderate and would make hearing soft-to-moderate speech in a noisy background difficult. The site of perforation corresponds to the degree of hearing loss. Typically, posterior perforations result in greater decibel loss compared to other locations. Hearing assessment evaluation by audiology is necessary for any child in whom hearing loss is suspected. When identified, amplification devices are recommended for those children with long-term conductive hearing loss or bilateral sensorineural hearing loss. Children with permanent hearing loss using amplification devices should be managed by a multidisciplinary team.

Although the literature on CSOM has shortcomings, reasonable evidence supports the efficacy of topical quinolones over systemic antibiotics. Use of ofloxacin or ciprofloxacin otic solution for 2 weeks is recommended. If treatment fails,

culture-directed antibiotics should be the next option, leaving the use of parenteral antibiotics as the last alternative. Some choices for intravenous therapy include piperacillin, ceftazidime, and the quinolones. If ear discharge does not respond to 21 days of therapy, other complications or diagnoses need to be entertained. When perforations fail to heal, surgical repair may be indicated. Computed tomography scan is recommended before surgical intervention to evaluate inflammatory diseases of the temporal bone. Magnetic resonance imaging is better for locating otogenic intracranial complications. When cholesteatoma is present, mastoidectomy with tympanoplasty is typically required.

Summary

- On the basis of research evidence, a recommended strategy for improving the care of middle ear infections is to identify the subset of patients least likely to benefit from antibiotic therapy. They include children ages 6 months to 23 months with unilateral disease without severe signs and symptoms (moderate or severe otalgia, otalgia lasting more than 48 hours, or temperature of 39°C [102.2°F]), and those older than 2 years of age with unilateral or bilateral disease who have mild signs and symptoms.(9)
- On the basis of research evidence, the initial treatment of otitis media with effusion is watchful observation. There is little harm in observing a child who is not at risk for speech, language, or learning difficulties compared to medical or surgical intervention.(4)
- On the basis of research evidence, administration of the annual influenza vaccine and the conjugated pneumococcal vaccination has been shown to have a small but statistically significant impact on the frequency of middle ear disease. (7)(8)
- On the basis of expert opinion, optimal outcomes depend on communication between clinicians and parents. At a minimum, primary care clinicians should state their reasons for their own clinical judgment about appropriate management and for referral to otolaryngology if necessary.

CME quiz and references for this article are at http://pedsinreview.aappublications.org/content/36/11/480.full.

Parent Resources from the AAP at HealthyChildren.org

- English: https://www.healthychildren.org/English/health-issues/conditions/ear-nose-throat/Pages/Ear-Infection-Information.aspx
- Spanish: https://www.healthychildren.org/spanish/health-issues/conditions/ear-nose-throat/paginas/ear-infection-information.aspx
- English: https://www.healthychildren.org/English/health-issues/conditions/ear-nose-throat/Pages/Your-Child-and-Ear-Infections.aspx
- Spanish: https://www.healthychildren.org/spanish/health-issues/conditions/ear-nose-throat/paginas/your-child-and-ear-infections.aspx

JOB AID

Prepare the Patient

- **Lap**
- **Shoulder**
- **Table (last resort)**

Prepare the Otoscope

- **Largest speculum that will fit**
- **Attach Insufflator bulb**
- **Hold handle like a pencil**

Landmarks (see the malleolus)

Light Reflex (one cone of light)

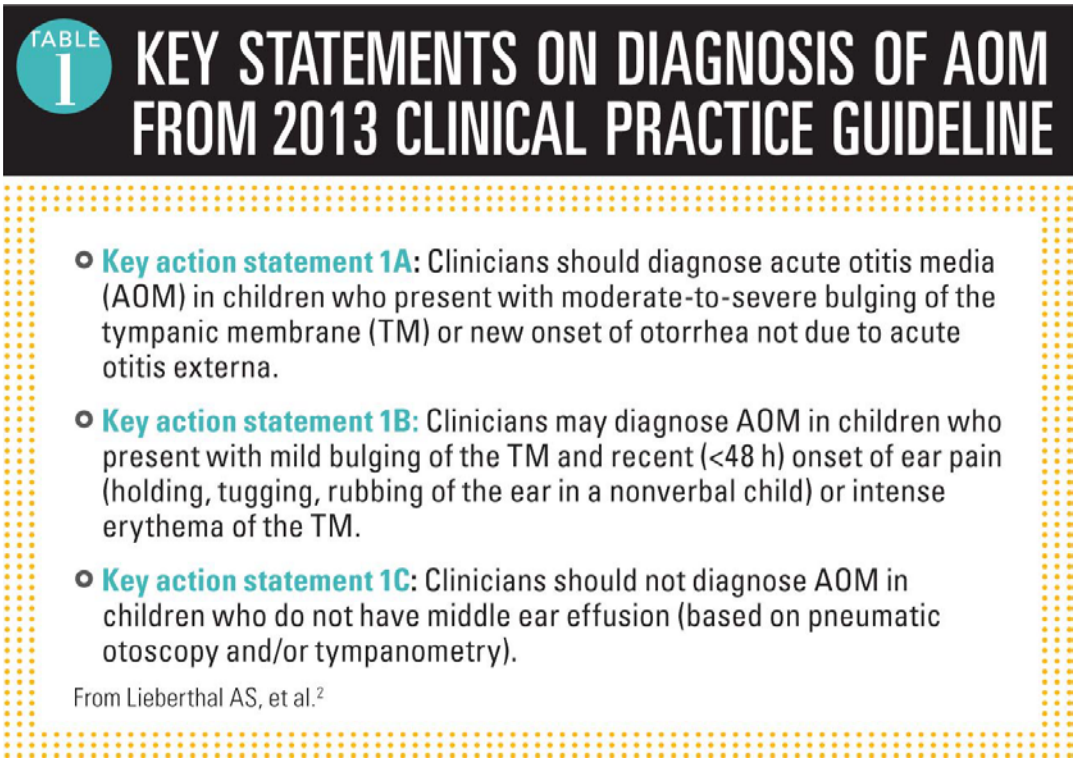
Bulging (yes or no)

Mobility (crinkle, crinkle little star)

Color (red - beware fever/crying)

4/5 abnormal = AOM likely
2-3/5 abnormal = OME likely
Bulging = AOM highly likely

Adapted from published materials and from original work by J. Lopreiato MD Jan 2018



Recommendations for Initial Management for Uncomplicated AOM[a]

Age	Otorrhea With AOM	Unilateral or Bilateral AOM[a] With Severe Symptoms[b]	Bilateral AOM[a] Without Severe Symptoms
6 mo to 2 y	Antibiotic therapy	Antibiotic therapy	Antibiotic therapy
≥2 y	Antibiotic therapy	Antibiotic therapy	Antibiotic therapy or additional observation[c]

- a Applies only to children with well-documented AOM with high certainty of diagnosis. b A toxic-appearing child, persistent otalgia more than 48 h, temperature ≥39°C (102.2°F) in the past 48 h, or if there is uncertain access to follow-up after the visit.
- c This plan of initial management provides an opportunity for shared decision-making with the child's family for those categories appropriate for additional observation. If observation is offered, a mechanism must be in place to ensure follow-up and begin antibiotics if the child worsens or fails to improve within 48 to 72 h of AOM onset.

Adapted from published materials and from original work by J. Lopreiato MD Jan 2018

TABLE 2 RECOMMENDED ANTIBIOTICS FOR TREATMENT OF ACUTE OTITIS MEDIA

INITIAL IMMEDIATE OR DELAYED TREATMENT		TREATMENT AFTER INITIAL TREATMENT FAILURE (48-72 H)	
Recommended first-line treatment	**Alternative treatment (if penicillin allergy)**	**Recommended first-line treatment**	**Alternative treatment**
Amoxicillin (80-90 mg/kg/d in 2 divided doses)	Cefdinir (14 mg/kg/d in 1 or 2 doses)	Amoxicillin-clavulanate (90 mg/kg/d amoxicillin, with 6.4 mg/kg/d clavulanate in 2 divided doses)[a]	Ceftriaxone, 3 d clindamycin (30-40 mg/kg/d in 3 divided doses), with or without third-generation cephalosporin
OR	Cefuroxime (30 mg/kg/d in 2 divided doses)	OR	Failure of second antibiotic
Amoxicillin-clavulanate (90 mg/kg/d amoxicillin, with 6.4 mg/kg/d clavulanate [amoxicillin to clavulanate ratio, 14:1] in 2 divided doses)[a]	Cefpodoxime (10 mg/kg/d in 2 divided doses)	Ceftriaxone (50 mg IM or IV for 3 d)	Clindamycin (30-40 mg/kg/d in 3 divided doses) plus third-generation cephalosporin
	Ceftriaxone (50 mg IM or IV daily for 1 or 3 d)		Tympanocentesis[b]
			Consult specialist[b]

Note: Cefdinir, cefuroxime, cefpodoxime, and ceftriaxone are highly unlikely to be associated with cross-reactivity with penicillin allergy based on their distinct chemical structures.

[a]May be considered in patients who have received amoxicillin in previous 30 d or who have otitis-conjunctivitis syndrome.

[b]Perform tympanocentesis/drainage if skilled in procedure, or seek consultation from otolaryngologist for tympanocentesis/drainage. If tympanocentesis reveals multidrug-resistant bacteria, seek infectious disease specialist consultation.

Abbreviations: IM, intramuscular; IV, intravenous.

From: Lieberthal AS, et al.[2]

TABLE 3

BACTERIA CAUSING AOM IN NORTH AMERICA, 2014

BACTERIA	PERCENTAGE TOTAL PATHOGENS
Streptococcus pneumonia	12%
Amoxicillin resistant	20%
Haemophilus influenzae	56%
Amoxicillin resistant	50%
Moraxella catarrhalis	22%
Amoxicillin resistant	100%

Note: Based on results from Legacy Pediatrics, Rochester, NY, 2011-2014 respiratory season.
Abbreviation: AOM, acute otitis media.
From Pichichero ME.[9]

Otitis Media Quiz

1. What are the five elements you should evaluate when you examine a child's tympanic membrane?

L *Landmarks – look for the long and short process of the malleolus*

L *Light reflex (solitary) off the tip of the malleolus in a pie shape*

B *Bulging of the TM (takes lots of practice to recognize) highly sensitive for AOM*

M *Mobility of the TM with pneumatic otoscopy (highly sensitive for middle ear effusion)*

C *Color – red is the least sensitive indicator of AOM since it could be due to fever, trauma, crying*

2. What are three ways to position a child in order to see the TM?

Lap facing parent

Infant held on the parent's shoulder

Supine on the exam table

3. When using the otoscope, what size speculum should you use?

The largest size that will fit into the canal and afford the widest view (and best seal)

4. Match the incidence rates below with the bacteria in acute otitis media based on the data from Pichichero.
   a. H. influenzae serotype b
   b. Nontypeable H. influenzae
   c. Streptococcus pyogenes
   d. Streptococcus pneumoniae
   e. Staphylococcus aureus
   f. Moraxella catarrhalis

12%	d
50-60%	b
20-25%	f

5. Which of the following are risk factors and which are protective factors for developing AOM ?

PCV-13 vaccine	protective
Influenza vaccine	protective

Adapted from published materials and from original work by J. Lopreiato MD Jan 2018

Exclusive feeding of human milk protective

Tobacco risk factor: may effect Eustachian tube function

Daycare attendance risk factor: cesspool of infectious diseases

Propped bottles/supine feeding risk factor: reflux of materials into the middle ear space

Fall/winter season risk factor: high prevalence of URIs

Young age risk factor: short horizontal Eustachian tubes, frequent infections

6. Criteria for diagnosing Acute Otitis Media (AOM) include:
   a. Moderate to severe bulging of the tympanic membrane (TM)
   b. New onset otorrhea not due to acute otitis externa
   c. Mild bulging of the TM and recent onset of ear pain
   d. Mild bulging with intense erythema of the TM
   e. All of the above

7. First line therapy for immediate treatment of acute otitis media include:
   a. Amoxicillin 40-45 mg/kg/day in 2 doses
   b. Amoxicillin 80-90 mg/kg/day in 2 doses
   c. Cefdinir 14 mg/kg/day in 1 or 2 doses
   d. Ceftriaxone 30-40 mg/kg/day in 3 doses
   e. Azithromycin 12 mg/kg/day in 1 dose for 5 days

8. In which of the following scenarios would you choose observation with pain control without the use of antibiotics?

   A. A 4-month-old with unilateral purulent effusion, decreased tympanic membrane mobility with pneumatic otoscopy, minimal pain, no fever, and no other generalized symptoms.

   B. A 15-month-old with bilateral purulent effusion, decreased tympanic membrane mobility with pneumatic otoscopy, minimal pain, no fever, and no other generalized symptoms.

   C. A 20-month-old with unilateral purulent effusion, decreased tympanic membrane mobility with pneumatic otoscopy, fever (temperature of 39.3°C [102.8°F]), and otalgia.

   D. A 30-month-old with unilateral purulent effusion, decreased tympanic membrane mobility with pneumatic otoscopy, fever (temperature of 39.4°C [103.0°F]), and otalgia.

   E. A 3-year-old with a unilateral purulent effusion, decreased tympanic membrane mobility with pneumatic otoscopy, minimal pain, no fever, and no other generalized symptoms.

Otitis Media Cases

1. A 15-month-old girl presents with a 3-day history of cough, congestion, and rhinorrhea and a 1-day history of temperature to 38.3°C (101°F) and right-sided "pink eye." On physical examination, she has right conjunctival injection and a right tympanic membrane that is erythematous and bulging, with minimal mobility with pneumatic otoscopy. Which of the following is the treatment of choice in this patient?

A. Observation without the use of antibiotics.

B. Oral amoxicillin.

C. **Oral amoxicillin-clavulanate.** Likely the otitis media-conjunctivitis syndrome due to nontypeable H. influenza

D. Topical ofloxacin ophthalmic drops.

E. Topical trimethoprim with polymyxin B ophthalmic drops.

2. A 2-year-old girl is being seen today for a health maintenance visit. Her mother states her daughter is feeling well today, but 3 months ago, while on vacation, she was treated for a left acute otitis media with amoxicillin. The patient is fully immunized and has normal growth and development. Her physical examination findings are normal except for her left tympanic membrane, which is gray-blue. Air fluid levels are present and there is decreased tympanic membrane mobility with pneumatic otoscopy. What is the next step in the management of this patient?

A. Oral amoxicillin-clavulanate.

B. Oral cetirizine.

C. Oral phenylephrine.

D. Parenteral ceftriaxone.

E. **Reassessment in 8 to 12 weeks.** This is OME and needs monitoring to see if the fluid clears with time.

3. You see the same 2-year-old girl described in the previous question in your office 12 weeks later. She has the same physical examination findings but is still without symptoms. Her parents note that she seems to say "What?" frequently when they are talking to her. What is your next step in the management of this patient?

A. Oral prednisone.

B. Reassessment in 8 to 12 weeks.

C. Referral to audiology for assessment of any hearing loss and possible need for tubes.

Adapted from published materials and from original work by J. Lopreiato MD Jan 2018

D. Referral to otorhinolaryngology.

E. Referral to speech pathology.

4. You are on a humanitarian mission on the USNS COMFORT and go ashore to see sick call. A 2-year-old boy presents with an 8-week history of persistent drainage from his left ear. On physical examination, you note purulent yellow material in the right external auditory canal and a large central perforation of the tympanic membrane. Of the following, the most common pathogen causing this condition is:

A. Methicillin-resistant staphylococcus aureus. This is chronic supportive otitis media, rare in the developed world. The mortality rate is 7-15%. Treatment with topical quinolones for 2 weeks is preferred over systemic therapy.

B. Moraxella catarrhalis.

C. Nontypeable Haemophilus influenzae.

D. Pseudomonas aeruginosa.

E. Streptococcus pneumoniae

Otitis Media Board Review

1. A-14 year-old girl presents with a 4-year history of recurrent infections. Her parents state that it seems she is on antibiotics almost every other month for the treatment of otitis media, sinusitis, or pneumonia. During a recent hospitalization for lobar pneumonia, the inpatient team measured serum immunoglobulins (Igs), which showed:

- Low IgG of 54 mg/dL (0.54 g/L) (normal range, 700 to 1,500 mg/dL [7 to 15 g/L])
- Absent IgA at <7.5 mg/dL (75 mg/L) (normal range, 15 to 200 mg/dL [150 to 2,000 mg/L])
- Low IgM of 10 mg/dL (100 mg/L) (normal range, 50 to 300 mg/dL [500 to 3,000 mg/L])

Despite the recurrent infections, the girl is otherwise growing and developing appropriately and has no other specific medical concerns.

Of the following, the MOST appropriate next laboratory test is

A. flow cytometry for B lymphocytes, T lymphocytes, and natural killer cells
B. genetic analysis for mutations of the Bruton tyrosine kinase (*Btk*) gene
C. lymphocyte proliferation assay of peripheral blood mononuclear cells to mitogens
D. measurement of antibody responses to protein and polysaccharide vaccines
E. measurement of IgG subclasses (IgG1, IgG2, IgG3, IgG4)

An adolescent or young adult who has recurring infections and hypogammaglobulinemia, such as the girl described in this vignette, should be evaluated for common variable immunodeficiency (CVID). The diagnosis of CVID requires three criteria: a decrease of more than 2 standard deviations of one immunoglobulin below the age-adjusted mean (usually IgG, with decreased IgA or IgM), poor antibody response to protein (eg, diphtheria tetanus toxoid) and polysaccharide vaccines (eg, 23-valent pneumococcal vaccine), and exclusion of other causes of hypogammaglobulinemia (Item C121). Because the girl already meets the first criterion, the next step is to measure baseline antibody titers, vaccinate her, and repeat antibody measurements in 3 to 4 weeks. The recommended appropriate protein vaccine response in adolescents consists of a fourfold increase in titers. An appropriate pneumococcal polysaccharide response in patients 5 years and older is a titer of 1.3 µg/mL or higher in 70% of pneumococcal serotypes. Patients who demonstrate both hypogammaglobulinemia and impaired vaccine response should be referred to an immunologist for additional testing and consideration for either intravenous or subcutaneous immunoglobulin replacement therapy.

Further testing that is usually performed by the immunologist includes flow cytometry,consideration of genetic analysis for mutations in the Bruton tyrosine kinase (*Btk*) gene, lymphocyte proliferation assay, and assessment of IgG subclasses. Flow cytometry uses technology that can detect specific cell surface markers of T cells (CD3, CD4, CD8), B cells (CD19), and natural killer (NK) cells (CD16, CD56). Most patients who have CVID have normal B, T, and NK cell numbers, although up to 10% can have low B cell numbers, and many patients have an inverted CD4/CD8 ratio. Although flow cytometry is important, the results are not part of the current laboratory criteria for diagnosing CVID.

Patients who have low-to-absent B-cell concentrations or who are younger than 2 years of age should be evaluated for X-linked recessive (Bruton) agammaglobulinemia. Flow cytometry screening detects most patients who have complete or partial expression of the Btk protein, but up to 30% of patients have abnormal function that can only be detected by *Btk* gene sequencing.

Additional T-cell qualitative analysis can include both anergy testing (eg, delayed hypersensitivity testing to *Candida*, tetanus, mumps, *Trichophyton*) and lymphocyte proliferation assay of peripheral blood mononuclear cells. Mitogen proliferation testing is expensive, typically yields normal results in patients who have CVID, and should be performed under the direction of an immunologist.

Many clinicians assess IgG subclasses (ie, IgG1, IgG2, IgG3, and IgG4), but the clinical significance of a low IgG subclass value is unclear. Although low IgG2 concentrations have been associated with a poor

polysaccharide response and low IgA concentrations in some patients, low values for one or more IgG subclasses is currently not recognized as a specific primary immunodeficiency, and the use of immunoglobulin replacement is controversial.

2. A 4-month-old infant comes to your office for a health supervision visit. When you pass through the waiting room, you observe his young mother prop the infant's bottle while he is in his stroller. **Of the following, the MOST appropriate action is to**

A. advise the mother to prop only bottles containing water
B. discuss the advantages of holding her baby during feedings
C. explain that the child is too young to have the bottle propped
D. recommend that the mother obtain a bottle sling
E. tell the mother that a bottle should not be propped when the infant is falling asleep

Infants should be fed when hungry, warm, and dry, not just when they are fussy in an attempt toquiet them. In addition, the bottle should be held, not propped, regardless of the infant's age. Even the use of a "safe" bottle holder such as a bottle sling should be avoided. Parents should be counseled that holding their baby when feeding enhances physical closeness and a feeling of security for the baby.

Propping a bottle increases the risk of choking and the development of otitis media. Parents also should be advised that their infant should not be put to bed with a bottle of formula or juice, a practice that could lead to dental decay.

A parent should not force a baby to eat. If the child stops feeding, the parent should try to burp the baby. If the infant still does not want to feed after burping, he or she has had enough. If the baby prefers the formula to be warmed, the parent should not use the microwave, which might create hot spots that can burn a baby's mouth.

3. A 2-year-old boy who has trisomy 21 has been plagued by middle ear infections for several months. You last saw him days ago and prescribed high-dose amoxicillin at 80 mg/3kg per day for recurrent otitis media. Today he has a new onset of drainage from the ear and continued fussiness and nocturnal awakening. Although his tympanic membranes are always difficult to see through his tiny canals, today purulent drainage occludes the membrane completely. You decide to discontinue the amoxicillin therapy.

Of the following, the BEST course of action for this patient is to
A. administer intramuscular ceftriaxone
B. administer one dose of intramuscular ampicillin
C. begin topical fluoroquinolone otic drops
D. begin trimethoprim-sulfamethoxazole
E. refer him for urgent placement of tympanostomy tubes

The boy described in the vignette is at higher-than-usual risk for persistent and recurrent otitis media because he has trisomy 21. He continues to have symptoms despite 3 days of antibiotic therapy and now has ear drainage. These findings are an indication that his antibiotic therapy should be changed. Other indications for a change in antibiotic therapy during the treatment of acute otitis media include persistent or recurrent fever after 2 to 3 days of therapy or suppurative complications.

For treatment of clinical failure 3 days into antibiotic therapy, as described for this boy, the American Academy of Pediatrics recommends high-dose amoxicillin-clavulanate (90 mg/kg per day amoxicillin and 6.4 mg/kg per day clavulanate) or intramuscular ceftriaxone for 1 to 3 days. A 3-day course of ceftriaxone is more effective than a single dose in achieving a bacteriologic cure. If a beta-lactamase-producing organism (such as nontypeable *Haemophilus influenzae* or *Moraxella catarrhalis*) is suspected, other agents may be indicated, including cefpodoxime, cefdinir, or cefuroxime. Although macrolides may be

used as first-line agents in children who are allergic to penicillin, their use is controversial due to high rates of pneumococcal resistance to these agents. Finally, trimethoprimsulfamethoxazole or sulfasoxazole is not adequate for treating *Streptococcus pneumoniae* infection.

Topical fluoroquinolones have no proven efficacy in acute otitis media in the presence of an intact tympanic membrane. They may be useful in this child, who is presumed to have had a ruptured tympanic membrane, but they should not supplant systemic antibiotic use.

Although otolaryngology evaluation that includes tympanocentesis may be needed for the child who fails to respond to a change in antibiotics, urgent referral to an ear-nose-throat specialist for tympanostomy tube placement is not indicated. Intramuscular ampicillin is unlikely to be effective for the child who has been receiving amoxicillin and would not be as effective as ceftriaxone because it is a short-acting antibiotic.

4. A 4-year-old boy presents with recurrent otitis media (OM) with persistent effusion. He is otherwise healthy. His mother is concerned about possible hearing loss and also wants to know if her son is at risk for any other neurologic complications because of his recurrent OM.

Of the following, the MOST likely neurologic complication for which this boy is at risk is
A. autistic spectrum disorders
B. balance difficulties
C. nystagmus
D. speech apraxia
E. tic disorders

The boy described in the vignette has a persistent middle ear effusion after recurrent bouts of otitis media. In addition to dampened conductance of sound to the inner ear, balance problems may occur, due to differences in pressure in the middle ear. However, "balance problems" in a 4-year-old also can be due to serious diseases affecting the brainstem and cerebellum. Therefore, any toddler who presents with such problems warrants a careful neurologic examination.

Autistic spectrum disorders involve impairments in language and communication. Although chronic conductive hearing loss can affect speech articulation, the other problems in autism with communication, social skills, and need for sameness do not occur. Similarly, speech apraxia, a neurologic problem affecting the child's ability to coordinate production of sounds to produce words, is not related to conductive hearing loss.

Nystagmus (ie, rhythmic oscillations of the eyes) is an important neurologic finding that should be sought in any person who has balance problems or subjective dizziness because it can indicate serious disease. Nystagmus may be peripheral, due to pathology in the inner ear or vestibule-cochlear nerve, or central, due to pathology in the brainstem or cerebellum. Middle ear effusions do not produce nystagmus. Most consultations for "dizziness" do not reveal any nystagmus, and neuroimaging, although often ordered, rarely is needed. Balance problems accompanied by nystagmus require urgent neurologic evaluation in the emergency department, if necessary. The differential diagnosis is very large, but some immediate considerations include toxins/ingestions, acute cerebellar ataxia, acute disseminated encephalomyelitis, opsoclonus myoclonus ataxia syndrome, cerebellar strokes, and posterior fossa tumors.

Tics are repetitive, nonrhythmic, patterned movements or sounds produced involuntarily or in response to premonitory urges. They are neurologic symptoms and are not produced directly by infections or middle ear effusions. Upper respiratory tract infections may act as a precipitant for tics in susceptible children.

Operator Instructions for OtoSim

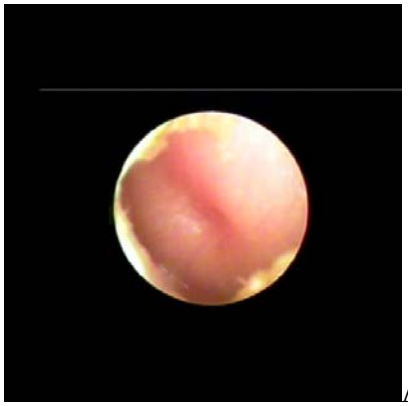
1. When the learner comes in, usher them to the OtoSim.
2. The OtoSim can already be open to the first image of the 'OtoSim Exam' or 'Test' which can be found under 'My Library'. (Accessed by clicking on the *OtoSim 2* icon on the desktop)
3. Hand the intern a paper copy of the OtoSim Exam 2017. Instruct them to write their name on the document.
4. Give the learner some time to become acquainted with the OtoSim and let them look at the first image. Instruct them that they are looking at a normal tympanic membrane and to familiarize themselves with the landmarks.
5. Inform them that they will be looking at a series of 12 slides and will have 30 seconds with each slide. All questions have 4 possible answers – Normal, acute otitis media, Serous otitis media (otitis media with effusion), and tympanosclerosis
6. When learners are ready, instruct them to look into the ear and begin to click through each slide by using the '**Next Page**' button in the Otosim software. (You can use either the clock in your room, the computer's clock, or a personal device to keep track of time.)
7. If they finish early they can move on to the next image.
8. Let the learner fill out questions 1-12.
9. Once they are done, quickly scan their answer sheet and mark what is incorrect using the provided answer key.
10. If they miss any questions, instruct them to look back into the OtoSim. From there, pull up any images that the intern missed, and use the provided script to explain the diagnosis.
11. Thank them and send them on their merry way.
12. On the same laptop, switch to Learning Space. Log-in as the intern using their email address. You can look up their email with the provided Walter Reed or Children's Hospital roster. For the password, you can use '007007' (without quotes) to log in. Navigate to **Peds Intern** learner data entry and select '**2016 Skills Station'** from the drop down menu.
13. Enter in their responses from their paper and click submit.
14. Reset the station to prepare for the next intern.

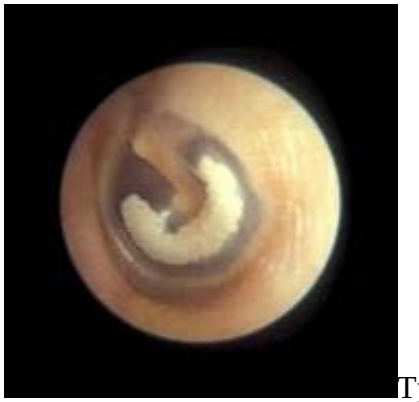
Additional Tips

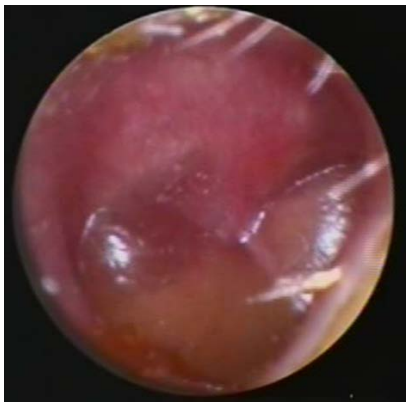
1. If something goes wrong – make sure that all of the connections are in place and all of the apparatuses are powered. Sometimes USB cords can get jostled out of a port.
2. If your screen flickers black for a moment, and then returns to normal it might mean that the OtoSim base has lost connection. Check the connections and restart the OtoSim software if needed.
3. Make sure that the OtoSim is not displaying "Waiting to connect …" at the bottom of the software's UI window – it means that the images will not show up.
4. When students start familiarizing themselves with the OtoSim, it may help to instruct them to move the 'tragus' out of the way rather than the 'pinna'. It's not what they're used to when they are examining ears so it might be a little counterintuitive at first.

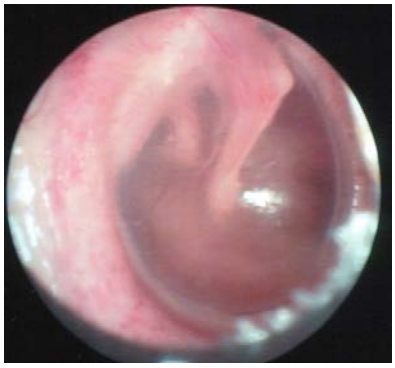
OtoSim Operator SCRIPT

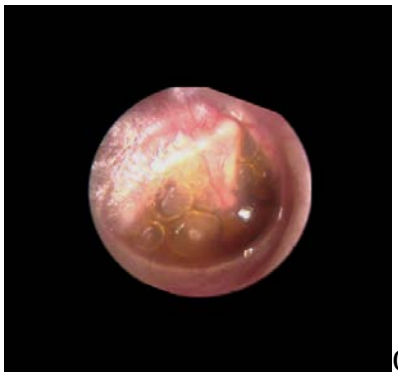
Reminder – the image number will always be one higher on the Otosim (1 will be 2, 2 will be 3, etc.), due to the first image being a normal membrane so the students can acclimatize to the equipment.

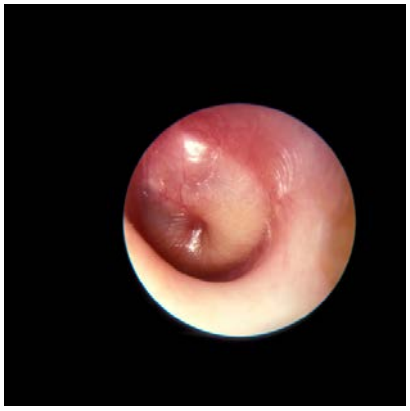
1)  Acute Otitis Media: Note the Loss of any landmarks, scattered light reflex and bulging of the TM with inflammation. This TM will have poor mobility.

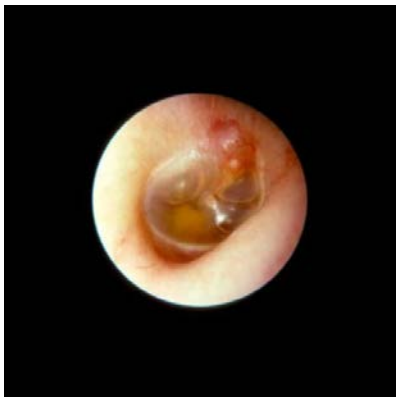
2.)  Tympanosclerosis: note the white scar across the TM. This is due to a prior perforation or a PE tube.

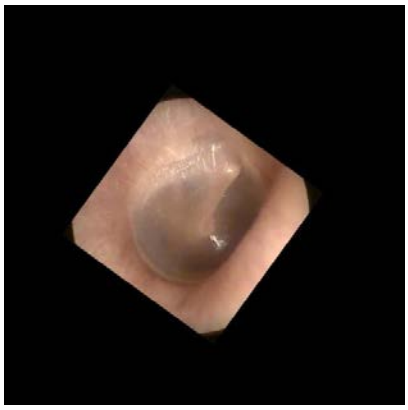
3.)  Acute Otitis Media: Note the Loss of any landmarks, scattered light reflex and purulent fluid in the latter half of the TM accompanied by inflammation. This TM will have poor mobility.

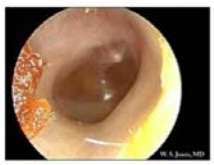
4.)  Normal TM: Note the landmarks (malleolus bone), solitary light reflex, absence of bulging, and translucent color of the TM.

5.)  Otitis Media with Effusion: Note the loss of landmarks, the scattered light reflex and the bubbles in the lower half of the TM. There is no inflammation.

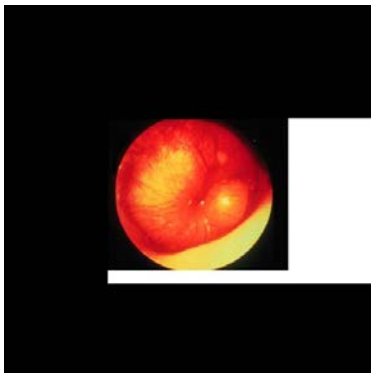
6.)  Acute Otitis Media: Note the Loss of any landmarks, scattered light reflex and bulging of the TM with inflammation. This TM will have poor mobility.

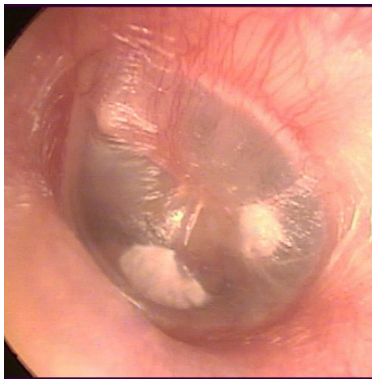
7.)  Otitis Media with Effusion: Note the landmarks (malleolus bone), solitary light reflex and the air fluid level in the lower half of the TM. There is no inflammation.

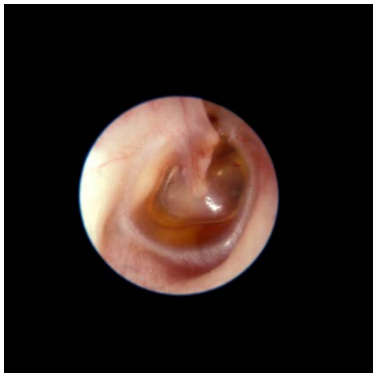
8.)  Normal TM: Note the landmarks (malleolus bone), solitary light reflex, absence of bulging, and translucent color of the TM.



9.) Otitis Media with Effusion: Note the landmarks (malleolus bone), solitary light reflex and the air fluid level in the lower half of the TM. There is no inflammation.

10.)  Acute Otitis Media: Note the Loss of any landmarks, scattered light reflex and bulging of the TM with inflammation. This TM will have poor mobility.

11.)  Tympanosclerosis: note the white scar across the TM. This is due to a prior perforation or a PE tube.

12.)  Otitis Media with Effusion: Note the landmarks (malleolus bone), solitary light reflex and the air fluid level in the lower half of the TM. There is no inflammation.

PE Tube – also known as a tympanostomy tube or pressure equalization tube, the PE tube is a small tube inserted into the eardrum in order to keep the middle ear aerated for a prolonged period of time and to prevent the accumulation of fluid in the middle ear.

TM – Tympanic Membrane, also known as the ear drum is a thin layer of tissue that separates the outer ear from the middle ear.