Ear Clinics International

VOLUME 3

Clinical Otology

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VOLUME III

Clinical Otology

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Clinical Otology

This volume is one of the series
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Michael M. Paparella and William L. Meyerhoff

Other books in this series include:

Paparella and Meyerhoff: Sensorineural Hearing Loss, Vertigo and Tinnitus

Paparella and Goycoolea: Clinical Problems In Otitis Media and Innovations in Surgical Otology

Preface

This, the third volume of International Ear Clinics provides a blend of current concepts of ear problems and otological surgical considerations by expert Otologists from various countries.

In the "Otitis Media Surgery" section, early otitis media in childhood or otitis medial with effusion (OME) are discussed including considerations of pathogenesis, diagnosis, ventilation tubes, and tonsillectomy and adenoidectomy (Goycoolea, Bluestone, Meyerhoff) followed by a common sequella of otitis media-tympanosclerosis (Schiff). Then tempanoplasty and ossiculoplasty concepts are discussed (Fisch, Goodhill, Sheehy) with long-term results of cholesteatoma surgery and mastoid cavity care (Palva).

Current stapes surgery methods including stapedotomy by Fisch and stapedectomy revision by Sheehy reveal some new ideas in the surgical treatment of otosclerosis.

The application of auditory brain stem response as an aid in diagnosis (Harford and Harker) and clinical concepts of diagnosing acoustic tumors (Luetje) are presented after which middle ear cranial fossa surgical methods are discussed (Harker).

In the next section, some new and innovative concepts of diagnosis and treatment of labyrinthine problems are described including fistulas (Goodhill), sudden deafness (Schiff), autoimmune inner ear disease (McCabe), cochlear implants (Luetje), and tinnitus masking (Harford). These medical and surgical labyrinthine topics are new and, in some cases, too new to be established but time and experience will help define their respective roles in Otology.

The final section includes topics on vertigo and surgery for vertigo including classical methods of diagnosis and treatment (Jongkees), and current methods for using surgery to treat intractable vertigo (McCabe and Paparella).

As in other editions of International Ear Clinics, these international otological experts contribute to the continuing dialogue of evolving methods for diagnosing and treating otological problems. Rarely can any concept be considered "definitive", rather these discussions are dedicated to an ongoing search for truth.

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CHAPTER 1

Pathogenesis of Otitis Media

Marcos V. Goycoolea, M.D., M.S., Ph.D.

Otitis media is an inflammatory disease of high incidence and prevalence which can evolve or resolve in a number of different and unpredictable manners. There are so many forms, complications, and/or sequelae that a general overview would necessarily end up as just a summary. It has been my purpose to describe our systematic approach to a single aspect, that is, subtle inner ear complications of otitis media. Since this is a review of our past and present experience, the literature will not be discussed. Complete discussions are included in our referenced papers.

Back in 1970, Drs. Paparella et al. (1) reported that otitis media could result not only in devastating inner ear changes such as suppurative labyrinthitis but also in subtle changes such as sensorineural hearing loss. Shortly thereafter, I came to Minnesota; we reviewed a large number of temporal bones with otitis media and observed that a significant number had the association of otitis media, round window membrane changes, and endolymphatic hydrops (2).

With this evidence in hand, we initiated a systematic experimental approach in order to verify or disprove these associations. The normal middle ear of the cat was described (3). The round window (light microscopy) appeared as a three-layered membrane with an outer epithelium (towards the middle ear) with a single layer of cuboidal cells, a middle core of connective tissue, and a flat squamous inner epithelium continuous with the one of the inner ear. The outer and middle layers are continuous with those of the middle ear, providing a continuity of blood and lymph vessels which are abundant at the lateral edges of the membrane.

Following this first step, a longitudinal study of histopathological changes in the middle ear of cats with induced otitis media (1 day to 6 months) was done (4). We observed that there are definite stages in the development of this disease, with definite patterns of cellular infiltration and effusion formation so we postulated the concept of a "Middle Ear Defense System" (5). Although this is not the main subject of this discussion, it must be mentioned that a clear understanding of this system is essential since it will eventually lead to a more rational and effective medical treatment of this disease. Hopefully, this could leave surgical procedures in an ideal role of restoration of function rather than that of erradication of disease.

From a general standpoint, if anything would pass from middle to inner ear it would do so necessarily via either the oval window, round window, bony fistulas, and/or blood or lymph vessels. With this in mind, we looked at the different areas in the middle ears of experimental animals and observed that in spite of all the changes, the oval window remained intact at all stages and that there were no bony fistulas (6). However, when we looked at the round window, it was evident that it followed the changes of the mucoperiosteum of the middle ear (7). The round window membrane changes were then quantified (8).

When we reviewed the literature, it was evident that the round window membrane, despite being three-layered, behaved like a semipermeable membrane. However, no studies had been done in permeability of macromolecules or toxins. In a group of animals with induced otitis media, we placed tritiated albumin in the round window niche and were able to recover it in perilymph 20 minutes later (9). We then placed tritiated staphylococcal exotoxin in the niche and recovered it in perilymph of

both normal and otitis induced animals (10, 11). The question posed was no longer whether macromolecules or toxins could pass into the inner ear, but what happens when they get there. Based on these observations, we suggested the possibility of an "Inner Ear Defense System", since otherwise, the incidence of sensorineural hearing loss following otitis media would be extremely common. We used staphylococcal exotoxin because staph is a frequent organism in chronic otitis media, and these strains produce a large number of extracellular products, many of them potent toxins. Some of these toxins have the capability of not only injuring hair cells and nerve fibers but also of blocking sodium pumps. This becomes extremely interesting since there are diseases of the inner ear and inner fluid imbalances whose pathogenesis are not known.

At this point in time what was needed were ultrastructural studies that would provide more detailed information. So, upon my return to Chile, we initiated these studies with Anna-Mary Carpenter and David Muchow. An ultrastructural study of the cat round window membrane was done that revealed interesting features (12). The outer epithelium has extensive interdigitations between the cells and abundant tight junctions. The cells have sparse microvilli and abundant mitochondria as well as a well-developed Golgi. The basement membrane, thinner than that of the nearby promontory mucosa is continuous. The core of connective tissue is rich in blood and lymph vessels especially towards the edges. The inner epithelium has lining cells with long lateral extensions with sparse and inelaborate junctions. There is no continuous basement membrane. If we add our preliminary observations (unpublished) of pathological membranes and tracers, we have a number of interesting phenomena. Substances can pass via the outer layer either through altered junctions because of inflammation or via micropinocytotic vesicles. On the other hand, observations on the inner layer reveal that this layer allows passage of substances to and from the inner ear giving the membrane interesting new roles of depurating and regulating inner ear fluids.

I believe that these aspects of otitis media are most interesting, and I firmly believe that systematic research in this area will help towards a better understanding of inner ear disease secondary to otitis media and, perhaps, may change some concepts in otology.

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CHAPTER 2

Efficacy of Various Methods of Therapy for Otitis Media[1]

Charles D. Bluestone, M.D.[2]

Otitis media is the most frequent diagnosis made by physicians who care for children and is probably the most common condition in adults who are treated by otolaryngologists. (1). Acute otitis media is usually suppurative or purulent, but serous middle ear effusions may also have an acute onset. Chronic otitis media with effusion has many synonyms, including such terms as secretory, serous, nonsuppurative, and "glue ear." A chronic effusion may be serous, mucoid, or even purulent. In some instances, the eardrum may be retracted or collapsed without a middle ear effusion, which is termed *atelectasis* of the tympanic membrane, and is the result of persistent or intermittent negative middle ear pressure. It is often difficult to determine from the history and visual inspection of the tympanic membrane the precise type of otitis media present since in most patients, especially infants and young children, the disease is a continuum of the different stages. Some patients may have recurrent acute attacks without an apparent effusion in-between, whereas others may have only chronic otitis media with effusion, and still others may have recurrent acute episodes superimposed on a persistent middle ear effusion. Atelectasis of the tympanic membrane may represent the only pathology in some patients but in others, the condition can be present between episodes of otitis media with effusion. Chronic otitis media with perforation and otorrhea is one of the sequelae of acute or chronic otitis media with effusion.

[1] This study was supported, in part, by a grant from the National Institute of Neurological and Communicative Disorders and Stroke, 1P01-NS-16337.
[2] The author would like to thank Ms. Sandra Arjona for her assistance in the preparation of this manuscript.

EPIDEMIOLOGY

Infants and young children are at highest risk for the acquisition of otitis media, with the peak prevalence rate occurring between 6 and 36 months, and a lesser peak between 4 and 7 years (see Fig. 2.1) (2).

Figure 2.2 shows the findings in 2,565 children followed for the first 3 years of life. In this study, it was found that only 29% of infants failed to develop at least one attack of otitis media, whereas about one-third had three or more episodes (3). In addition, the study showed that after the first episode, 40% of children had a middle ear effusion that persisted for 4 weeks and 10% had an effusion which was still present at 3 months. Infants who develop otitis media with effusion in the first years of life have an increased risk of recurrent acute or chronic middle ear effusions.

The overall prevalence of the disease in children has been estimated at between 15–20% (4). However, the incidence and prevalence of the disease tend to decrease as a function of age after the age of 6 years. The incidence is higher in males, lower socioeconomic groups, Alaskan natives (Eskimos), American Indians, children with cleft palate and other craniofacial anomalies, and higher in whites than in blacks. The incidence is also higher in winter and early spring (5).

ACUTE OTITIS MEDIA WITH EFFUSION

In the classic description of this condition, a child who has an upper respiratory

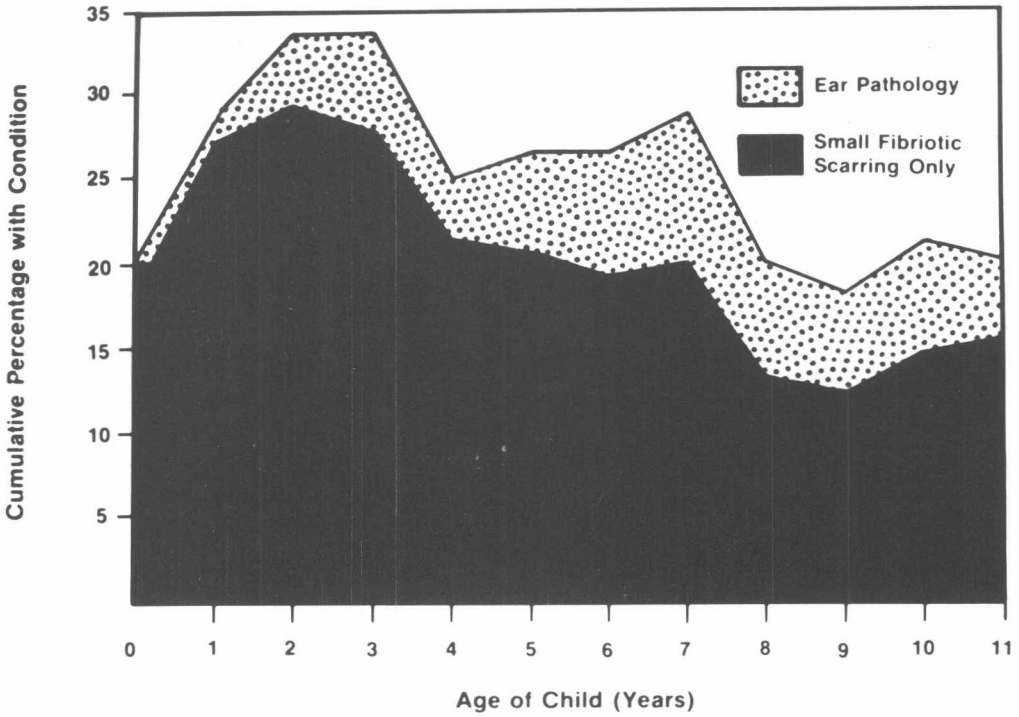

Figure 2.1. Point prevalence study of 2,158 infants and children in the Washington, D.C. area (2).

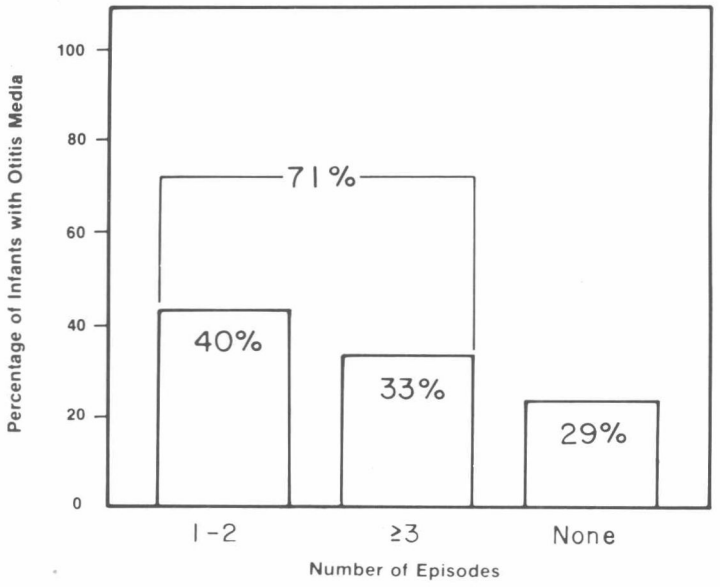

Figure 2.2. Study of epidemiology of otitis media from the Greater Boston Collaborative Media Program. Adapted from Teele et al. (3).

infection for several days suddenly develops otalgia, fever, and hearing loss. Examination with the pneumatic otoscope reveals a hyperemic, opaque, bulging tympanic membrane that has poor mobility. Purulent otorrhea may be present. However, earache and fever are not invariable concomitants of infection. Because of the

variability of symptoms, an otoscopic examination should always be included in the evaluation of infants and children; those who have diminished or absent mobility and opacification of the tympanic membrane should be suspected of having a bacterial otitis media with effusion. Middle ear infection must be ruled out in any child with a "fever of undetermined origin." When the diagnosis of acute otitis media with effusion is in doubt, or when determination of the causative agent is desirable, aspiration of the middle ear should be performed.

Rational therapy for acute otitis media with effusion depends upon knowledge of the bacterial cause of the disease. The bacteria that have been cultured from middle ear effusions in children with acute otitis media have been shown to be the same found in the nasopharynx (6). *Streptococcus pneumoniae* has been cultured from approximately 30–40% of the effusions and is the most common causative agent in all age groups. *Haemophilus influenzae* causes about 20% of cases (Fig. 2.3). This proportion declines with increasing age but *H. influenzae* is still significant in *all* age groups. Recently, there has been an increasing percentage of *H. influenzae* strains, 15–30% that have been β-lactamase producing and therefore, ampicillin-resistant (7, 8). *Branhamella catarrhalis* is present in about 5%. Group A β-hemolytic streptococcus and *Staphylococcus aureus* account for 7 and 2% respectively. In about 25% of effusions, no bacteria are cultured. In neonates, approximately 20% of effusions may contain gram-negative enteric bacilli.

In patients with the classic signs and symptoms of acute otitis media antimicrobial therapy is the treatment of choice (Table 2.1) (9). Since the clinician rarely is certain of the causative organism before starting therapy for otitis media, ampicillin is the single most useful drug, and will usually be effective against the most commonly encountered bacteria. Oral ampicillin, 50–100 mg/kg/24 hrs, in four divided doses for 10–14 days is recommended. Amoxicillin, 20–40 mg/kg/24 hr, is probably equally effective and can be given in three divided doses. If the patient is allergic to the penicillins, then a combination of oral erythromycin, 50 mg/kg/24 hr, and triple sulfonamides, 100 mg/kg/24 hr (or sulfisoxazole, 150 mg/kg/24 hr), in four divided doses, is a suitable alternative. The combination of trimethoprim and sulfamethoxazole, 8–40 mg/kg/24 hr in two divided doses, also can initially be given to penicillin-sensitive individuals, but its effectiveness in the treatment of acute otitis media due to *Streptococcus pyogenes* is uncertain. A new cephalosporin, cefaclor, 40 mg/kg/24 hr, in three divided doses, appears to be a promising new antimicrobial agent for otitis media since it is effective against the common pathogens causing acute otitis media. The clinical efficacy of these antimicrobial agents is summarized in Table 2.2.

Additional supportive therapy, includ-

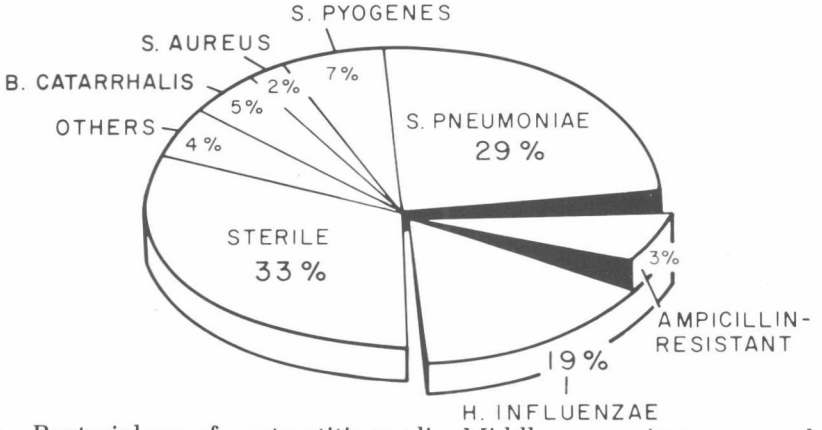

Figure 2.3. Bacteriology of acute otitis media. Middle ear aspirates were obtained by tympanocentesis from 83 ears of children 1–12 years of age (7).

ing analgesics, antipyretics, and local heat, will usually be helpful. In some instances, meperidine hydrochloride may also be required for sedation. The efficacy of antihistamines and decongestants in the treatment of acute otitis media has not been proven.

If the patient continues to have appreciable pain or persistent fever, or both, after 24–48 hr, tympanocentesis/myringotomy should be performed as a diagnostic and therapeutic procedure. At this stage, the presence of an effusion alone does not constitute a clinical failure. In patients with unusually severe earache, myringotomy may be performed initially in order to provide immediate relief.

When an unusual organism is cultured from a middle ear aspirate, sensitivity testing will help in the choice of antimicrobial agents. An example of this situation is an acute otitis media due to *H. influenzae* that is resistant to ampicillin. When this occurs or when the patient fails to improve clinically after the initial treatment with ampicillin or amoxicillin and a tympanocentesis/myringotomy is not performed, the initial antimicrobial should be changed since an ampicillin-resistant *H. influenzae* should be suspected. Erythromycin in combination with a sulfonamide, or trimethoprim-sulfamethoxazole, or cefaclor are appropriate choices at present.

All patients should be re-evaluated approximately 2 weeks after the institution of treatment. At this time, some patients will have had complete resolution of the middle ear effusion but in others complete clearing of the effusion may take 6 weeks or longer. Within 2–3 months, the tympanic membrane should be entirely nor-

Table 2.1
Therapeutic Results in Acute Otitis Media (9)

Drug	% Therapeutic Success	
	*H. influenzae**	*S. pneumoniae*
Ampicillin	99	99
Penicillin V and Triple Sulfonamides	92	100
Erythromycin and Triple Sulfonamides	93	95
Penicillin V	42	100
Erythromycin	49	96
Triple Sulfonamides	83	76
Placebo	43	20

* Ampicillin sensitive

Table 2.2
Efficacy of Selected Antimicrobial Agents for the Common Pathogens in Acute Otitis Media*

Antimicrobial Agent	*S. pneumoniae* 35%	*H. influenzae* 20%		*B. catarrhalis* 5–10%	*S. pyogenes* 5–10%	*S. aureus* 2–10%
		Non β-lactamase 17%	β-lactamase 3%			
Ampicillin or Amoxicillin	+	+	−	±	+	±
Erythromycin-Sulfisoxazole	+	+	+	+	+	+
Trimethoprim-Sulfamethoxazole	+	+	+	±	−	±
Cefaclor	+	+	+	+	+	+

* Based on available data from clinical trials.
+ Effective.
± Effective for some strains but not all.
− Not effective.

mal. If complete resolution has occurred and the episode represents the only known attack, the patient may be discharged. However, periodic follow-up is indicated for patients who have had recurrent episodes.

RECURRENT ACUTE OTITIS MEDIA

It is not uncommon for children, especially infants, to have recurrent bouts of acute otitis media. Some children develop an acute episode with almost every respiratory tract infection, have more or less dramatic symptoms, respond well to therapy, and improve with advancing age. Others are more difficult, in that they have persistent middle ear effusion and suffer recurrent episodes of acute otitis media with effusion superimposed on the chronic disorder. The child with recurrent acute otitis media with effusion who completely clears between episodes may be managed as previously outlined. However, if the bouts are frequent and close together, further treatment, similar to that described for patients with chronic otitis media with effusion, is indicated. In many of these children, the underlying cause is not evident but myringotomy with insertion of middle ear tympanostomy tubes is frequently helpful. Prophylactic antimicrobials (a daily dose of ampicillin or sulfonamides) have been advocated as an alternative to tympanostomy tubes in children with recurrent acute otitis media with effusion who are free of effusion between attacks (Table 2.3). The efficacy of myringotomy with tympanostomy tube insertion and of chemoprophylaxis is as poorly established as is the usefulness of other forms of prevention, such as hyposensitization and adenoidectomy (10).

CHRONIC OTITIS MEDIA WITH EFFUSION

Chronic middle ear effusions may be thin (serous), thick (mucoid), or purulent in character. Pneumatic otoscopy will frequently reveal either a retracted or convex tympanic membrane. The membrane is usually opaque but when it is translucent, an air-fluid level or air bubbles may be seen and an amber or sometimes bluish fluid may be apparent in the middle ear. The mobility of the ear drum is almost always impaired. Occasionally, even when the middle ear is free of effusion, the tympanic membrane will be retracted and its mobility impaired. This finding usually indicates the presence of negative middle ear air pressure, which, when extreme, is termed "atelectasis of the tympanic membrane"; it may be accompanied by the same symptoms usually associated with otitis media with effusion. In both conditions, auditory acuity is usually decreased, and although systemic symptoms are usually absent, there may be behavioral disturbances owing to the child's inability to communicate adequately. A feeling of fullness in the ear, tinnitus, and even vertigo may be present. Audiometry may be helpful in establishing the diagnosis but is not a reliable indicator, because some patients, even with thick middle ear effusions, have fairly good hearing. Tympanometry is a more reliable diagnostic tool (11). A patient with chronic otitis media with effusion who has not received prior antimicrobial

Table 2.3
Chemoprophylaxis for Recurrent Acute Otitis Media with Effusion

Study	Drug	Duration	% Reduction
Ensign et al. (26) (Eskimos)	Sulfamethoxypyridazine	9 months	56 (Otorrhea)
Maynard et al. (27) (Eskimos)	Ampicillin	1 year	47 (Otorrhea)
Perrin et al. (28)	Sulfisoxazole	6 months	81
Biedel (29)	Sulfisoxazole	2 months (with URI)	71

therapy should be treated initially as a case of acute otitis media with effusion, since bacteria are frequently present (12, 13).

A study was conducted of 274 children who had recurrent acute or chronic otitis media with effusion (14). Figure 2.4 shows that 45% of the ears with effusion were found to contain bacteria and 11 percent bacteria that were "probable pathogens" (*S. pneumoniae*, *H. influenzae*, and *S. pyogenes*). Bacteria were also found in 40% of the ears without effusions. The type of organism found did not vary with the age of the patient studied or the season of the year. Pathogens have also been aspirated from young infants with chronic effusions (Fig. 2.5) (15). The significance of these bacteria in the etiology of recurrent acute or chronic otitis media with effusion remains to be demonstrated. However, the efficacy of antimicrobials, as well as decongestants and antihistamines, for chronic otitis media with effusion has not been proven. Occasionally, attempts at middle ear inflation by Valsalva's or Politzer's method are successful.

If the effusion persists for 8 weeks or longer, or if there have been frequent recurrences of episodes of acute otitis media with effusion, the patient requires further evaluation. Several avenues of investigation are open: a search for respiratory allergy may prove fruitful; a lateral roentgenogram of the nasopharynx may reveal adenoid tissue obstructing the nose and nasopharynx; immunological studies may be of value if other organs are involved (the lung, for example). In addition, more thorough physical examination may reveal abnormalities, such as submucous cleft palate or a tumor of the nasopharynx, that require definitive management.

For those patients in whom medical management has failed, myringotomy with aspiration of the middle ear fluid is indicated. Frequently, insertion of a tympanostomy tube may be necessary to allow the middle ear mucous membrane to return to normal and to prevent subsequent accumulation of effusion. Myringotomy and insertion of ventilation tubes may also be helpful in patients with atelectasis of the middle ear when significant symptoms—pain, hearing loss, vertigo, or tinnitus—are present. Ventilation tubes should be used to prevent permanent structural damage and cholesteatoma if a deep retraction pocket develops in the posterosuperior quadrant or in the attic (pars flaccida) portion of the tympanic membrane. Occasionally, troublesome otorrhea develops after the insertion of tympanostomy tubes. This can usually be treated successfully with ear drops containing neomycin, polymyxin, or colistin with hydrocortisone. Since these medications may be ototoxic, some physicians advocate the use of systemic antibiotics without the aural drops. In most children, otitis media with effusion is usually self-limiting and will improve with advancing age, but in se-

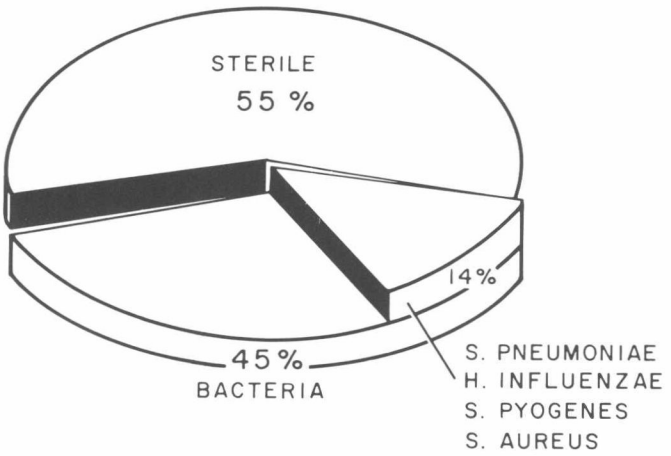

Figure 2.4. Bacteriology of ears of children 1–16 years of age who had chronic or recurrent otitis media with effusion (14).