AN EVIDENCE-BASED APPROACH TO TREATING OTITIS MEDIA

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PEDIATRIC OTOLARYNGOLOGY

AN EVIDENCE-BASED APPROACH TO TREATING OTITIS MEDIA

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Patient care is ideally based on evidence derived from the best available studies. The practitioner who treats children with otitis media is fortunate in this regard, because a wealth of high quality clinical trials and epidemiologic studies have been published. Further, much of this evidence has been synthesized into bottom-line efficacy estimates and treatment guidelines that deal specifically with the medical management of otitis media. [70] [71] [72] [79] [84]

Otitis media implies the presence of a middle ear effusion (MEE), or fluid in the middle ear space (Table 1) . MEE accompanied by acute symptoms is called *acute otitis media* (AOM). AOM is caused by ascent of viral or bacterial pathogens from the nasopharynx into the middle ear during an upper respiratory infection. MEE without associated symptoms is called *otitis media with effusion* (OME). OME may arise as a sequelae to AOM or spontaneously; the latter is also called *silent otitis media* when it occurs as an incidental finding during physical examination or screening tests. The nonspecific term *ear infection* applies to AOM and OME, because pathogenic bacteria generally are present in the middle ear with both conditions. [63]

This article presents an evidence-based approach to managing otitis media. Rational management begins by understanding the natural history of untreated otitis media and knowing what to expect from medical therapy. [74] **Next, a stepwise treatment plan is presented, based on epidemiologic studies, systematic reviews of clinical trials, and personal experience as a pediatric otolaryngologist who has successfully treated thousands of children with otitis media.**

TABLE 1 -- OTITIS MEDIA DEFINITIONS AND EPIDEMIOLOGY

Otitis Type	Definition	Comment
MEE	Fluid in the middle ear space, regardless of cause; hearing loss may be present depending on the volume of fluid	Diagnosis requires assessment of middle ear function by pneumatic otoscopy or tympanometry
Myringitis	Erythema of the tympanic membrane, without MEE; similar appearance occurs from dilation of tympanic membrane vessels when crying during otoscopy	Most often viral but may be seen in early stages of AOM or during resolution; does not require antibiotic treatment

AOM	**MEE with rapid onset of one or more of the following: otalgia, ear pulling, otorrhea, fever, irritability, anorexia, vomiting, or diarrhea**	**Most frequent diagnosis made by pediatricians; affects about 50% of children by age 1 year, 65% by age 2 years, and 70% by age 3 years**
OME	**MEE without signs or symptoms of acute infection; chronic OME implies duration longer than 2 to 3 months**	**Occurs in both healthy children and following an episode of AOM; 15% prevalence with seasonal variations**
Recurrent AOM	**At least three episodes of AOM in the past 6 months, or four episodes in 12 months; also called the *otitis-prone condition***	**Affects about 15-30% of children; MEE may persist to varying degrees between episodes**

AOM = acute otitis media, OME = otitis media with effusion.

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WHAT TO EXPECT FROM NATURAL HISTORY

Otitis media has a favorable natural history. Data from observational studies [80] [86] and from control groups in randomized control trials [71] [72] [79] [84] show that most cases of AOM and OME resolve without treatment (Table 2) . For example, in two recent well-designed clinical trials, 86% and 92% of placebo-treated children with AOM were clinical cures. [15] [38] To appreciate the impact of natural history on perceptions of treatment efficacy, consider the following:

- If 100 children with AOM caused by amoxicillin-resistant bacteria are nonetheless treated with amoxicillin, how many will have complete clinical resolution in 7 to 14 days? About 70% to 90% will be "cured" as shown in Table 2 . The child's immune system cares little if the bacteria are resistant to the drug; it mounts an effective inflammatory response regardless.
- If 100 children with persistent OME after AOM have chiropractic manipulation for 1 month, how many will resolve? About 60%, assuming that chiropractic is no better than placebo. If "treatment" is continued for an additional 2 months, the "cure" rate will rise to 90%.
- If 100 children with silent OME detected in a school screening program receive homeopathic treatment for 3 months, how many will resolve? About 65%, assuming that homeopathy is no better than placebo. If "treatment" is continued for an additional 3 months, 85% will be "cured" of effusion.
- If 100 children with recurrent AOM take garlic concentrate for 12 months,

how much will the frequency of AOM diminish? About 1.5 to 3.0 annual episodes will be "prevented," assuming that garlic is no better than placebo.

TABLE 2 -- NATURAL HISTORY OF UNTREATED OTITIS MEDIA

Otitis Type	Population Studied	Approximate Rate of Spontaneous Resolution
AOM [72]	Children receiving placebo or no drug in antibiotic trials of initial empiric therapy	70-90% at 7-14 days *
OME [80]	Children with residual middle ear effusion following an episode of AOM	60% at 1 month 80% at 2 months 90% at 3 months

OME [86]	Children with OME of unspecified duration detected by tympanometric screening	65% at 3 months 85% at 6 months
OME [71] [79] [84]	Children receiving placebo or no drug in antibiotic trials, most with OME duration 4-8 weeks	15-30% at 2-8 weeks
Recurrent AOM [84]	Children receiving placebo for prophylaxis of recurrent AOM	1.5-3.0 episodes per year, decrease in AOM

* Resolution of asymptomatic middle ear effusion not required for cure.

The examples above are provided to illustrate the favorable natural history of otitis media, not to demean alternative medicine. Alternative medicine, however, is used by 11% of children, [76] most often for chronic disease (e.g., otitis media) and without the knowledge of the child's physician. [23] Because most cases of otitis media are self-limited, the efficacy of alternative medicine--or any intervention--can be judged only by prospective clinical trials with a parallel control group. Without a thorough appreciation of the spontaneous course of untreated otitis media, practitioners and caregivers can easily mistake natural history for treatment effects.

Short-term spontaneous resolution of AOM most likely reflects the host immune response and local inflammatory reaction. This phenomenon is appreciated in Denmark, Norway, Sweden, and the Netherlands, where most children 2 years of age and older with nonsevere AOM are not treated initially with antibiotics. [28] [36] Unfortunately, the middle ear inflammation that accompanies AOM can result in lingering OME after symptom relief. Spontaneous clearance of residual OME, however, occurs in 90% of children within 3 months (Table 2) as inflammation subsides and the eustachian tube reopens. Because OME is so common following antibiotic treatment for AOM, clearance of the fluid is unnecessary for a successful outcome in efficacy trials. [72]

Long-term spontaneous resolution of recurrent AOM and chronic OME most likely reflects a gradual maturation in the child's immune system and eustachian tube function. Further, because most patients seek medical care when at their worst, the next event is often a change for the better, irrespective of treatment given (regression to the mean). [21] Children enter clinical trials for recurrent AOM with three to five annual episodes but average only one to two episodes during the next 12 months when treated with placebo. [84] A similar

pattern has been reported for children with recurrent sore throat after entering a tonsillectomy trial. [59]

WHAT TO EXPECT FROM MEDICAL TREATMENT

More than 250 clinical trials have sought to define the impact of medical treatment on otitis media. Systematic literature reviews (meta-analysis) of published randomized control trials yield the mean estimates of treatment efficacy listed in Table 3 . These data have been summarized as follows [74] :

- Antibiotics have a modest but statistically significant impact on the treatment of otitis media. About seven children with AOM or OME must be treated to improve a single child, beyond what would occur from natural history alone. Despite this modest effect, some studies show faster symptom relief with antibiotics than with placebo. [15] [38] [51]
- Antibiotics have a modest but statistically significant impact on the prevention of otitis media. Preventing a single episode of AOM requires that prophylaxis be given to one child for 9 months, or to nine children for 1 month.
- Subgroup analyses have not demonstrated a significant increase in clinical efficacy for newer, more expensive drugs over established standards, such as amoxicillin, when treating AOM or OME.
- Combining an antibiotic with an oral steroid seems promising, but the evidence is sparse, inconsistent, and just misses statistical significance.
- Antihistamine and decongestant preparations, alone or in combination, have comparable efficacy to placebo. Consequently, there is no justification for their use when treating OME, unless they are consciously administered to achieve a placebo effect.

TABLE 3 -- WHAT TO EXPECT FROM MEDICAL TREATMENT FOR OTITIS MEDIA

Otitis Type	Treatment Group Versus Control Group	*Impact of Therapy*	Outcome Time	Statistically Significant?

AOM [72]	Abx versus placebo or no drug	14% increase in symptom relief	7d-14d	Yes
	Penicillin versus amoxicillin	Trend favoring amoxicillin	7d-14d	No
	Cefaclor versus amoxicillin	Equivalent outcomes	7d-14d	No
	Cefixime versus amoxicillin	Trend favoring amoxicillin		
OME [1]	Abx versus placebo or no drug	14% increase in short-term cures	10d-2m	Yes
	Steroid-abx versus abx alone	Trend favoring steroid-abx	7d-14d	No
	Antihistamine/ decongestant versus placebo	Equivalent outcomes	2w-12w	No
Recurrent AOM [84]	Abx prophylaxis versus placebo	0.11 episode/month decrease	10w-2y	Yes
	Sulfisoxazole prophylaxis versus placebo	0.20 episode/month decrease	10w-2y	Yes

Abx = antibiotic.

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Qualification of these comments is required. First, the results apply only to clinical efficacy; the ability of antibiotics to destroy middle ear pathogens-- bacterial efficacy--may exceed that suggested by clinical outcomes. [45] Second, bacterial resistance patterns are changing, with an increasing prevalence of multidrug-resistant *Streptococcus pneumoniae* [49] and beta-lactamase-producing *Haemophilus influenzae* and *Moraxella catarrhalis*. [11] Older studies may have included children with bacteriology different than those encountered today, but the high rate of spontaneous otitis media resolution makes it unlikely that this would substantially alter results. Finally, because the results reflect mean treatment effects, individual patients may vary in their response to antibiotics.

The modest impact of antibiotics on otitis media argues for judicious treatment, not therapeutic nihilism. Although natural history--not antibiotics-- accounts for most clinical resolution of AOM, delayed suppurative complications (e.g., mastoiditis) are exceedingly rare compared with the preantibiotic era. For OME the modest short-term benefit of antibiotics makes it unlikely that prolonged or repetitive therapy will offer any advantage; therefore, treatment should be limited to one or two drugs spaced at least several weeks apart. For recurrent AOM, the modest benefits of antibiotic prophylaxis probably are exceeded by the risk of accelerated bacterial resistance, particularly in group day care, where horizontal transmission of resistant organisms is common. [13] Prophylaxis might be reserved for selected children not enrolled in day care, with frequent or severe infections.

SELECTING AN ANTIBIOTIC FOR OTITIS MEDIA

Recommended drugs for managing otitis media are listed in Table 4 . The most important decision concerns which class of antibiotic to use--prophylactic, first-line, second-line, or third-line--not which agent to administer within a class. Prophylactic antibiotics are indicated only for recurrent AOM as defined in Table 1 ; there is no benefit to long-term prophylaxis for OME. [66] [83] First-line antibiotics are used for initial empiric therapy of uncomplicated AOM or OME. Second-line drugs are indicated for initial treatment failures, complicated infections, and children with ipsilateral conjunctivitis suggesting *H. influenzae* infection. [12] Because no comparative differences in clinical outcomes have been reported among second-line antibiotics, drug choice should be based on cost, convenience, and tolerance.

If the prevalence of beta-lactamase-producing pathogens is rising, [11] [25] how can amoxicillin still be the drug of choice for initial treatment of otitis media? It is because of a favorable natural history, which occurs independently of bacterial resistance patterns. [64] AOM treatment failures occur despite susceptible bacteria, and successes occur despite bacterial resistance. [61] [72] For example, if 20% of children with uncomplicated AOM have beta-lactamase-producing bacteria, resistance will account for failure in only 4% of cases because spontaneous resolution is 80%. This theory assumes that 35% of AOM is caused by *S. pneumoniae*, 30% by *H. influenzae*, and 10% by *M. catarrhalis*, of which approximately 0%, 35%, and 90% produce beta-lactamase. [10]

Penicillin-resistant *S. pneumoniae* are rising in prevalence, particularly among children in group day care. [81] Recent use of a beta-lactam antibiotic is

TABLE 4 -- RECOMMENDED DRUGS FOR MEDICAL MANAGEMENT OF OTITIS MEDIA

Category; Generic (Trade) Names	Frequency, Duration	Pediatric Daily Dosage	Comments
Prophylactic antibiotics			
Amoxicillin (Amoxil)	QD, 1-6m	20 mg/kg/d	Must refrigerate; refill every 2 weeks
Sulfisoxazole (Gantrisin)	QD, 1-6m	50-75 mg/kg/d	No refrigeration necessary
First-line antibiotic therapy			
Amoxicillin (Amoxil)	TID, 10d	40 mg/kg/d	Still the drug of choice for initial therapy
Trimethoprim-sulfamethoxazole, (Bactrim; Septra)	BID, 10d	1 tsp each 10 lb body weight	When child is penicillin-allergic
Second-line antibiotic therapy			
Amoxicillin-clavulanate (Augmentin)	TID, 10d	40 mg/kg/d on amoxicillin	Broad spectrum, but 15-20% gastrointestinal upset
Azithromycin (Zithromax)	QD, 5d	10 mg/kg day 1; 5 mg/kg days 2-5	Suspension can be given without regard for food; capsules cannot
Cefprozil (Cefzil)	BID, 10d	30 mg/kg/d	Not approved before 6 mo of age
Cefpodoxime (Vantin)	QD, 10d	10 mg/kg/d	Broad spectrum, convenient dosing
Ceftibuten (Cedax)	QD, 10d	9 mg/kg/d	Broad spectrum, convenient dosing
Cefuroxime (Ceftin)	BID, 10d	30 mg/kg/d	Broad spectrum, but bitter taste
Clarithromycin (Biaxin)	BID, 10d	15 mg/kg/d	Broad spectrum, well tolerated
Loracarbef (Lorabid)	BID, 10d	30 mg/kg/d	Must give 1 hour ac or 2 hours pc
Third-line antibiotic therapy			
Clindamycin (Cleocin)	TID, 10d	8-12 mg/kg/d	Superb for resistant pneumococcus
Ceftriaxone (Rocephin)	QD, 1-5d	50-75 mg/kg/d IM	Useful for refractory acute otitis media
Oral steroids			
Prednisolone (Pediapred, Prelone)	QD, 10d	1 mg/kg/d × 5 d; ½ mg/kg/d × 5 d	Give together with an antibiotic

ac = before meals, pc = after meals.

also a risk factor. Amoxicillin achieves MEE levels effective against 90% of pneumococci with intermediate penicillin resistance, contrasted with the inadequate levels achieved by most second-line drugs. [39] [53] This helps explain reports of pneumococcal bacteremia and meningitis during initial treatment of AOM with cefixime [57] and clarithromycin. [68] For highly penicillin-resistant pneumococci, the only orally administered antibiotic with adequate MEE levels is clindamycin, [39] [53] hence its listing as a third-line agent in Table 4 . Note that *Clostridium difficile* colitis can occur with any broad-spectrum antibiotic and is no more common with clindamycin than with amoxicillin or the cephalosporins. [26] A pediatric suspension of clindamycin is available.

Single-dose intramuscular ceftriaxone is no "magic bullet" for AOM, and its impact on OME has not been studied. Recent trials show a mean 79% clinical improvement with single-dose ceftriaxone versus 84% improvement with 10 days of amoxicillin, [33] cefaclor, [17] or trimethoprim-sulfamethoxazole. [4] [58] Although the difference is not statistically significant, we cannot conclude with certainty that 79% resolution offers any benefit beyond natural history. Further, liberal use of a potent, broad-spectrum antibiotic, such as ceftriaxone, may accelerate bacterial resistance. [81] Consequently, the author suggests reserving ceftriaxone for third-line therapy (e.g., second-line treatment failures) and for AOM with intracranial or intratemporal complications (e.g., meningitis).

The optimal duration and dosing of antibiotic therapy is uncertain. Amoxicillin-treated children with AOM had similar outcomes with 3-day versus 7-day, [37] 3-day versus 10-day, [18] 5-day versus 10-day, [35] and 10-day versus 20-day regimens. [43] Furthermore, clinical resolution is unaltered when amoxicillin is given once, twice, or thrice daily. [50] [65] These negative findings are not surprising given that the majority of AOM clinical resolution occurs by natural history and that there is no worldwide consensus on whether antibiotics are necessary for most cases. Limited data are available for OME, but the findings for AOM most likely apply. Because efficacy estimates (see Table 3) are derived mostly from clinical trials using 10-day therapy and dosing schedules approved by the manufacturer, the author recommends that practitioners do the same. Individualized variations in duration and dosing, however, are unlikely to significantly alter results.

STEPWISE APPROACH TO AOM

AOM remains the most common childhood disorder seen in physicians' offices and in hospital emergency departments. Annual visitation rates for AOM have more than doubled from 1975 to 1990, with a corresponding rise in antibiotic drug prescription rates. Although amoxicillin is currently prescribed twice as often as other drugs, a disturbing trend has occurred toward increased use of more expensive, broad-spectrum agents, such as cephalosporins. This trend may contribute to rising health care costs and the emergence of antibiotic resistance. [48]

Aggressive treatment for AOM with expensive, broad-spectrum antibiotics reflects unrealistic expectations on the part of practitioners and caregivers (Table 5) . [74] There is no benefit to initial empiric therapy with second-line drugs (see Table 4) over first-line agents, because 70% to 90% of AOM improves clinically without treatment. For the 90% to 95% of children who respond favorably to antibiotics, about 80% of cures are from spontaneous resolution and only 10% to 15% from drug therapy. [72] The primary benefit of antibiotic treatment on AOM is most likely to reduce the incidence of delayed suppurative complications,

TABLE 5 -- STEPWISE APPROACH TO MANAGING ACUTE OTITIS MEDIA

Step	Comment
1. Select an antibiotic	Base decisions on cost, convenience, and tolerance, not bacterial spectrum; use a second-line antibiotic (see Table 4) if otitis-conjunctivitis syndrome or early relapse of prior AOM
2. Define realistic expectations	About 90-95% symptom relief, excluding asymptomatic MEE, within 10-14 days (80% from spontaneous resolution, 10-15% from antibiotic); main purpose of antibiotic is to reduce chance of suppurative complications
3. Retreat clinical failures	Use a second-line antibiotic (see Table 4) if symptoms persist; retreatment with first-line drugs is less effective
4. Use tympanocentesis sparingly	Reserve for retreatment failures with severe symptoms, or those refractory to third-line antibiotics (see Table 4) ; no role for tympanocentesis earlier in therapy
5. Monitor residual OME	Residual OME after AOM is the rule, not the exception, and may last for several months; consider reating with a second-line antibiotic (see Table 4) after 6-8 weeks

similar to the impact of antibiotics on group A streptococcal pharyngitis. For example, acute mastoiditis complicated more than 20% of cases of AOM in the preantibiotic era [75] but now has an incidence of less than 0.1%. [52]

Persistent AOM following treatment is most often secondary to middle ear inflammation after bacteria are killed, either by antibiotics or by the host immune response. Other causes of persistent AOM include bacterial resistance to the initial antibiotic [61] and viral pathogens or copathogens in the middle ear. [19] Because the cause of failure generally is not apparent, continued antibiotic therapy is indicated to cover any persistent bacteria that may predispose the child to suppurative complications. Retreatment with a second-line antibiotic is more effective (60-90% clinical resolution) than retreatment with amoxicillin or trimethoprim-sulfamethoxazole (25-40% clinical resolution). [62]

Penicillin-resistant *S. pneumoniae* may cause persistent AOM, particularly in otitis-prone children fewer than 2 years of age who attend group day care. [8] [85] Clindamycin is the most effective orally administered antibiotic for resistant pneumococcus; about two thirds of highly resistant

strains also may be susceptible to intramuscular ceftriaxone (not single-dose therapy). [8] High-dose amoxicillin (60-80 mg/kg/d) also has been proposed and may be appropriate first-line therapy for high-risk children in communities with endemic penicillin resistance. [14] Myringotomy should be reserved for cases refractory to second-line and third-line antibiotics and for children with immune dysfunction or multiple drug allergies. When used as initial therapy for severe AOM, however, myringotomy is no more effective than antibiotics alone. [38]

Residual OME after resolution of acute symptoms is a consequence--not a complication--of AOM. About 50% of children in clinical trials have an asymptomatic effusion following treatment for AOM, unrelated to the duration or bacterial spectrum of the initial antibiotic. [43] [72] Fortunately, about 90% of episodes resolve spontaneously within 3 months unless acute reinfection occurs (see Table 2) . Treatment of residual OME with additional antibiotics has a modest impact

on short-term cures (see Table 3) , but the impact on long-term cure is uncertain. [84] Therefore, at most, one first-line antibiotic and one second-line antibiotic should be used for stubborn effusions following AOM.

STEPWISE APPROACH TO OME

The first step in managing OME is diagnosing its presence. Many children with OME have a normal-appearing tympanic membrane, making it easy to miss an effusion unless middle ear function is assessed. Tympanometry is used most often in this regard, although pneumatic otoscopy has comparable accuracy. [82] The positive predictive value for OME of a flat (type B) tympanogram (i.e., the likelihood that an effusion is present if the tympanogram is abnormal) is between 49% and 99%. A false-positive tympanometry result can be caused by impacted cerumen, a foreign body, tympanic membrane perforation, or improper placement of the instrument tip on the ear canal wall. Because of these limitations, pneumatic otoscopy is recommended for primary diagnosis of OME with tympanometry as a confirmatory test. [79]

Detecting OME does not imply a need for active treatment (Table 6) . About 90% of effusions less than 2 to 3 months' duration resolve without treatment within a few months (see Table 2) . OME of longer duration has cure rates of only 15% to 30% from watchful waiting (see Table 2) , even when observation is extended to 30 months. [41] Regardless of OME duration, the impact of antibiotic therapy is marginal (see Table 3) and short-lived; antibiotic-treated and placebo-treated children have comparable outcomes several weeks after completing therapy. [44] Aggressive antibiotic treatment of OME is therefore difficult to justify, especially because the incidence of delayed suppurative complications is near

TABLE 6 -- STEPWISE APPROACH TO MANAGING OTITIS MEDIA WITH EFFUSION

Step	Comment
1. Be patient	Most cases resolve without treatment (see Table 1) , particularly when following a recent episode of AOM
2. Use antibiotics sparingly	Antibiotics boost short-term resolution by about 15% and therefore benefit only one child of every seven treated; do not use repetitive, prolonged, or prophylactic antibiotics
3. Put the odds in your favor	Limit passive smoke exposure; treat sinusitis; control food and inhalant allergies
4. Test hearing after 3 months	Any child can be tested, regardless of age; tube insertion is recommended for bilateral effusions lasting 4 months or longer with an associated hearing loss
5. Consider steroid-antibiotic therapy	Most effective when hearing is normal and child is not otitis-prone; observe varicella precautions (see text)
6. Fit the punishment to the crime	Chronic effusions without hearing loss can be managed expectantly; consider surgery if accompanied by otalgia, recurrent AOM, retraction pockets, speech problems, or antibiotic intolerance

zero. Autoinflation of the eustachian tube, by means of a plastic nasal cannula and attached balloon, is a harmless adjunct to watchful waiting that may be tried in older children. [7] [77] Prophylactic antibiotics and antihistamine-decongestant preparations offer no benefits beyond placebo therapy.

Clinicians can improve the odds of OME resolution by modifying risk factors and controlling concurrent illness. The risk of getting AOM or OME is increased with passive smoke exposure, group day-care attendance, and bottle-feeding rather than breast-feeding infants. [79] The associations, however, are modest (relative risk about 2.0), and many breast-fed children cared for at home by nonsmokers still obtain otitis media. Nonetheless, efforts to limit smoke exposure seem prudent, particularly for children in group day care, in which 18% of cases of OME may be attributable to parental smoking. [24] Because allergy to milk proteins may cause middle ear inflammation, [6] the author recommends a milk-free diet for several weeks as a diagnostic trial in children fewer than 2 years of age. In older children with OME, concurrent illnesses, such as sinusitis and allergic rhinitis, should be brought under optimal control.

A child with bilateral OME for 3 months or longer should undergo hearing evaluation. [79] No child is too young to test, including infants fewer than 6 months of age. OME generally causes a mild conductive hearing loss (27 dB hearing level [HL]), but 20% of ears have a pure-tone average of more than 35 dB HL. [27] Although the relationship between early OME and language development is controversial, the literature supports a direct connection between hearing and language with middle ear effusion as an intermediate variable. [28]

Placement of tympanostomy tubes is recommended for children with 4 to 6 months of bilateral OME and hearing loss, defined as 20 dB HL or higher for the better ear. [79] Hearing levels obtained in a soundproof booth, however, may underestimate the auditory impact of OME on children in real-world listening environments. For example, the ability of children to recognize words presented at soft levels or with background noise deteriorates when OME is present, even when hearing levels are normal. [69] Difficulties in word recognition may cause behavioral problems, poor attention span, or poor school performance. Therefore, affected children with bilateral OME and normal hearing may still benefit from tympanostomy tubes on a selective basis. Finally, hearing levels fluctuate relative to the volume of middle ear fluid and should be periodically retested when deferring surgery because of normal hearing.

Steroid therapy is not recommended for children 3 years of age or younger with OME [79] but may be used selectively in older children as a last-resort medical alternative to surgery. [73] Oral prednisone or prednisilone (see Table 4) is given concurrently with a second-line antibiotic, provided that there has been no varicella exposure for 3 weeks and there is no coexisting AOM or sinusitis. Children who get varicella while taking steroids should discontinue the drug and be considered for oral acyclovir therapy to minimize the likelihood of severe disease. [1] Relapse of OME occurs in 40% of initial responders following steroid-antibiotic therapy, yielding a 6-month cure rate of about 25%. Children without hearing loss or recurrent AOM seem to have the most favorable outcomes. [73]

Decisions concerning the relative merits of ongoing medical therapy for OME versus surgical intervention (i.e., tympanostomy tubes) must be individualized (Table 7) . Children with asymptomatic OME who also have normal hearing, speech, school performance, and tympanic membrane appearance may be monitored with extended periods of watchful waiting. The key word in the preceding sentence is *monitored*; implicit in a wait-and-see approach is interval otoscopy and audiometry every 3 to 4 months to detect changes in hearing status or the structural integrity of the tympanic membrane. In contrast, a hearing-impaired

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TABLE 7 -- FACTORS INFLUENCING DECISIONS FOR OR AGAINST SURGERY FOR OME

Factor	Favors Surgery	Favors Alternatives to Surgery
Epidemiology		
Laterality of OME	Bilateral	Unilateral
Duration of OME	Less than 3 months	3 months or longer
AOM history	Recurrent AOM	Infrequent AOM
Daytime environment	Group day care	Home-based care
Passive smoke	Frequent smoke exposure	No smoke exposure
Current season	Fall or early winter	Spring or early summer
Impact on child		
Physical symptoms	Ear pain, tugging, or pulling	Asymptomatic
Hearing	Bilateral hearing loss	Normal hearing
Speech and language	Speech delay or misarticulation	No speech impairment
Behavioral symptoms	Abnormal behavior	Normal behavior

School performance	Adversely affected	Unaffected
Miscellaneous		
Otoscopic appearance	TM retraction or collapse	Air bubbles or air-fluid level
Antibiotic tolerance	Multiple drug allergies	Antibiotics well tolerated
Baseline otitis media risk	High-risk population *	Normal risk
Other indication for surgery on pharynx or ears	Present	Absent

TM = tympanic membrane.

*Cleft palate, immunodeficiency, Down syndrome, craniofacial anomalies, Eskimos, Native Americans.

child with unilateral or bilateral OME and a baseline sensorineural loss would benefit from early tympanostomy tube insertion, not prolonged medical therapy. Adenoidectomy is effective for OME in older children [30] [47] [60] but is not recommended for those age 3 years or younger. [79]

STEPWISE APPROACH TO RECURRENT AOM

A network of primary care doctors representing nine countries was asked to rate how certain they were when diagnosing AOM in young children. Survey results indicated a disconcerting 58% level of diagnostic certainty in patients aged 0 to 12 months, rising to 66% at 13 to 30 months, and 73% for children more than 30 months of age. [29] These results illustrate the difficulty of diagnosing AOM in young children, not the incompetence of the physicians surveyed. With recurrent AOM, the issue of diagnostic certainty is paramount because of a geometric increase in the potential consequences.

Even a skilled otoscopist can struggle to glimpse the tympanic membrane in an uncooperative child with small ear canals or obstructing cerumen. If obstructing cerumen cannot be removed easily, the child should be referred to an otolaryngologist for microscopic cleaning of the ear canal. When the tympanic membrane is visualized, a test of middle ear function is performed to verify that a MEE is present (tympanometry or pneumatic otoscopy). Unfortunately the severity of tympanic membrane inflammation predicts neither the presence of MEE nor the clinical course of recurrent AOM. [3] A red eardrum commonly

occurs during brisk crying and viral myringitis, which are self-limited conditions distinct from AOM.

Recognizing that problems with diagnostic certainty can never be completely avoided, the author recommends tailoring the treatment of recurrent AOM episodes accordingly. When certainty is high, treatment of the episode should proceed as outlined earlier (see Table 5) . Examples include purulent otorrhea, a bulging tympanic membrane, or acute symptoms with a documented MEE. When certainty is low, the caregiver may be given a prescription for a first-line antibiotic and told to treat the child only if acute symptoms do not subside after 24 to 48 hours of expectant therapy. This approach avoids unnecessarily treating viral myringitis and false-positive diagnoses of AOM. When certainty is moderate, judgment is required. Infants and young children with severe symptoms should probably be treated, but older children with nonsevere symptoms may be managed expectantly.

Primary prevention of recurrent AOM involves modifying risk factors and using vaccines (Table 8) . Children in group day care are at increased risk for recurrent AOM, but the size of the group--not day care per se--is responsible. [42] [46] When the group size is six children or fewer, risk is not increased. Pacifiers should be discouraged in day care settings, because their use accounts for 25% of recurrent AOM in children less than 3 years of age. [56] Children in day care also benefit from an influenza A vaccine, which reduces the incidence of AOM by about 40% during the influenza season (January to February). [20] [34] In contrast, the pneumococcal vaccine (children 2 years or more) does not decrease overall incidence of AOM but reduces vaccine-type pneumococcal AOM. [9] This may be beneficial given a rising prevalence of multidrug-resistant pneumococcus. Finally, breast-feeding (4 months or longer) has been shown to reduce AOM frequency in longitudinal studies. [2] [22]

Enthusiasm for antibiotic prophylaxis of recurrent AOM must be tempered by reality: a child must be treated for 9 months, on average, to prevent one AOM episode beyond what would occur from natural history alone. [74] Although

TABLE 8 -- STEPWISE APPROACH TO MANAGING RECURRENT ACUTE OTITIS MEDIA

Step	Comment
1. Confirm the diagnosis	Distinguish myringitis from true otitis media; confirm MEE by tympanometry or pneumatic otoscopy

2. Put the odds in your favor	Limit passive smoke exposure; consider group day-care alternatives; discourage pacifier use in day care
3. Practice prevention	Encourage breast feeding; control allergies; consider pneumococcal vaccine (age 2 years or more) or influenza vaccine (day care)
4. Use prophylaxis with caution	Risk of acclerated bacterial resistance often outweighs minimal benefit of prolonged antibiotic prophylaxis
5. Avoid unproven therapies	Antihistamine/decongestant combinations are of no benefit; chiropractic, homeopathy, and naturopathy are unproven
6. Fit the punishment to the crime	Recurrent AOM with minimal symptoms can be managed expectantly; consider surgery if accompanied by febrile seizures, antibiotic intolerance, hearing loss, speech problems, or chronic OME

statistically significant, the clinical significance is questionable when balanced against risks of accelerated bacterial resistance. Particular caution applies to children in group day care, where bacterial resistance is already more common. [67] Intermittent prophylaxis during respiratory illness is appealing but may be less effective than continuous treatment. [5] Furthermore, when OME persists between episodes of recurrent AOM, prophylaxis does not increase resolution of the baseline effusion. [66] [83] These findings argue for judicious use of antibiotic prophylaxis on a restrictive and individualized basis.

When medical options have been exhausted, surgery must be considered. Tympanostomy tubes are effective in controlling recurrent AOM, with or without intercurrent OME, because they effectively bypass the child's immature and poorly functioning eustachian tube. [16] [31] [32] Breakthrough episodes of AOM while on antibiotic prophylaxis are not a mandatory prerequisite to tube insertion because of the concerns about prophylaxis expressed earlier. What is important, however, is the frequency and severity of AOM episodes and the presence or absence of associated sequelae, such as hearing loss, speech problems, or multiple drug allergies. Adenoidectomy is effective for recurrent AOM in children who have had tympanostomy tube insertion at least once previously. [60]

SUMMARY

More than 20 years ago, a shrewd clinician remarked, "There is little evidence that those antimicrobial agents which hypothetically or in vitro are more effective . . . are superior in the treatment of otitis when compared to penicillin alone." [78] Several hundred clinical trials later, the advantages of broad spectrum drugs remain unproved, and questions remain as to whether antibiotics are required for most episodes of AOM. Further, antibiotics have been demoted to the status of optional therapy for OME. [79] This situation is unlikely to change as new studies with new antibiotics proliferate.

What is clear, however, is that accelerated patterns of bacterial resistance mandate an evidence-based approach to managing otitis media. Bacteria have an uncanny ability to learn new mechanisms of antibiotic resistance. [55] A large part of bacterial "education" has undoubtedly been fueled by antibiotic prescriptions from well-intentioned physicians, with unrealistic expectations of drug efficacy. A judicious approach to antibiotic treatment of otitis media can result only from knowing the spontaneous course of the disorder and incremental effect of antibiotics on clinical outcomes.

In this article, a series of unifying concepts are developed to help practicing clinicians with an evidence-based approach to managing otitis media. Critical review of the published evidence suggests that the most favorable outcomes from medical treatment will occur if practitioners:

- appreciate the favorable natural history of untreated otitis media
- realize that OME may take months to resolve following a single AOM episode
- modify risk factors to improve the odds of spontaneous resolution
- use pneumatic otoscopy and confirmatory tympanometry to diagnose OME

recognize the limited impact of antibiotic therapy on treatment and prevention

balance the benefits of antibiotics against the risk of accelerated bacterial resistance

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avoid repetitive, prolonged, or prophylactic antibiotic treatment of chronic OME

avoid ineffective therapy, such as antihistamine/decongestant preparations

An important aspect of management is helping caregivers understand the natural history of otitis media and the impact of medical treatment on short-term and long-term outcomes. Realistic expectations on the part of all involved parties should facilitate rational decisions about watchful waiting, medical therapy, and the need for surgical intervention.

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