Chapter 12: Otitis media with effusion (glue ear)

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Otitis media with effusion is one of the commonest chronic otological conditions of childhood. It is described by a variety of synonyms. Otitis media with effusion results from alteration of the mucociliary system within the middle ear cleft where serous or mucoid fluid accumulates in association with a negative pressure. The pressure change is almost invariably caused by malfunction of the eustachian tube. Although there are no signs of inflammation, bacteria can be cultured from the effusion in as many as 50% of cases, particularly if special techniques are used.

An effusion frequently remains in the middle ear following acute suppurative otitis media, but usually spontaneous clearance occurs within a few weeks. Chronic otitis media with effusion is especially prevalent in children with cleft palate (Stool and Randall, 1967; Paradise, Bluestone and Felder, 1969). It frequently occurs in association with chronic upper respiratory tract infection and conditions affecting the nose and sinuses. These include allergic rhinitis, fibrocystic disease and ultrastructural cilial abnormalities of the respiratory tract mucosa. It is found very often in children suffering with Down's syndrome (Stote, 1981) or Hurler's syndrome and other craniofacial abnormalities.

The condition occurs in childhood as overt or covert hearing loss presenting as an educational or behavioural problem. In younger children it may present as speech and language delay or as an articulation defect. Often the hearing loss is first detected on routine screening examinations before or at 3.5 years of age, or later at a preschool testing. Sometimes attention is drawn to it by frequent episodes of otalgia which indicate an exacerbation of acute suppurative otitis media superimposed on the middle ear effusion. Occasionally, presentation is with complications such as otorrhoea secondary to perforation of the tympanic membrane.

Treatment varies widely and is naturally dependent on the duration and severity of the condition. It is accepted that mild forms of the disease resolve spontaneously, particularly in the summer months. Unilateral effusions, though not without effect, seem less detrimental to normal childhood development than if the condition is bilateral. As yet, no satisfactory study has demonstrated any long-term benefit from the large variety of medical measures prescribed as treatment. Topical and systemic vasoconstrictor substances, and anti-allergy remedies have their proponents. Antibiotics have been prescribed; systemic steroids have also been tried, but all methods remain unproven.

Surgical treatment is often recommended to the ears in the form of myringotomy and aspiration with or without insertion of a ventilation tube. Surgery may also be recommended to the sinuses as antral lavage and to the postnasal space and pharynx in the form of adenoidectomy and tonsillectomy. It is removal of the adenoids and tonsils which is mainly responsible for the morbidity and mortality in relation to treatment. The main reasons postulated for adenoidectomy as a means of treatment and as a method for prevention of recurrence of the effusion are centred on the size of the adenoids and their possible role as a focus of ascending eustachian tube infection. In addition, they may alter nasopharyngeal relationships. The potential source of infection from the tonsils has been similarly implicated.
Tonsillectomy is often additionally advised on grounds which, on their own merit, might not substantiate a need for removal of the tonsils alone. Arguments for (Bateman, 1959; Gottschalk, 1972; Potsic, 1980; Marshak and Ben Neriah, 1980) and against (Editorial, 1977; Sade, 1979; Roydhhouse, 1980; Stool, 1980; Stell, 1981) adenoidectomy and adenotonsillectomy for all types of middle ear disease in childhood have been discussed and reported in symposia worldwide (Lim et al, 1976, 1984; Paradise, 1976; Senturia et al, 1980).

Considering the large numbers of these operations performed for this condition, it is interesting that so few studies have been carried out to validate their efficacy. It seems that the belief that adenoidectomy relieves acute suppurative otitis media has been extrapolated, as yet without convincing supportive evidence, as grounds for the management of chronic otitis media with effusion.

This chapter does not address itself to the particular problem of unilateral middle ear effusion arising in association with a postnasal space neoplasm. This situation naturally requires an entirely different clinical approach.

Terminology

Since the original description by Politzer (1869) there has been a vast literature relating to this condition. Over the years the changing nomenclature has indicated current attitudes, often in relation to supposed aetiology (Black, 1984a). It has been variously termed catarrhal, exudative, seromucinous, serous, secretory and non-suppurative otitis media. More recently, middle ear effusion and otitis media with effusion have been current terminology. To many clinicians and lay persons it is known as 'glue ear'. An acceptable classification for otitis media with effusion should allow further subdivision according to the nature of effusion and the duration of the condition. It may be defined as the presence within the middle ear cleft of an effusion which may be serous or mucoid but not frankly purulent. Although not associated with clinically obvious signs or symptoms of infection, bacteria may be cultured from the effusion in approximately one-third to one-half of the cases.

Incidence and natural history

All forms of otitis media mainly affect infants and young children. It is probably a worldwide problem. Population studies are often unsatisfactory and difficult to compare, some reporting prevalence, and others incidence. It is likely that the first episode of acute suppurative otitis media occurs before the age of one year in 50-60% of cases. Around 70% of children have experienced their first attack before the age of 3 years. Teele, Klein and Rosner (1980) found that following the first attack of acute otitis media in infants, 40% had no effusion after one month and 90% were effusion free after 3 months. However, unlike acute otitis media, the epidemiology of otitis media with effusion is poorly documented. Reported studies rely on different otoscopic and tympanometric methods for identification.

In the UK, Brooks (1976) reported an incidence of 50% in children aged 5-7 years. Tos and Poulsen in 1979 and Tos, Holm-Vensen and Sorensen (1982) found an incidence of 30% in Danish children aged 2-4 years. Lous and Fiellau Nikolajsen (1981), also from Denmark, reported a 26% incidence in 7-year-old children. Silva et al (1982), in New Zealand, found 17.1% of a sample of 879 5-year-old children had either unilateral or bilateral
otitis media with effusion. Suarez Nieto et al (1983) indicated a prevalence of 8.7% in 472 children screened from a population of 5414 Spanish children aged from 2 to 12 years. The prevalence decreased with increasing age from 38.8% at 2 years to 1.1% at 11 years, fitting a logarithmic regression curve. A prospective study of 70 babies followed from birth to one year showed that 54% had one or more episodes of otitis media and 10 developed bilateral middle ear effusions (Marchant et al, 1984). As judged symptomatically and by otoscopic findings, the incidence reached a maximum by about the fifth year in the series studied by Pukander, Sipila and Karma (1984) and thereafter there was a gradual decrease. Recently in the USA, Casselbrant et al (1985) have demonstrated a cumulative incidence in preschool children aged between 2 and 6 years - the incidence was 53% in the first year and 61% in the second year. Findings were based on pneumatic otoscopy and tympanometry. They also showed that 80% of the effusions resolved within 2 months. The prevalence showed a seasonal variation and a strong association with the presence of upper respiratory infection. The incidence was independent of age within the 2-6-year-old age group.

It has been suggested, but not proven, that otitis media with effusion develops as a sequel to the more widespread use of antibiotics. There may also be an inverse relationship with the decreasing incidence in complications of suppurative otitis media in conjunction with the advent of antibiotic treatment (Feigin, 1982). This development is seen either to be a result of incomplete resolution of the acute infection or a reflection of changing virulence of the organisms causing acute suppuration. An alternative postulate has been interference by antibiotics of local IgM production within the middle ear. Finally, there may be altered resistance to infection within the community whose general health has improved.

There appear to be racial difference in incidence of otitis media - Eskimos and American Indians being more frequently affected than American whites, and black children having a lower incidence that white children. Most studies demonstrate a higher incidence of suppurative otitis media and otitis media with effusion in males than in females. The racial variations may be due to genetic and anatomical differences in the skull base and eustachian tube. The male predilection may reflect the overall male predominance for childhood infections. Recently, Tos and Stangerup (1985) have reported reduced pneumatization of the mastoid air cell system in children with a history of otitis media with effusion or tubal dysfunction. Boys had smaller systems than girls and the degree of middle ear pathology was greater in boys. This was thought to relate to the more frequent upper respiratory tract infection in boys. The study supports the environmental, rather than the hereditary theory of mastoid pneumatization. Socio-economic, genetic and environmental factors affect the development of otitis media. Accepted risk factors are: a family history of otitis media in parents or siblings, parental occupation and smoking; and in Scandinavia, the type of nursery care (Klein, 1979).

The distribution of patients within any clinic reflects the method of referral and the facilities and expertise of the referring physicians. At present there seems to be a peak incidence of children aged between 3 and 6 years attending otolaryngology clinics. However, as the diagnosis in infancy is difficult and the condition is often asymptomatic, it is probably more prevalent in this age group than is realized (Marchant et al, 1984). After the age of 10 years it is less frequent and at this stage one experiences the complications rather than the effects of the primary condition.
Studies by Henderson et al (1982) have confirmed that the incidence of acute otitis media with effusion is increased in children with viral respiratory infection (P<0.001). Of these infections, respiratory syncytial virus, influenza virus and adenovirus conferred a greater risk than infection with parainfluenza virus, enterovirus or rhinovirus. There is a close seasonal relationship between the incidence of acute suppurative otitis and otitis media with effusion, with a peak in January, February and March and a minimum incidence in August, September and October. This seasonal change correlates with the incidence of respiratory syncytial viral infections (Hinchcliffe, 1976).

Due to the enormous increase in literature in the 1950s, it was thought by some authors that there was a real increase in the incidence of the disease at that time. However, this may have been apparent rather than real. Coincidental improvement of otological services for children with more sophisticated audiological screening tests and the advent of otological microscopy are probably responsible for more accurate and frequent diagnosis. The increase may reflect improved availability of otolaryngological and paediatric services. It may be due to earlier recognition of the condition by general practitioners and an awareness by parents of the effect of hearing difficulties during childhood. The number of therapeutic procedures for the condition has risen dramatically in recent years. A rise has occurred in North America, Scandinavia, Japan and in the UK. It is now said by some to be reaching epidemic proportions and the condition has been termed the ‘new dyslexia’ (Black, 1985a).

**Aetiology**

The major underlying factors responsible for the production of otitis media with effusion are a combination of eustachian tube malfunction with superadded infection. It is the wide variety of conditions affecting eustachian tube function which confer the more generalized clinical picture to otitis media with effusion. These may be considered under three main headings:

1. **eustachian tube malfunction**
   - cleft palate
   - submucous cleft palate
2. **altered mucociliary system**
   - infection (nose, sinus, postnasal space, tonsils, pharynx)
   - allergy
   - immunological factors
   - surfactant deficiency
   - ultrastructural changes in cilia
   - fibrocystic disease
   - hormonal factors
   - other factors
3. **nasopharyngeal disproportion**
   - craniofacial abnormalities
   - adenoids and nasopharynx.
**Eustachian tube malfunction**

The underlying tubal dysfunction may reflect the situation that exists before the normal change occurs from the childhood to the adult configuration of the eustachian tube. This is said to occur at about the age of 7 years (Holborow, 1970). It is after this time that spontaneous resolution of otitis media with effusion occurs. Following the demonstration by Stool and Randall (1967) of otitis media with effusion in children with cleft palate, Paradise, Bluestone and Felder (1969) indicated the universality of effusions in these children in whom the underlying defect causing tubal dysfunction is an abnormal mode of action of the tensor palati muscle. There is also evidence that otitis media with effusion improves following palatal repair.

Tubal dysfunction may result either from skull base abnormalities or where there are anatomical variations in the nasopharynx. These may be defined in relation to differences in the angle subtended by the floor of the anterior cranial fossa and basisphenoid with the level of the hard palate. Consequently otitis media with effusion is more common in acknowledged craniofacial abnormalities such as Down's and Hurler's syndromes.

Bluestone and Cantekin (1979) described otitis media in conjunction with both tubal obstruction and abnormal patency. Functional and mechanical obstruction may occur (Bluestone and Beery, 1976), the former where there is a collapse of the eustachian tube with increased compliance. The situation is found as a result of differences in the structure of tubal cartilages in young children. Mechanical obstruction may be either extrinsic as in the case of postnasal space tumour or adenoid hyperplasia, or may be intrinsic as a result of mucosal disease (Bluestone, 1982). These mechanisms correlate with the previously held *hydrops ex vacuo* theory which suggests that in tubal obstruction, due to gas absorption, a negative pressure develops in the middle ear cleft. As a result, a sterile transudate is formed. This is clearly not the sole mechanism, as it is now realized that bacterial or viral infection with an accompanying inflammatory exudate is a more likely co-factor as a cause for otitis media with effusion in many cases. It has been shown that transudation, exudation and absorption all contribute to middle ear effusion formation, regardless of the effusion type (Lim, 1979).

**Altered mucociliary system**

**Infection**

Positive bacterial cultures were demonstrated in 40% of middle ear fluid specimens by Senturia et al (1958) and subsequently other workers have produced positive cultures in 22-52% of effusions. The bacteria found in cases of chronic otitis media with effusion are similar to those cultured in acute suppurative otitis media (Klein, 1980), which in turn are similar to the bacteria found in the nasopharynx. *Streptococcus pneumoniae* and *Haemophilus influenzae* account for the majority of cases. The remainder are caused by group A beta-haemolytic streptococcus, *Staphylococcus aureus* and *Branhamella catarrhalis*. Mills, Uttley and McIntyre (1984) have suggested that some cases of otitis media with effusion result from incomplete resolution of acute suppurative otitis media. Treatment with penicillin of resistant strains of *H. influenzae* and *Staph. aureus* may be a factor in the process. The same authors (Mills, Uttley and McIntyre, 1985) have more recently confirmed, from studies of bacterial
flora, that invasion of the middle ear may occur from the nasopharynx in cases with effusion. Experimental evidence from a study by De Maria et al (1984) suggested that a surface endotoxin of *H. influenzae* may be responsible for the induction of otitis media with effusion.

The close relationship between respiratory viral infection, particularly with respiratory syncytial virus and acute suppurative otitis media, has been mentioned and it must be stressed that both show a close seasonal relationship with otitis media with effusion. Ruokonen, Sandelin and Makinen (1979) showed a 50% incidence of *H. influenzae* in children with otitis media with effusion or recurrent acute otitis, compared with 14% in non-otitis media cases. Similarly, virus isolates were positive in 28% of otitis cases compared with 3% in the remainder without otitis. However, Maw and Speller (1985) have shown no significant differences in the cultures of bacteriological swabs from the postnasal space of children with otitis media with effusion, compared with age-matched children undergoing surgery for strabismus during the same season of the year. There was only a slight preponderance of *Streptococcus pyogenes* (P<0.05) in the patient group.

Allergy

The role of allergy as a causative factor for otitis media with effusion is unproven. Some studies have suggested an increased incidence in otitis media with effusion in allergic patients. This has not yet been supported by accurately controlled studies with total and specific immunoglobulin estimations. It may be that the increased susceptibility to respiratory infections found in patients with respiratory allergy is responsible for their tubal dysfunction (Clemis, 1976). Alteration of immune responses within the middle ear system may occur as a result of immediate hypersensitivity, as a cytotoxic response, as a response by the complement system or due to delayed hypersensitivity via a cellular immune mechanism (Lim and De Maria, 1982). Phillips et al (1974) showed the mean IgE content of the middle ear exudate to be 12 times higher than the mean serum IgE for the same children. However, the IgE, IgM and IgA concentrations were the same both in exudate and serum. By contrast, other studies revealed no abnormalities of IgE (Mogi, Maeda and Yoshida, 1976).

More recently, Borge (1983) has shown that children with otitis media with effusion have a higher positive family history of atopy and a higher incidence of atopic disease compared with the control subjects. However, the selection criteria did not include IgE estimations in both controls and atopic subjects.

Church et al (1981) demonstrated large numbers of mast cells in the adenoids. These are capable of binding IgE and releasing histamine and other inflammatory mediators on antigen challenge. Subsequently, Collins et al (1985) showed that the total amount of histamine in patients with bilateral otitis media with effusion was significantly higher than in patients without the condition. They suggested that adenoidectomy may reduce a potential source of inflammatory mediator from the vicinity of the eustachian tube. However, in a study based on serum IgE levels, Maw (1986) was not able to show any difference of outcome in cases with otitis media with effusion following treatment with adenoidectomy or by insertion of a ventilation tube, whether atopy was present or not. Mills and Brain (1985) have shown a relationship between a previous history of acute otitis media and otitis media with effusion, but no aetiological relationship between the latter and allergy. In a review paper, Clemis (1976) concluded that allergic factors, although not the only cause, are important in the
aetiology of otitis media with effusion. However, it seems that a true causal relationship has yet to be proven.

**Immunological factors**

On the basis of protein and enzyme studies, Palva, Raunio and Nousianen (1974) claimed that the middle ear effusion must result from active secretion rather than transudation. In support of this, middle ear mucosal biopsies from patients with otitis media with effusion have an increased density of mucous glands and goblet cells compared with those suffering from otosclerosis or tympanosclerosis. Whereas in the latter conditions the glands are infrequently active, in cases of effusion, 90% are found to be active. Palva, Lehtinen and Virtanen (1983) postulated that the adenoid or even the lymphoid tissue of the entire oropharynx could act as a source of bacterial antigen. This might maintain an immune complex disease in some patients with otitis media with effusion.

Because of the pathological similarities between rheumatoid arthritis and otitis media with effusion, De Maria, McGhee and Lim (1984) measured rheumatoid factor both in middle ear and serum samples in patients with chronic otitis media with effusion. The factor was present in 85% of effusions but in only 8% of serum samples. Titres were seven times higher in mucoid than in serous effusions. The presence of the factor was unrelated to the patient's age or history; or to the bacterial growth from the effusion.

**Surfactant deficiency**

It has also been suggested that, perhaps as a result of proteolytic enzyme activity from bacteria, a deficiency develops in the eustachian tube of surfactant, a surface tension lowering substance. Surface active phospholipids which reduce surface tension at the liquid/air interface have been demonstrated in dogs and rabbits by thin layer chromatography (Hills, 1984).

**Ultrastructural changes and fibrocystic disease**

Otitis media with effusion occurs more commonly with the immotile cilia syndrome and particularly with that form of the condition which constitutes the Kartagener's syndrome. Likewise, an alteration of mucociliary activity from whatever cause will affect middle ear function. It is also responsible for the association of otitis media with effusion and patients suffering from mucoviscidosis or fibrocystic disease.

**Hormonal changes**

Hormone dysfunction with high oestrogen levels or cases with hypothyroidism may alter tubal function sufficiently to produce an effusion, although this is infrequent in children.

**Other factors**

Finally, there have been suggestions that otitis media may in some cases result from or coexist with a leak of perilymph. This raises the possibility of an aetiological correlation between conductive and sensorineural hearing loss (Knight and Phillips, 1980).
Whatever the precise infective, immunological or other mechanism involved, the end result of tubal dysfunction is the same.

**Nasopharyngeal disproportion**

**Craniofacial abnormalities**

Children with Down's syndrome are known to have a disproportionate increase in the basal angle of the skull in relation to their cranial capacity. This alone, or in combination with the size of the adenoids, may be responsible for the nasopharyngeal disproportion and resultant eustachian tube malfunction found in Down's syndrome. A similar explanation may hold true for other cases with craniofacial abnormalities such as Hunter's or Hurler's syndromes. Indeed, even in normal children the actual size of the adenoids may be less important than their size in relation to the nasopharynx.

**Adenoids and nasopharynx**

The range in size of normal adenoids at different ages is difficult to ascertain. Almost all studies have been performed using lateral radiographs, often with a lateral cephalometric technique. Physiological variations in the size of the nasopharyngeal airway occur during sleep and during crying. They also relate to the position of the mouth and movement of the soft palate. Jeans et al (1981) have shown that the growth of the soft tissues of the postnasal space representing the adenoids outstrips growth of the nasopharynx from 3 to 5.5 years of age with the resultant reduction in the nasopharyngeal airway. Subsequently, growth of the nasopharynx increases while soft tissues remain relatively unchanged and thus the airway increases. There is a significant different in the mean area of the nasopharynx between males and females throughout development, although more so from 13 years onwards. The difference between the sexes in the area of the nasopharyngeal soft tissues is only significant at the age of 5 years and the difference in the airway is only significant from 13 years onwards.

Very careful studies were made by Linder-Aronson (1970) in relation to the size of the adenoids and nasopharynx and symptoms of nasal obstruction. He confirmed that enlarged adenoids led to mouth breathing. Furthermore, when obstruction was present, it was associated with a particular type of facial skeleton. There was noted to be reasonable agreement between the clinical assessment of adenoid size and the measurement on radiographs. The nasal airflow was lower for larger than for smaller adenoids and it was increased following adenoidectomy. The study appeared to support the hypothesis that adenoids affect the mode of breathing which then influences the individual's dentition. Hibbert and Whitehouse (1978) reported the correlation of lateral radiographic studies with adenoid size.

Johnson, Murray and Maran (1983) have indicated the errors inherent in this type of technique. Lateral cephalometric radiographs are therefore recommended to assess accurately the size of the adenoids and postnasal space airway. Studies of interobserver variability in clinical and radiological assessments of adenoid size and their correlation with adenoid volume have been made (Maw, Jeans and Fernando, 1981). These confirmed the findings of Hibbert and Tweedie (1977) of an extremely close correlation between adenoid weight and volume (R=0.997; P<0.001). Jeans, Fernando and Maw (1981) have reported a radiological
study based on interobserver agreement to assess accuracy in the measurement of adenoid enlargement.

Quarnberg (1981) has shown a relationship between large adenoids and the occurrence of acute otitis media in children aged less than 4 years. He also showed a similar relationship with radiological clouding of the maxillary sinuses. It was suggested that both factors might be responsible for the prolongation of acute otitis media. McNicholl (1983) has demonstrated nasal abnormality at the vomeroethmoid suture in children with otitis media with effusion. This he postulated may cause turbulence in the postnasal space. Todd (1984) noted a large eustachian tube calibre in patients with otitis media and in cleft palate patients compared with controls (P<0.001). However, the eustachian tube diameter was smaller than in patients with otitis media with effusion and allergic airway disease. (P<0.05).

**Clinical presentation**

As suggested by the definition, in its quiescent phase, otitis media with effusion has none of the signs and symptoms usually attributed to infection of the middle ear cleft. Thus, the most frequent presentation is with latent or overt hearing loss. Whichever is the case, the loss often fluctuates in severity. When latent in infants and young children it may present with impaired speech and language development (Rapin, 1979). There may be behavioural difficulties and scholastic retardation (Silva et al, 1982, 1986; Stewart et al, 1984). Only rarely do younger children complain of hearing difficulty. It is frequently first detected on routine screening tests; either clinically, audiometrically or by impedance studies. Indirect symptoms such as shouting, insularity, increasing the volume of the television and delay in reading development are commonly found.

Otalgia often occurs, frequently in a recurrent form. When present, it usually results from secondary infection of the fluid within the middle ear cleft. Invariably this results from an ascending eustachian tube infection. It is frequently coincident with a cold or minor upper respiratory tract infection, but occasionally follows sinus infection or an episode of allergic rhinitis. It often follows swimming.

It is possible to recognize certain clinical subgroups of otitis media with effusion:

1. latent or overt hearing impairment without significant postnasal obstruction, otalgia or upper respiratory tract infection

2. obvious postnasal obstruction with hearing impairment but only occasional upper respiratory tract infection, minimal allergy and, rarely, otalgia

3. upper and lower respiratory tract disease with generalized nasal obstruction and hearing impairment without otalgia of which there may be three types: non-specific catarrhal conditions; rhinosinusitis; and allergy

4. recurrent otalgia and hearing impairment with only occasional otorrhoea, few upper respiratory tract infections, occasional mild nasal obstruction and/or mild allergy
(5) acute upper respiratory tract infections which are infrequently tonsillitis, leading to otalgia, with hearing impairment and occasional otorrhoea

(6) cases with chronic irreversible eustachian tube malfunction, for example cleft palate, Down's, Hurler's and other syndromes with craniofacial abnormality, or ultrastructural cilial abnormalities of the respiratory tract mucosa.

**Diagnosis and screening**

Clinical, audiometric and tympanometric assessment may be used for screening and diagnosis. In most centres, they form the basis by which to judge selection for medical or surgical treatment. They also provide a means of evaluating improvement or otherwise, at follow-up examinations. There is considerable variation in appearance of the tympanic membrane in otitis media with effusion (Malcolmsen, 1969). There is a similar degree of inter- and intraobserver variability in the otoscopic assessment of the tympanic membrane with a pneumatic otoscope. An experienced otoscopy should have a high degree of specificity and rather better sensitivity (Paradise, Smith and Bluestone, 1976b).

The use of magnification with an operating microscope may further improve diagnostic accuracy. The degree of retraction of the pars tensa may be assessed by the extent of splitting and derangement of the light reflex, by the rotation and displacement of the malleus handle, and by the prominence of the lateral process of the malleus. The pars flaccida may be indrawn to a variable degree. Attic retraction and sometimes erosion of the outer attic wall anterior and posterior to the neck of the malleus may occur at a later stage. The degree of retraction of the tympanic membrane reflects the negative middle ear pressure which reduces the mobility of the membrane. Both retraction and mobility should always be assessed with Siegle's or similar type of pneumatic otoscope. The colour and loss of translucency of the membrane range from pale grey or amber to a black or so-called 'blue drum'. It may be thickened, dull and opalescent, or thin and reflective. With poor illumination, minimal changes may be difficult to distinguish from the normal state. Increased vascularization of radial vessels is very frequent and, in some cases, there is also an increase in the malleolar vessels. Fluid levels and air bubbles may be visible within the middle ear cleft. Atelectatic change of the pars tensa and pars flaccida may be present to a variable degree.

Tuning fork tests may be helpful particularly in children over 4 years of age when a negative Rinne test is said to predict a hearing loss in excess of 15-20 dB (Yung and Morris, 1981). However, the author's own studies refute this suggestion (Capper, Slack and Maw, 1987).

Pure-tone audiometry is only of limited diagnostic value for the identification of otitis media with effusion. It does, however, provide some assessment of the severity of the disease. It can be used as a guide by which to monitor the progress and the effects of treatment. Fiellau Nikolajsen (1983) showed some relationship between the severity of hearing loss and middle ear changes. He confirmed some further relationship between hearing loss and impedance results. Dry ears had a mean hearing threshold of 17 dB. The mean for minimal otitis media with effusion was 23 dB, for moderate 29 dB and for infected middle ears, 34 dB. Overall in 79 out of 88 ears tested, the mean hearing threshold averaged 23 dB. Fria, Cantekin and Eichler (1985) showed the speech awareness threshold in infants aged between
7 and 24 months with otitis media with effusion to be in the order of 24.6 dB hearing level. Older children from 2 to 12 years of age with otitis media with effusion had mean three frequency pure-tone audiometric and speech reception thresholds of 24.5 dB and 22.7 dB respectively. It was found that the hearing acuity was not related to age or the duration of history of otitis media with effusion. There was no relationship between hearing level and the type of impedance curve. Ruben and Math (1978) have shown that the presence of conductive hearing loss due to otitis media with effusion may delay the diagnosis of an underlying sensorineural hearing loss.

Tympanometry was first introduced into Scandinavia (Metz, 1946), then into the UK (Brooks, 1968) and later into the USA. It provides an effective screening test for the detection of negative middle ear pressure, although it will not distinguish between such a pressure change with and without middle ear effusion (Beery et al, 1975; Grimaldi, 1976; Cantekin, Beery and Bluestone, 1977). There are limitations in its use with young children where there is increased compliance of the external auditory meatus (Paradise, Smith and Bluestone, 1976). Most normal studies show maximum compliance in a range of +200 to -200 mm of water with a rounded or peak curve. The advent of screening programmes led to the development and validation of less expensive automatically recording impedance meters (Fria, Cantekin and Probs, 1980). Diagnostic predictability of 84% may be achieved with a simple peak versus no peak pattern of classification, and compares favourably with 85.8% accuracy with more sophisticated impedance and otoadmittance meters (Cantekin, Beery and Bluestone, 1977). Fiellau Nikolajsen (1983) modified Jerger's (1970) nomenclature subdividing the tympanograms into four types:

- type A with middle ear pressure from +200 to -99 mm of water
- type C₁ with middle ear pressure from -100 to -199 mm of water
- type C₂ with middle ear pressure from -200 to +400 mm of water
- type B had flat curves without a well-defined compliance maximum.

Recently Alhady and Sharnoubi (1984) have demonstrated a very highly significant relationship in mean values of middle ear pressure in patients with adenoidal hyperplasia. They also showed a significant relationship in patients with chronic sinusitis compared with patients suffering with chronic tonsillitis in whom there was no relationship.

Management

It is accepted that there may be numerous forms of treatment for otitis media with effusion and, as yet, a correct management approach remains to be defined (Lim, 1985). As Snow (1980) pointed out, none of the treatment methods available are mutually exclusive and some may be efficacious to a limited extent. Naturally, management of the effect of the effusion on hearing thresholds varies according to the duration and severity of the hearing loss. Many cases resolve spontaneously without treatment. Although these and other milder cases do not require intervention, they need observation and follow-up. Other similar cases may be managed by improved teaching techniques and individual attention in the classroom, until spontaneous resolution has occurred. It is unlikely that thresholds of less than 20 dB across the speech frequencies will require treatment, which may also be withheld in unilateral cases for longer periods of time than if the condition is bilateral.
The variable effect on an individual's hearing acuity is difficult to assess, particularly in young children. Furthermore, the differential effects of intermittent conductive hearing loss as against a continuous problem are unclear. However, there seems little doubt that where the condition is prolonged for more than several months, linguistic and learning abilities are affected and psychosocial changes seem to occur. These are difficult to monitor and evaluate.

The effects of recurrent bouts of otalgia both locally on the ear and more generally on childhood development is not known. Most studies have not demonstrated any long-term benefit from the wide variety of medical treatments so far investigated in properly controlled trials. Few studies have demonstrated whether treatment can prevent the development of later complications within the middle ear.

**Medical treatment**

Longitudinal studies show that, not only is there seasonal variation in the condition, but relapses and remissions occur several years after treatment has been prescribed. Many reported studies present results only 6 weeks and 3 months after treatment. Fraser, Mehta and Fraser (1977) could not demonstrate any improvement in children with otitis media with effusion either as a result of autoinflation of the eustachian tube or using 0.5% ephedrine hydrochloride nose drops. There was no effect from medication with an antihistamine-sympathomimetic amine mixture. Other similar medical regimens have not proved to be effective in obtaining a cure (Hayden et al, 1984; Hughes, 19784). Stewart et al (1985) showed no effect on otitis media with effusion from a mucolytic agent (bromhexine hydrochloride). There have been preliminary reports of the effect of gaseous ventilation of the middle ear cleft with sulphur hexafluoride. However, long-term studies are unavailable (Andreassen et al, 1983).

Management of nasal allergies with topical steroid preparations such as beclomethasone and flunisolide may reduce eustachian tube malfunction, but trials in relation to otitis media with effusion are awaited. Extrapolation of the management of acute suppurative otitis media has led to the recommendation of similar regimens for the management of otitis media with effusion. However, a study by Van Buchem, Dunk and Van T. Hof (1981) did not demonstrate significant differences in the clinical course of acute otitis media whether or not antibiotics had been prescribed. To date, there have not been any convincing statistically controlled trials indicating a sustained cure rate for otitis media with effusion following antibiotic treatment. Short-term reports of the effectiveness of co-trimoxazole (Marks, Mills and Shaheen, 1981) have been contradicted by longer term follow-up studies (Marks, Mills and Shaheen, 1983). More recently, Thomsen et al (1986) have shown short-term cure rates for otitis media with effusion following long-term treatment with a combination of amoxycillin and clavulanic acid. The effect was only demonstrable for 3 months in children over the age of 5 years. Despite a report by Persico, Podoshan and Fradis (1978) showing improved response rates postoperatively in the treatment of otitis media with effusion with ampicillin and prednisolone, compared with ampicillin alone, there seems little convincing supportive evidence to recommend the use of systemic steroids.

The development of vaccines against *Streptococcus pneumoniae* and certain viruses that seem to be associated with acute otitis media may hold some hope of reducing the
incidence of this condition. However, at the present time there does not appear to be any effective medical cure for otitis media with effusion.

_Surgical treatment_

**Myringotomy and ventilation tube insertion**

Myringotomy incision for relief of _acute suppurative otitis media_ should be made either over the point of maximum bulging of the tympanic membrane or in a curvilinear fashion vertically in the postero-inferior segment. The incision splits the middle fibrous layer of the tympanic membrane and care must be taken to avoid middle ear structures.

For aspiration of _serous or mucoid effusions_, a radial incision is made, separating the fibres of the middle layer. The incision is preferably placed in the antero-inferior or antero-superior quadrant. To prevent early closure of a simple myringotomy, thermal incision shave been suggested, but probably offer no significant benefit over use of a sharp, thin myringotome. Care must be taken to avoid excessive damage to the fibrous layer which may lead to thin, triangular scar formation at the site of the incision.

Immediate improvement of the hearing loss can be achieved by this procedure. Unfortunately, in all reported series, there is a significant recurrence rate, with reaccumulation of the fluid and return of the hearing impairment. This situation can be overcome by insertion of a ventilation tube often referred to as a grommet. For insertion of a ventilation tube the wire should be cut short. The tube is held with fine forceps by the flange or by the wire and not by the lumen. The upper edge of the flange is introduced into the incision and the remainder of the tube is pressed into position with a fine needle or with the tip of the myringotome. It is held in place by the tension of the separated fibres of the middle layer. The lumen should be patent and free from secretions, blood or trauma resulting from serrations of the crocodile forceps. The type of material used for manufacture of the tube and whether or not it is inserted in the antero-superior or antero-inferior quadrants do not appear to affect the time of extrusion. However, tube design, the experience of the operator and whether or not the tube fits loosely when inserted, all significantly affect extrusion rates (Mackenzie, 1984). Since Armstrong's initial report in 1954 subsequent studies have demonstrated the limitation of ventilation tubes both in the long term for hearing improvement and in the shorter term because of the need for re-insertion. Gundersen and Tonning (1976) confirmed satisfactory improvement in speech reception thresholds to 20 dB or less in the short term. Later however, Gundersen, Tonning and Kveberg (1984) reported longer term follow-up with a mean of 12.5 years in 95 out of 100 patients. A total of 179 ears were treated and 28 were found to have permanent hearing loss due to chronic otitis media or adhesions with an average loss of 34 dB. The results led the authors to question the long-term efficacy of ventilation tube insertion.

The mean duration for survival of a functioning tube appears to be about 6-12 months, with no demonstrable benefit of hearing gain after 12 months (Brown, Richards and Ambegaokar, 1978).

Ventilation tubes are associated with more complications than occur with myringotomy alone. There is frequently short-lived otorrhoea. Scarring and tympanosclerosis of the
tympanic membrane occur in a significant number of patients. Residual perforation of the tympanic membrane occasionally follows use of a tube. In one-quarter to one-third of cases with established otitis media with effusion, re-insertion is required on one or more occasions until spontaneous resolution of the effusion occurs (Curley, 1986). Richards et al (1971) and Kilby, Richards and Hart (1972) from Cardiff demonstrated that 24 months following myringotomy in one ear and insertion of a Shepard ventilation tube in the other, all of the tubes had been extruded. There was no significant difference in hearing thresholds in either ear and fluid was still present in 30% of ears in each group. Impedance studies showed no significant differences, but thin tympanic membrane scars were more frequent in ears treated with tubes. Brown, Richards and Ambegaokar (1978), also from Cardiff, reported the 5-year follow-up of 55 cases. They showed no difference in the hearing thresholds 6 months following insertion of ventilation tubes compared with myringotomy alone. They also showed a 42% incidence of tympanosclerosis and a 13% incidence of thin scars. There was a recurrence rate of 33% which was the same whether or not a tube had been inserted. Adenoidectomy had been performed in all cases and tonsillectomy in a few.

As time passes, the incidence of tympanosclerosis increases and was shown by Miller, Wilson and Richards (1982) to be as high as 70% after 10 years. In a study from the present author's department, Slack et al (1984) confirmed this figure for at least some degree of tympanosclerosis 21 months after insertion of ventilation tubes. In this study, such tympanic membrane changes were almost never seen in the contralateral unoperated ear. Birck and Mravec (1976) studied 736 children and 2237 ventilation tube insertions. Adenoidectomy with or without tonsillectomy was performed in 44% of patients and of these, 35% required a further tube insertion. There was a failure rate of 27% for adenoidectomy alone. As with other studies, a high incidence of failure was noted in the group of children suffering with allergic disease in addition to middle ear effusion. Otorrhoea was reported in 15% of cases.

From Copenhagen, Tos and Poulsen (1976) reported the late results of treatment with tubes in 109 patients. Adenoidectomy was usually also performed at the same time, although had previously been carried out in 37%. They showed a 60% total cure rate and a 25% partial cure rate and indicated that re-insertion of tubes was required in 23% of cases. The studies of Miller, Wilson and Richards (1982) have been confirmed by Tos et al (1984) and dispute the suggestion that middle ear ventilation with a tube may prevent serious long-term complications such as atelectasis and attic retraction. In many centres, myringotomy and aspiration alone are practised in the first instance, reserving tube insertion for recurrent cases.

The high complication rate resulting from ventilation tubes has led some authors to suggest a policy of unilateral rather than bilateral insertion, especially in young children (Lildholt, 1979; To, Pahor and Robin, 1984). Lildholt reported 91 children with bilateral otitis media with effusion in which adenoidectomy was performed together with unilateral myringotomy and tube insertion. The contralateral ear was left untreated and no difference was found in the middle ear pressure or hearing level one month after extrusion of the tube. One-quarter of the ears suffered otorrhoea. The study is slightly invalidated, in that certain cases had been submitted to previous adenoidectomy. Such a compromise regimen of unilateral treatment for bilateral cases has also been suggested by Bonding, Tos and Poulsen (1982) and Sade (1979). The former studied the effect in bilateral cases, of unilateral tube insertion compared with myringotomy alone, repeating the work of Kilby, Richards and Hart which had been performed 10 years earlier in 1972. They suggested that, in 75% of cases,
resolution of effusions had occurred following adenoidectomy and myringotomy and that part of the improvement was spontaneous and unrelated to treatment. It was suggested that a ventilation tube did not improve long-term eustachian tube function. More recently, Lildholt (1983) repeated his recommendation for elective unilateral tube insertion. Notwithstanding any of these problems, ventilation tube insertion is the most common surgical procedure performed in children in the USA (Vogelsang and Birck, 1984) and is fast reaching similar proportions in the UK (Black, 1984b).

Surgical treatment may be indicated for any obvious underlying condition affecting eustachian tube function. It is accepted that earlier rather than late closure of a cleft palate defect will result in improvement of the aural condition. Occasionally, antral washouts are required and sometimes submucosal diathermy is helpful to reduce the nasal obstruction caused by swollen inferior turbinates.

**Adenoidectomy and adenotonsillectomy**

Since before the turn of the century, and in particular in the preantibiotic era, adenoidectomy had become the accepted method of treatment for the relief of recurrent suppurative middle ear disease. This rationale was based on the assumption that, in some way, the adenoids affected the eustachian tube function and by the *ex vacuo* theory, produced a transudate within the middle ear cleft. This hypothesis was supported by the frequent finding of a unilateral middle ear effusion in association with postnasal space carcinoma involving the eustachian tube cushion. It would seem more reasonable to recommend adenoidectomy in cases presenting with significant symptoms of nasal obstruction and otitis media with effusion but often these are just the cases which are excluded from randomly allocated studies. Recommendation for surgery in children with small non-obstructive adenoids was based on the premise that they acted as a focus of potential ascending eustachian tube infection. Studies by Maw and Speller (1985) refuted this. Adenoidectomy was frequently combined with tonsillectomy, presumably for those cases where there was coexistent upper respiratory tract infection and tonsillitis. Often, however, the aural condition was used to justify tonsillectomy where it could not be advised on its own merits.

Naturally a very high incidence of these surgical procedures in small children has been a cause for concern. Ultimately in 1958, Sataloff and Menduke, and later, McKee (1963a,b) reported some poorly controlled studies showing a limited efficacy of these operations. Doubt was cast upon these results when subsequent studies demonstrated the presence of middle ear disease in 60% of cases where either adenoids had previously been removed or were not found to be present (Dawes, 1970; Mawson and Fagan, 1972). In that year, there were 917000 tonsil and adenoid operations in the USA, with a rate of 4.5 per 1000. In 1978, 25000 Danish children, equivalent to approximately 40% of the total birthrate, had been treated by adenoidectomy partly on account of otitis media with effusion. A survey by Hibbert (1977) showed that in the UK 80% of otolaryngologists advised adenoidectomy as part of the treatment for otitis media with effusion and most surgeons felt it was an enlargement of the adenoids which produced the effusion. This was thought to result from obstruction of the eustachian tube orifice.

Snow (1980) carefully reviewed the literature regarding adenoidectomy, adenotonsillectomy and treatment with various medical measures in cases persisting for more
than 6 weeks. Such cases were recommended for myringotomy and ventilation tube insertion. Adenoidectomy was not said to be indicated for the majority of first episodes of otitis media with effusion unless there was nasal obstruction, rhinorrhoea or adenoiditis. He suggested that adenoidectomy is more likely to be recommended in recurrent otitis media with effusion following ventilation tube insertion. The position of tonsillectomy in his view is much less certain and is not usually recommended on the basis of otitis media with effusion by itself. Stell (1981) reviewed research from his own and other departments and reached the conclusion that adenoidectomy might be abandoned with virtually no ill effects except in certain cases of obstructive upper airway disease or cor pulmonale. However, his references were not specifically directed to otitis media with effusion or its treatment.

The number of operative procedures on the tonsils and adenoids has diminished during the last decade, but they still account for 50% of all major surgical operations performed on children, 25% of all hospital admissions and 10% of all hospital bed days in the USA, where 25% of all children will undergo this type of surgery (Bluestone, 1982). Black (1985b) confirmed the steady falling rate for adenotonsillectomy operations in the UK by as much as 46% between 1967 and 1980. The reduction within the Oxford Regional Health Authority in children younger than 9 years, suggests the fall for adenoidectomy alone to be significantly less than for the combined procedure. During the same period there was an increase in the frequency of myringotomy as judged on a national basis. Black demonstrated a significant increase in all surgery for 'glue ear' from 47.2% to 68.1%. He noted a social class gradient for these operations and in particular for myringotomy and adenoidectomy, the highest rate for surgery being in the upper social classes. He revealed a twofold difference between health districts, and his data excluded those children managed in private hospitals.

The arguments for and against adenoidectomy and adenotonsillectomy for otitis media with effusion continue. The few studies directed specifically to the problem are not without their design faults. The numbers are usually small. Inclusion criteria are often unsatisfactory and evaluation of an end point for the middle ear condition has been difficult to define. Not all have been randomly controlled nor even prospective and only more recent investigations have included impedance studies in their assessment. There has been failure to evaluate the adenoids and tonsils separately and in many there is a tendency, for ethical reasons, to exclude the most severely affected children. Seldom has inter- and intraobserver variability been considered. Not all studies account for the obvious variables of age, sex, atopy, seasonal variation and adenoid size. Finally, there is often a failure to identify precisely the type and severity of the middle ear effusion to be assessed.

In an uncontrolled study, Lemon (1962) noted a 40% recurrence rate of secretory otitis media in 100 non-adenoidectomy cases compared with only 3% in 100 children submitted to adenoidectomy. In an initial study of 1413 children, McKee (1963a) confirmed a reduction in the incidence of otitis media following adenotonsillectomy. Subsequently, with 200 further children he demonstrated that the benefit with respect to otitis media was attributable to adenoidectomy alone (McKee, 1963b). Similarly Roydhouse (1970) found a reduction in otitis media following adenotonsillectomy in 251 cases, particularly during the first year postoperatively. Stroyer Andersen et al (1979) showed some beneficial effect of adenoidectomy in cases with secretory otitis.
Bluestone, Cantekin and Beery (1975) demonstrated radiographically, retrograde obstruction of the eustachian tube in relation to otitis media and enlarged adenoids. They found adenoidectomy was more successful in the prevention of otitis media in children where there was retrograde obstruction of the eustachian tube, than in children without evidence of preoperative obstruction. They also showed improved prevention of otitis media following adenoidectomy where there were larger, rather than smaller adenoids, particularly if the child did not suffer from allergic rhinitis. Atopic individuals were more likely to develop otitis media following adenoidectomy. This study was uncontrolled, of short follow-up and with limited numbers.

In a later study, commenced in 1971, and reported by Roydhouse in 1980, it was demonstrated that the cure rate for otitis media with effusion was no better following adenoidectomy and ventilation tubes, compared with tubes alone. The cases were followed from 3.7 to 4.3 years. However, there was a greater relapse rate in the non-adenoidectomy group who required 9% more tubes. In addition, radiographs of the adenoids suggested that the group cured without adenoidectomy tended to have smaller adenoids.

Mawson, Adlington and Evans (1967) studied 400 patients and found a significant reduction in sore throats but no altered incidence of otitis media following adenotonsillectomy. Dawes (1970) demonstrated that in two-thirds of 270 cases of middle ear effusion, the adenoids were either not present or had been previously removed. Mawson and Fagan (1972) subsequently showed that 65% of 81 children with middle ear effusions had previously been submitted to adenoidectomy.

Rynel Dagoo, Ahlbom and Schiratzki (1978) omitted cases with severe prolonged nasal obstruction in a study of 76 children randomly allocated to control and adenoidectomy groups. They demonstrated in both groups a reduction of colds, suppurative and serous otitis media and of nasal obstruction which was more obviously reduced in the adenoidectomy group in the first year. However, if middle ear fluid was found at the time of adenoidectomy, myringotomies and insertion of ventilation tubes were also performed. There were only 12 cases of serous otitis media in the adenoidectomy group and 18 in the control group with crude criteria for middle ear diagnosis. The validity of this study is therefore considerably reduced.

In a small, very carefully controlled prospective study of 42 cases, Fiellau Nikolajsen, Falbe-Hansen and Knudstrup (1980) could not demonstrate any beneficial effect of adenoidectomy on impedance measurements. However, the 20 children randomly allocated for adenoidectomy and myringotomy, compared with the 22 for myringotomy alone would probably not constitute the type of case normally submitted for adenoidectomy in some other centres. Furthermore, some had previously been submitted to adenoidectomy before the study commenced. With rather inadequate supportive data, Sade (1979) reported no better improvement in otitis media with effusion after adenoidectomy and insertion of a ventilation tube compared with insertion of a tube alone. A recent study by Widemar et al (1985) was reported to show no effect of adenoidectomy on tympanic membrane changes, pure-tone audiometry on tympanic membrane changes, pure-tone audiometry and impedance findings in cases with otitis media with effusion. However, bilateral myringotomies had been performed in all cases and insertion of tubes in those with mucoid secretions. These additional procedures somewhat invalidate their assumptions, for the study lacks a group treated by
adenoidectomy alone. By contrast, a retrospective study by Marshak and Ben Neriah (1980) showed a statistically non-significant improvement rate (P<0.3) in otitis media with effusion after adenoidectomy and myringotomy (74%) compared with myringotomy alone (59%), but Birck and Mravec (1976) recorded a 27% failure rate for adenoidectomy alone particularly where allergy was coexistent.

Prospective randomized studies by the author (Maw, 1983; 1985a,b; 1986) showed that adenoidectomy alone produces significant clearance of middle ear effusion in 31.3% of cases at 6 months, and 41.7% at one year, judged by pneumatic otoscopy. It also results in no peak/peak conversion of impedance curves in 22.5% of cases at 6 months and 29.8% at one year. There is an audiometric hearing gain of 12.78 dB at 6 months and 13.52 dB at one year. The effect of adenoidectomy was enhanced in older children - aged more than 5 years - compared with younger children and in those with larger, rather than smaller adenoids, as demonstrated by preoperative lateral cephalometric radiographs. The sex of the child and the presence or absence of atopy had no effect on the outcome. The improvement in relation to adenoid size was short lived and any effect after 6 months may have resulted from age rather than adenoid size.

The combination of tonsillectomy with adenoidectomy provided no additional benefit. Indeed, compared with adenoidectomy alone, although the combined procedure had a more beneficial effect when assessed after 6 months, the effect was reversed after one year. The reduced effectiveness by the addition of tonsillectomy may be due to palatal scarring altering nasopharyngeal anatomy and function. The addition of myringotomy and ventilation tube insertion with adenoidectomy and adenotonsillectomy, resulted in only slightly improved hearing thresholds after 6 months and no significant difference after one year. There was improved otoscopic clearance of effusion and impedance change when a ventilation tube was also used. However, to achieve this slight benefit and maintain adequate hearing thresholds, re-insertion of the tube was required in 26% of the cases in the adenoidectomy group and 34% in the adenotonsillectomy group.

Treatment with a ventilation tube alone, produced much the same hearing thresholds after 6 months and 12 months as those cases treated by adenoidectomy and adenotonsillectomy alone. However, with only a tube, re-insertion was required in 54% of cases to achieve continued and satisfactory overall hearing thresholds.

Bulman, Brook and Berry (1984) have demonstrated significant benefit from adenoidectomy at 3 and 6 months postoperatively as judged by pure tone audiometry. Any further benefit after 6 months was not demonstrable possibly because of removal of the more severely affected cases from the trial. Paradise et al (1986) have recently confirmed significant improvement in recurrent acute otitis media and otitis media with effusion following adenoidectomy. The beneficial effects were seen to persist for at least 2 years postoperatively. Their study was well controlled, prospective and of a very careful design. The correlation between adenoid size radiologically or volumetrically and the presence or absence of middle ear effusion is poor. However, Hibbert (1979) showed reduction of the postnasal space airway (P<0.05) in children with middle ear effusions, compared with age-matched controls, and the author’s own studies substantiate this finding (Phillips, Maw and Harvey, 1987). It seems possible therefore that, although the adenoids are no larger in children with middle ear effusion, some aspects of the morphology of the postnasal space may be different.
On the basis of these investigations, it would seem that surgery should not be recommended until bilateral effusions have been confirmed to have had significant effect on hearing thresholds for at least 3 months. Treatment of unilateral cases may be further deferred, but naturally other factors such as speech, language and learning require consideration. Adenoidectomy should probably be recommended selectively in those cases with larger than average adenoids as demonstrated on a lateral cephalometric radiograph. Improved results may be expected in children more than 5 years of age. However, younger children with obstructive adenoids would also be expected to benefit by adenoidectomy. In addition, myringotomies should be performed bilaterally.

Insertion of a single ventilation tube provides immediate restoration of hearing acuity. It would be expected that after approximately 6-12 months, extrusion will occur and the child's parents should be advised of the likely need for repeat insertion in at least 25% of cases. By limiting tube insertion to only one ear, any complications would be significantly reduced. Naturally, the state of the tympanic membrane with respect to the degree of atelectasis may indicate a need for bilateral tube insertion and perhaps even prolonged ventilation with a long-term type of tympanostomy tube. Recommendation for adenoidectomy can be made in the knowledge that overall, regardless of adenoid size, there is at least a 40% rate of clearance of effusion after one year. Careful selection of cases with regard to age and adenoid size may significantly improve this figure. Unless there are very specific indications for tonsillecetomy in children with otitis media with effusion, the operation should not be additionally recommended. Obviously, some children with combined aural and obstructive upper airway disease due to their tonsillar enlargement may require tonsillar surgery.

**Sequelae**

The linguistic and learning effects of untreated otitis media with effusion, especially if bilateral, are well recognized and documented (Silva et al, 1986). In severe cases, without treatment it seems likely that tympanic membrane retraction, particularly in the attic region will occur.

Tympanosclerosis frequently develops following ventilation tube insertion and this is not often an accompaniment of simple myringotomy and aspiration (Tos, Bonding and Poulsen, 1983). Brown, Richards and Ambegaokar (1978) reported a 42% incidence at 5 years and a 13% incidence of thin scars in the ears with tubes, compared with a zero incidence of either condition in the control ear. A 10-year follow-up rate of 67% was obtained for 34 of these patients. Miller, Wilson and Richards (1982) noted a most significant finding of increased pars flaccida pathology which was of similar incidence in the tubed and untubed control ear. Barfoed and Rosberg (1980) demonstrated tympanosclerosis in 61% of cases 4.5-7.5 years following tube insertion and also noted more marked pseudomembrane formation, cicatrization and atrophy. These occurred particularly at the site where the tympanic membrane had been disrupted by placement of the tube. Slack et al (1984) have confirmed that the incidence of tympanosclerosis progresses rapidly, so that even after one year, slightly less than 40% of cases have some degree of the condition and after 21 months, the incidence is 70%. Furthermore, there is a gradual increase in the distribution of the sclerotic process throughout the drum. It appears that there is a predisposition for its development to commence in the posteroinferior quadrant in cases where the ventilation tube is inserted anteroinferiorly.
There is some equivocal relationship between tympanosclerosis development and mucoid rather than serous effusions.

The development of attic retraction sacs in relation to otitis media with effusion was reported by Tos and Poulsen (1980). More recently, Tos et al (1984) have confirmed the data reported by Miller, Wilson and Richards (1982). In a sample of healthy, non-selected children, they showed attic retraction, atrophy or tympanosclerosis in 24% of 5-year olds, 37% of 6-year olds and 39% of 7-year olds. There was a correlation between the tympanometric profile, the frequency of otitis media and the eardrum abnormality which did not seem to be corrected by treatment with ventilation tubes.

Suppuration after tube insertion has been reported in as many as 34% in the series by Barfoed and Rosberg (1980); 41% of cases by Kokko (1974) and 30% of cases in Lildholt's series (1983). Persistent perforation develops more frequently where there is otorrhoea and all series of any size, document the development of a small number of cholesteatomata in the operated ears.

In view of the findings by Miller, Wilson and Richards (1982) and Tos et al (1984) one must question further the ability of ventilation tubes to forestall the progression of tympanic membrane changes due to negative middle ear pressure. This is particularly related to those changes which occur in the attic. All otologists have witnessed the steady progression of tympanic membrane changes which occur in some cases of otitis media with effusion as a result of chronic negative middle ear pressure. Ultimately a state of severe atelectasis develops which is extremely difficult both to arrest or correct. A thin two-layered membrane becomes indrawn onto the medial wall of the middle ear. It is draped over the ossicles and indrawn towards the eustachian tube and attic regions. Often some degree of ossicular erosion occurs particularly of the long process of the incus. Outer attic wall erosion also occurs revealing the neck of the malleus and body of the incus over which the thin retracted membrane is applied. At this stage, middle ear ventilation is invariably impossible to achieve. These patients, especially if bilateral disease is present, require a hearing aid. Attempts at reconstructive surgery in these instances are demanding and often unrewarding.