Chapter 10: Management of chronic suppurative otitis media

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Chronic suppurative otitis media is typically a persistent disease, insidious in onset, often capable of causing severe destruction and irreversible sequelae, and clinically manifests with deafness and discharge. The existence of chronic suppurative otitis media in prehistoric times has been clearly documented (McKenzie and Brothwell, 1967). These authors also referred to the discovery of cholesteatoma in a skull found in Norfolk, UK, and thought to be of Anglo-Saxon date. Radiological changes in the mastoid as evidence of previous infection have been the subject of enquiry in 417 temporal bones from South Dakota Indian burials (Gregg, Steele and Holzhueter, 1965) and in 15 prehistoric Iranian temporal bones (Rathbun and Mallin, 1977); both of these studies demonstrated changes compatible with previous infection in approximately 40% of specimens.

The incidence of chronic suppurative otitis media appears to depend on race and socio-economic factors. A significantly higher incidence of the disease was reported in Innuit (Eskimos) and American Indians (Fairbanks, 1981), in the Alaskan indigenous population (Tschoop, 1977), in Australian aboriginal children (McCafferty et al, 1977), and among black South Africans (Meyrick, 1951). Socio-economic factors such as poor living conditions and overcrowding, poor hygiene and nutrition have been suggested as a basis for the widespread prevalence of chronic suppurative otitis media in the Third World and similar factors were observed among the poor whites with chronic ear disease in Appalachia (Kentucky), the incidence of which closely resembled that seen in the American Indians (Fairbanks, 1981). In systematic investigation of middle ear disease in samples of the general population in Goteborg, Ruding et al (1983) observed the incidence of perforated tympanic membrane to be 2.1% and 2.3% among the 60- and 50-year-old cohorts respectively, compared with only 0.8% in the 20-year-old cohort. The incidence of active disease was 1.05% in the 60-year and 1.15% in the 50-year cohorts. These findings of increased prevalence of perforated tympanic membranes in the older compared with the younger age group concur with the results of Hinchcliffe (1961) who, in an earlier study involving and adult rural population in the UK, found the overall incidence of active chronic suppurative otitis media to be 1.1%. An incidence of active chronic suppurative otitis media of 0.6% among the adult population of the UK was reported by Browning et al (1983b).

The management of chronic suppurative otitis media has witnessed a profound change over the last 100 years, from the early attempts at surgical exposure of the middle ear in 1889 to the present day techniques of tympanoplasty in persistent but inactive disease and the 'canal-up' or the 'canal-wall-down' techniques in cholesteatoma surgery (Milstein, 1980). Earlier methods of radical surgery were necessary to control, even at the expense of hearing loss, an undoubtedly destructive disease associated with serious complications at a time when antibiotics were unavailable. The introduction, over the last four decades, of antimicrobial therapy in the treatment of infection has virtually eliminated the risk of chronic ear disease following acute necrotizing otitis media during acute exanthemata. Developments in microbiology, together with the emphasis on preserving hearing in chronic suppurative otitis media, has further modified the approach to its management.
The modern concept of management of chronic suppurative otitis media therefore demands careful assessment of the clinical presentation of the disease, the extent of the destructive pathological process and sequelae, if any, the nature of microbial flora within the ear, and the functional loss. No assessment of the ear with active chronic suppurative otitis media is complete without a search for both possible complications and the presence of a distant nidus of infection in the upper respiratory tract.

**Clinical assessment**

Clinical assessment of the presenting ear in chronic suppurative otitis media requires a careful evaluation of the history and examination, both of which are essential in determining the type, state and extent of the disease process prior to management strategy.

**History**

The classical symptoms in uncomplicated disease are of a long-standing history of unilateral or bilateral, painless otorrhoea associated with deafness. The type and duration of discharge frequently, though not necessarily, relate to the histopathological changes within the middle ear cleft and mastoid and serve as a useful guide to the clinician in assessing the activity of the disease. In the 'tubotympanic-type' of the disease, the discharge is intermittent and mainly mucoid or mucopurulent and is often precipitated by an upper respiratory tract infection, or may follow entry of water through the perforation after swimming; typically the discharge is non-odorous. In contrast, in the 'atticoantral-type' the discharge is frequently scanty, but may be profuse in the presence of active mixed infection and, in addition to being malodorous, the ear is seldom dry.

The presence of bloody discharge, facial palsy or a history of pain, vertigo, or severe headache are evidence of complications. While conductive deafness is usually the rule rather than the exception in tubotympanic disease, in the atticoantral type, patients may sometimes deny a hearing loss if the cholesteatoma is confirmed to the attic only in the early stages or when the cholesteatoma sac acts as a bridge between the necrosed long process of the incus and the head of the stapes. A history of any previous ear surgery must also be sought.

**Examination**

Clinical examination forms the main basis of assessing the activity, type and extent of the disease in chronic suppurative otitis media and includes naked eye inspection of the ear, otoscopy and examination of the ear under the microscope. It is imperative to assess the state of the upper respiratory tract in tubotympanic disease by examination of the nose, pharynx and postnasal space. Inspection of the affected ear with a head mirror helps to evaluate the type of discharge in respect of its colour, consistency and odour. Occasionally, a fleshy polyp may be seen in the external auditory meatus or opening; secondary otitis externa may be present; the postaural region may reveal a scar from previous surgery. In the presence of a history of vertigo, evidence of spontaneous nystagmus is sought and the ear tested for the fistula sign. A swab is obtained for aerobic and anaerobic culture and sensitivity.
Otoscopic inspection with an auriscope is particularly useful in the evaluation of tubotympanic disease in its quiescent phase when the site and size of the perforation, the state of the remainder of the tympanic membrane, and the nature of the middle ear mucosa are noted. In atticoantral disease, otoscopic examination may reveal the presence of a crust, polyp or granulations obscuring cholesteatoma in the attic. A posterior retraction pocket may be associated with keratin debris and a necrosed lenticular process of the incus with granulations over the deep meatal margin.

Microscopical evaluation of every ear with active chronic suppurative otitis media at initial presentation is essential to formulate a policy of management. Debris and/or discharge, which is frequently pulsatile, is cleared from the ear by aspiration as an outpatient or 'office' procedure; however, in children, general anaesthesia may be desirable. Microscopic inspection of the ear allows the examiner to obtain a bacteriological swab from the exudate in the middle ear, from a site at which the disease is in its active state. The following observations are then made and recorded:

1. the size and site of the defect in the tympanic membrane
2. the state of the remainder of the drum around the defect - the presence of any tympanosclerosis, and the lack of middle fibrous layer around the central perforation
3. the appearance of the middle ear mucosa through a perforation - oedematous and slightly injected, red and velvety, the presence of tympanosclerotic plaques
4. the presence of a polyp and granulations and its site - in the attic or deep posterior meatal margin, in the posterior retraction pocket, in a modified radical cavity
5. the extent of the cholesteatoma sac
6. the integrity of the ossicular chain - disruption of incudostapedial joint, necrosis of the long process of the incus, medial retraction and shortening of the handle of malleus.

It is advisable to make a schematic representation of the findings under the microscope in the patients' case notes since repeated examination may be required as part of medical management of the disease and changes observed in the initial active stage could well resolve under treatment.

Classification of chronic suppurative otitis media

Chronic suppurative otitis media is traditionally classified into two main groups - tubotympanic and atticoantral disease. Tubotympanic disease was considered 'safe' from complications while the atticoantral type was considered to be a 'dangerous' form of the disease in view of the risk of intracranial suppuration. Such a view has recently been seriously challenged by Browning (1984a) who, in a retrospective study of 26 cases of consecutive otogenic brain abscess admitted to the West of Scotland Institute of Neurological Sciences between 1973 and 1980, observed that 46% had cholesteatoma, 38% had mucosal disease, and 15% had previously undergone a modified-radical mastoidectomy. It would appear from the above study that persistent active infection whether associated with cholesteatoma, persistent
mucosal disease in the middle ear or in a modified-radical mastoidectomy cavity predisposes the patient to the risk of intracranial infection.

**Tubotympanic disease**

Tubotympanic disease is characterized by the presence of a central perforation and the clinical presentation varies depending on the extent and severity of the disease. Thus, several factors influence the condition in any particular ear and at any given time, for example the patency of the eustachian tube, the presence of a nidus of infection in the upper respiratory tract, the natural mucosal barrier to infection which is impaired in immune compromised patients, the presence of mixed aerobic and anaerobic microbes, the extent and degree of mucosal changes, and the secondary migration of squamous epithelium. For details of histopathological changes, the reader is referred to Chapter 3. However, clinically tubotympanic disease presents as:

1. **Active disease:** when the patient reports to the clinician with a discharging ear and/or deafness

2. **Inactive disease:** if bilateral the only presenting feature is deafness, while in unilateral disease the patient may not seek medical advice.

**Active tubotympanic chronic suppurative otitis media**

Active disease is usually preceded by either an extension of infection through the eustachian tube from the upper respiratory tract, for example after a common cold, or by way of the external auditory meatus following swimming. The anterior pulsatile discharge varies from mucoid to mucopurulent. Occasionally, there is a long interval free from discharge and the patient may have overlooked a previous episode(s) of ear disease, perhaps made apparent by syringing. The size of the perforation may vary from a pinhole to a large subtotal defect confined to the pars tensa. It is not unusual to find a large polyp in the external auditory meatus. Extension of the infection into the mastoid air cells resulting in widespread and persistent mucosal disease should be suspected if conservative measures fail to control the infection, or if there are granulations in the mesotympanum with or without secondary migration of skin, in which event there is frequently a pulsatile discharge over the posterosuperior quadrant.

**Inactive tubotympanic disease**

This stage of the disease represents a balance between the various pathophysiological factors outlined above and infection. It is remarkably symptom free apart from mild conductive deafness. The ear at examination presents a dry central perforation with a pale thin middle ear mucosa. In a few, one ear may be the seat of active tubotympanic disease while the opposite ear demonstrates an inactive disease; in others an unsuspected dry perforation is discovered on routine examination.
Atticoantral disease

The typical feature of atticoantral disease is the presence of a cholesteatoma. The terminology has attracted a good deal of criticism and the alternative terms of keratoma, epidermoid tumour, epidermosis and many more have been suggested to describe what is basically the same pathological entity, that is the presence of keratinizing squamous epithelium in the middle ear cleft. It is not within the scope of this chapter to discuss the merits or otherwise of the various terminologies and the author prefers to adhere to the term 'cholesteatoma'. For a detailed description of aetiology, pathogenesis, and spread of cholesteatoma within the temporal bone together with its complications, the reader is advised to refer to appropriate sections.

The cholesteatoma may vary in size from a small sac confined to the attic or to the posterosuperior quadrant of mesotympanum, to widespread disease involving the entire mastoid bowl and the posterior half of the mesotympanum. Occasionally the cholesteatoma may extend medially into the petrous apex or into the entire middle ear cavity including the eustachian tube opening inferiorly. Extensive disease may lead to complications.

Bacteriological assessment

The wide range of microbes, both aerobic and anaerobic, present in chronic suppurative otitis media has been the subject of exhaustive investigation. However, the exact role of these organisms in the disease process is uncertain. Earlier studies reported the predominance of Gram-positive bacteria. Friedmann (1952) isolated *Staphylococcus aureus* in 32.7% of 318 cases, of which 41% were penicillin resistant and 59% sensitive; among the Gram-negative organisms, *Proteus* was isolated in 27%, *Pseudomonas aeruginosa* in 16%, and *Escherichia coli* in 10.7%. Subsequent studies have stressed the widespread presence of mixed Gram-positive and negative organisms in varying proportions, with Gram-negative aerobes predominating.

The widespread prevalence of Gram-negative aerobes in chronic suppurative otitis media, in particular in tubotympanic disease, has cast serious doubt on the role of the nasopharynx as the source of infection. An alternative theory of a 'faecal-aural' route has been suggested (Fairbanks, 1981). In a carefully documented study of different types of *Proteus* organisms associated with active chronic suppurative otitis media, Senior and Sweeney (1984) demonstrated the presence of no less than 57 strains in 38 patients. Furthermore, nine patients were tested for *Proteus* in the ear during, pre- and post-treatment, and seven were discovered to be reinfected with a different strain which led the authors to believe that *P. mirabilis* and *P. vulgaris* were particularly virulent in relation to chronic suppurative otitis media. These authors concluded that the 'faecal-aural' route does not play a significant role in the microbial colonization in active chronic suppurative otitis media.

Examination of various reports on the nature of aerobic bacterial flora in active chronic suppurative otitis media, either in tubotympanic or in cholesteatoma has failed to demonstrate any significant difference in the type of aerobic Gram-negative organisms. However, there is a greater predominance of *Staph aureus* among the Gram-positive organisms in tubotympanic disease (Harker and Koontz, 1977; Sweeney, Picozzi and
Browning, 1982; Brook, 1985). The presence of multiple strains of both Gram-negative and positive aerobes is the rule rather than an exception. In a quantitative study of both aerobic and anaerobic microbes in active chronic suppurative otitis media, Sweeney, Picozzi and Browning (1982) showed rather exceptionally high counts of *Pseudomonas* of $10^{11}$ bacilli per millilitre compared with the counts of other main aerobic and anaerobic species. The presence of beta-lactamase-producing microbes of both aerobic and anaerobic types in 69% of 33 patients was reported by Brook (1985) and has considerable implications for the chemotherapeutic management.

Perhaps the most exciting development in the field of microbial flora in chronic suppurative otitis media, in recent years, is the discovery of the presence of non-sporing anaerobes. Recent improvements in culture techniques of anaerobic organisms have further contributed to their successful isolation ever since their association in otogenic brain abscess and meningitis was first described (Smith, McCall and Blake, 1944; Heineman, Braude and Osterholm, 1971; Ingham, Selkon and Weiser, 1975; Yoshikawa, Chow and Guze, 1975; Chattopadahay, 1977; de Louvois, Gortvai and Hurley, 1977). The main species of anaerobes isolated from exudate in chronic suppurative otitis media were *Bacteroides melaninogenicus* and *B. fragilis*. Non-sporing anaerobes were invariably isolated together with aerobic organisms; however, in a few patients, mainly anaerobes were isolated.

Jokipii et al (1977) reported an average ratio of 3.8 bacteria, 1.9 anaerobes and 1.9 facultative species, in the exudate. In a quantitative study of aerobic and anaerobic microbes in chronic suppurative otitis media, Sweeney, Picozzi and Browning (1982) demonstrated an average count of $10^9$ anaerobic organisms per millilitre. The widespread distribution of *Bacteroides* species in the oral cavity, the oropharynx, nasopharynx and the nasal cavity in health has been described by Finegold (1981). The commonest species isolated from these sites is *B. melaninogenicus*, the most common non-sporing Gram-negative pathogen associated with infections in the oral cavity and otitis media (Collee, 1982). Recently, however, Hudac (1980), Sweeney, Picozzi and Browning (1982) and Browning et al (1983a) have demonstrated the prevalence of *B. fragilis* in chronic suppurative otitis media, although *B. melaninogenicus* is still the commonest Gram-negative non-sporing anaerobe. The route of entry of these organisms in chronic suppurative ear disease is still uncertain; like Gram-negative aerobes they are not usually discovered in a normal domestic environment (Whitby and Rampling, 1972). The alternative route through the ear is a possibility.

The role of anaerobic organisms in active chronic suppurative otitis media, has been the subject of intense investigation and speculation. The metabolism of facultative species in mixed infections, by lowering the local concentration of oxygen and reduction in oxidation-reduction potential, provides a suitable environment for the anaerobic pathogens (Onderdonk et al, 1976). The reduction of the partial pressure of oxygen due to obstruction of air around cholesteatoma or granulations causes an inverse increase in carbon dioxide pressure and, as a direct result of this, the anaerobes multiply (Sugita et al, 1981). Further evidence of synergy between the Gram-negative bacilli, particularly coliforms and *Proteus*, and *Bacteroides* species was elaborated by Ingham et al (1977), who reported inhibition of phagocytosis, by human leucocytes, of these Gram-negative bacilli in the presence of *Bacteroides* species in studies *in vitro*. Evidently, the frequent isolation of *B. fragilis* in chronic suppurative otitis media may reflect an even greater pathogenic potential and has important implications in the clinical
management of the disease (Sweeney, Picozzi and Browning, 1982). The production of certain
growth factors by one organism that permits survival of another pathogen at the infected site
was demonstrated by MacDonald, Socransky and Gibbons (1963).

In a review of the role of anaerobes in mixed infections Gorbach (1982) elaborated
the following five reasons for the success of *B. fragilis*:

(1) virulence factor
(2) growth factors
(3) cascade effect
(4) protective environment of an abscess
(5) immunological factors.

Among the growth factors essential for the growth of *B. melaninogenicus* is the
molecule naphthoquinone which is closely related to vitamin K and produced by non-
pathogenic diphtheroides. Many strains of *B. melaninogenicus* require vitamin K for their
growth *in vitro* and for their pathogenicity *in vivo*. One of the immunological factors is the
resistance to phagocytosis by the polysaccharide in the capsule of *B. fragilis*. Furthermore,
aanaerobes are known to interfere with the phagocytosis of aerobes. Kelly (1978) showed that
when a mixture of *E. coli* 9 x 10⁴ and *B. fragilis* 9.3 x 10⁴ was inoculated into a freshly
inflicted wound in guinea pigs, the wound demonstrated profound inflammation and copious
pus, while inoculation of the same quantity of organisms separately into different wounds
failed to show such infection. Furthermore, a threshold of 10³ *E. coli* and 10⁴ *B. fragilis* was
required to produce pus. The results of the above experiment were extrapolated to the clinical
context by Sweeney, Picozzi and Browning (1982), when they observed, in a quantitative
study of both aerobic and anaerobic microbes in active chronic suppurative otitis media,
bacterial counts of greater than 10⁴. The latter authors, therefore postulated that the
characteristic malodorous pus associated with tissue destruction may represent an example of
such a 'pathological synergy' in the clinical situation.

Further examples of the presence of fetid pus in anaerobic infections may be seen in
acute maxillary sinusitis secondary to dental sepsis and in periodontal abscess. The
demonstration of beta-lactamase-producing organisms in more than two-thirds of patients with
active chronic suppurative otitis media, most of whom received multiple courses of
antimicrobial drugs including penicillin, erythromycin, co-trimoxazole (Brook, 1985) is a
disturbing clinical development. The same author in an earlier study *in vitro* (Brook et al,
1983) demonstrated the ability of beta-lactamase-producing strains of both *B. fragilis* and *B.
melaninogenicus* to protect group A beta-haemolytic streptococci from penicillin.

The bacteriological assessment in active chronic suppurative otitis media should,
therefore, include a culture and sensitivity test from an ear swab for both Gram-positive and
Gram-negative aerobes and a separate swab for anaerobic culture which should be transported
in a special container to the microbiology laboratory.
**Audiological assessment**

Until recently, it was widely accepted that pathological changes in uncomplicated chronic suppurative otitis media resulted in a conductive hearing loss. Prasansuk and Hinchcliffe (1982) described four basic dysfunctions in chronic suppurative otitis media which correlate hearing levels with the otoscopic appearance of the perforated tympanic membranes - impairment of the tympano-ossicular impedance matching mechanism; reduction of the 'baffle' effect on the round window; underlying middle ear pathology such as mucosal oedema, fluid, granulations, cholesteatoma, osteitis and ossicular necrosis which impairs the tympano-ossicular mechanism; and underlying cochlear dysfunction. Audiometric study of hearing loss in perforated tympanic membranes was reported by Anthony and Harrison (1972). However, it was not possible to draw a significant quantitative correlation between the size and site of the perforation and the hearing loss. In their pilot study on 15 consecutive young patients with active bilateral chronic suppurative otitis media, Prasansuk and Hinchcliffe (1982) were able to identify quantifiable clinical descriptions of perforated tympanic membranes that correlated with air conduction hearing threshold levels. Furthermore, these authors were able to predict, by a mathematical formula, the threshold of hearing from the duration of the aural discharge.

The evidence of sensorineural hearing loss in chronic suppurative otitis media is much more recent. Paparella, Brady and Hoel (1970) reporting on the decade-audiograms in 279 ears out of more than 500 studied from patients with chronic suppurative otitis media, observed significant sensorineural hearing loss particularly at higher frequencies both in unilateral and bilateral disease. Such a loss was attributed to diffusion of toxic products from inflammation into the scala tympani via the round window membrane causing temporary or permanent threshold shifts of bone conduction, confined initially to the basal turn but capable of spreading to the apical turns. The presence of serofibrinous exudate within the scala tympani in juxtaposition to the round window membrane in experimentally-induced otitis media in cats, was observed to substantiate the above hypothesis (Goycoolea et al, 1980). It must be stressed, however, that the scala tympani in such animals was remarkably devoid of any cellular deposits. Of the 13 temporal bones of mostly adult patients with chronic suppurative otitis media examined histologically, Paparella, Hiraide and Brady (1972) reported the presence of serofibrinous and inflammatory cells in the cochlea of four cases, although definite hair cell loss due to the chronic ear disease could not be confirmed.

It is well known that accurate assessment of bone conduction thresholds in the presence of conductive hearing loss is fraught with difficulties. Walby, Barrera, and Schuknecht (1983), in a retrospective study of 37 patients with uncomplicated and unilateral chronic suppurative otitis media, confirmed the evidence of increased bone conduction thresholds at 0.5, 1, 2, and 4 kHz on the diseased side when compared with normal, opposite ears. Furthermore, there was a greater loss in bone conduction with a longer duration of the disease. The above authors, in the same study, examined histological sections from 12 temporal bones with unilateral chronic suppurative otitis media and found no evidence of abnormality in the hair cells and the supporting structures within the cochlea when compared to the normal opposite ear. They postulated, based on their findings, that the abnormally raised bone conduction thresholds in chronic suppurative otitis media may well be due to changes in the mechanics of sound conduction.
Paparella et al (1984) in a multicentric epidemiological survey of sensorineural hearing loss in chronic suppurative otitis media, involving six medical centres in five countries, reported highly significant differences between the bone conduction thresholds in the control and diseased side and between those with bilateral disease and the controls from four of the medical centres. They stressed the importance of repeating the bone conduction measurements at frequent intervals, particularly when the disease is in both its active and inactive stages. Conversely, Dumich and Harner (1983) observed no significant evidence of sensorineural hearing loss in 200 patients with chronic suppurative otitis media.

The audiological assessment in chronic suppurative otitis media must commence by assessing the hearing with a tuning fork (512 or 1024 frequency) and a Barany noise box. The use and limitations of the tuning fork in the diagnosis of conductive hearing loss has been discussed by Doyle, Anderson and Pijl (1984). An accurate pure tone audiogram with appropriate masking for air and bone conduction is carried out at the first visit and at intervals to determine, in particular, the level of cochlear reserve. If surgical treatment is planned, it is essential, in bilateral disease, to choose the worse hearing ear. A ‘dead’ ear with healed disease on the one side, and active disease on the other, is sometimes seen and such a finding has important implications in management. A speech audiogram with masking is advisable. Preoperative assessment of eustachian tube function is unhelpful (Smyth, 1980(i); Sheehy, 1983).

Radiological assessment

It is not the intention of the author to describe in detail the various projections of plain radiographs of the mastoid to evaluate the destructive process associated with chronic suppurative otitis media, as this subject has been extensively dealt with elsewhere (Phelps and Lloyd, 1983, see also Chapter 2).

Computerized tomographic coronal scans define the scutum, Prussak’s space, the tegmen tympani, the ossicular heads, and the horizontal portion of the facial nerve, while axial scans reveal sinus tympani, facial recess, lateral semicircular canal, stapes and the vertical portion of the facial nerve (Jackler, Dillon and Schindler, 1984). It does seem, however, that the contribution of computerized tomographic (CT) scanning in the management of chronic suppurative otitis media is outstanding when applied to the diagnosis of intracranial complications, especially extradural, subdural and intracerebral abscesses.

The radiological assessment of chronic suppurative otitis media, where possible, should include a lateral view of the affected mastoid and a general lateral view of the skull. The radiologist’s report, not uncommonly, concentrates on the appearances of the mastoid air-cell system and perhaps to the presence or absence of bone erosion on such plain films. However, to the clinician the lateral view offers important information about the anatomical dimensions within the mastoid segment, information that is relevant to the surgical management.

Medical management of active chronic suppurative otitis media

The medical management of active chronic suppurative otitis media is a complex clinical problem, occupying as it does a major proportion of the clinical work load of an average otolaryngology outpatient department in the UK. A great deal of expense is incurred
in both general and hospital practice by the use of either topical or systemic antimicrobial agents and, all too often, the results of controlling the infection are disappointing to both patient and clinician alike. However, antimicrobial drugs have a proven role in the management of acute suppurative otitis media and the prevention of its complications. The following factors can be identified to account for the disappointing results of antimicrobial therapy in chronic suppurative otitis media, particularly in diffuse mucosal disease involving the mastoid bowl and the middle ear cavity.

1. Poor drainage of inflammatory exudate: the morphology of the middle ear cleft, with its inherent narrow channels of communication between the mesotympanum and the attic, the attic and the mastoid antrum, is such that all of these may be the site of obstruction in active diffuse mucosal disease. Similarly, pinhole central perforation is an impediment to proper drainage to the exterior and for the entry of antibiotic drops into the middle ear.

2. The presence of destructive disease associated with osteitis and granulations/polyps further promotes retention of inflammatory exudate.

3. The lack of information on the efficacy of antimicrobial therapy in chronic ear disease based on large scale controlled trials.

4. The presence of keratinizing squamous epithelium and keratin debris, both of which provide a natural have for organisms.

5. The presence of mixed aerobic and anaerobic bacterial flora: except for chloramphenicol ear drops, none of the commonly used antibiotic/hydrocortisone ear drops have any therapeutic effect on the anaerobes.

6. Failure of antibiotics to penetrate the inflammatory exudate (Senior and Sweeney, 1984).

7. The possibility of reinfection with a different strain of the same species, for example Proteus species.

8. The possibility that certain strains may have particular virulence in relation to a chronically diseased ear.

9. The presence of debris and inflammatory exudate in the middle ear prevents topical antibiotic drops from acting on the organisms.

10. Mucosal changes in active chronic suppurative otitis media particularly in patients with a long history of the disease, are characterized by subepithelial scarring and devascularization, both of which predispose to poor mucosal concentration of antimicrobial agents (Browning et al, 1983a; Jahn and Abramson, 1984).

11. Pathological synergy between aerobes and anaerobes, particularly the Bacteroides species, which promotes inhibition of phagocytosis of aerobes in conditions such as chronic suppurative otitis media (Sweeney, Picozzi and Browning, 1982).
(12) Consistently high bacterial counts of both aerobes and anaerobes in the pus.

(13) Bacterial presence in chronic suppurative otitis media is a result of secondary invasion of inflamed mucosa caused by an as yet unidentified process (Browning et al, 1983b).

(14) Emergence of beta-lactamase-producing Bacteroides species in chronic suppurative otitis media (Brook, 1985).

(15) Other associated generalized disorder, for example immune deficiency, Wegener's granulomatosis, histiocytosis X, etc.

The aim of medical treatment in uncomplicated chronic suppurative otitis media is to control the infection and thereby eliminate aural discharge.

Correction of the hearing loss is usually by surgical means.

**Tubotympanic disease**

**Anterior central perforation**

Exacerbation of active infection in an ear with a small anterior central perforation is frequently fuelled by an episode of upper respiratory infection and is characterized by the presence of pulsatile mucoid or occasionally mucopurulent aural discharge. Isolation of the same type(s) of organism in the aural discharge as that present in the nose, oropharynx or nasopharynx, for example, Streptococcus pneumoniae, Staphylococcus aureus, Haemophilus influenzae (Palva and Holopainen, 1978), has governed the use of systemic broad-spectrum antimicrobial agents resulting in control of the disease in the majority of patients. Indeed, it is not unusual to see such an outcome in children by the time they are seen in the outpatient clinic, the child having completed a course of chemotherapy from the general practitioner. An attempt must be made to identify and eliminate the nidus of infection in the upper respiratory tract. Similar exacerbation of the disease is observed if water, from swimming or following syringing, gains access to the middle ear and treatment along the above lines often results in control of infection.

**Central or marginal perforation**

The size of the central perforation may vary from a small defect of 2 mm to a total defect in the pars tensa. Similarly, the size of the marginal perforation may also vary. Medical management is described below under the diffuse mucosal variety. It is not always possible to make a distinction on clinical grounds between disease confined to the mucosa of the middle ear and that which is widespread in the mastoid bowl, although the presence of osteitis with granulations and a malodorous discharge should raise suspicions.

**Diffuse mucosal disease**

Widespread involvement of mucosa within both the mastoid bowl and the middle ear is characterized by the presence of destructive osteitis and granulations and can be seen in
both tubotympanic and atticoantral types. In the tubotympanic type, it exists usually with a large subtotal or posterior marginal defect. In the atticoantral type, an attic defect is observed and keratinous debris may be present. It is also evident in a few radical/modified radical mastoidectomy ears postoperatively, either in the cavity, in the middle ear, or in both. It would be appropriate to deal with the medical management of diffuse mucosal disease as a 'common entity' since the pathological changes, and notoriously poor results of treatment, appear to be common to all three forms of the above disease, in relation to the anatomical sites.

Reference has already been made to the several factors which consistently influence the high rate of failure to control infection in such a complex disease by medical means. A swab for aerobic and anaerobic culture and sensitivity along the lines already suggested should be carried out. Several modalities of treatment have been suggested to achieve the primary aim in management - eradication of infection. The lack of large scale controlled trials makes critical appraisal of different modalities difficult.

**Aural toilet**

(a) *Cotton-buds:* mopping the discharge with cotton-buds, either self-made or prepacked sterile ones, is a convenient method for dealing with aural discharge. Patients are taught to mop the discharging ear with self-made fine cotton-buds several times a day, the procedure being repeated on each occasion until the ear appears dry. Prepacked cotton-buds, although a little more bulky, are convenient to use in a discharging mastoid cavity. The patient's relatives can also be taught how to do this. Browning (1984b) reported cessation of discharge in 85% of patients treated by dry mopping with cotton-buds once the ear has been cleaned out thoroughly by the clinician.

(b) *Syringing:* clearing the debris and inflammatory exudate by syringing the ear has been practised in some centres. Physiological saline solution at body temperature is recommended by Chui (1982) and Jahn and Abramson (1984), and a solution containing white vinegar, to provide an acid medium and counteract alkaline pus, diluted 1:2 with water at body temperature and repeated twice daily is suggested by Jahn and Abramson (1984). Syringing of an infected ear is not widely practised in the UK.

(c) *Suction aspiration debridement:* aspiration of inflammatory exudate, under the operating microscope is probably the most popular method. The magnification offered by the microscope allows accurate assessment of the site and size of the tympanic membrane defect, the extent and type of pathological changes, the evidence of destructive disease in the ossicular chain where possible, the presence of sequelae of chronic ear disease, such as tympanosclerosis in the middle ear and atrophic changes in the drum. Furthermore, small polyps can be removed to allow better drainage of inflammatory products. Suction aspiration is attempted as an 'office procedure' without a general anaesthetic in adults. Aspiration debridement during active disease forms an important part of medical management and is carried out either at weekly intervals in the outpatient department (Cronin, Dogra and Khan, 1974), or daily as a preoperative regimen (Karma et al, 1978). Preoperative conservative treatment has been shown to decrease significantly the amount of 'culture-positive' ears prior to surgery (Palva, Karaja and Palva, 1971). Young children will require general anaesthesia for suction aspiration and initial assessment.
Antimicrobial agents

These are used either topically or systemically or by both routes.

(a) Topical antiseptic agents: several antiseptic agents have been in use and their therapeutic effects have been attributed to the acid medium they provide, since most microbes prefer an alkaline medium (Fairbanks, 1984). Antiseptic ear drops include aluminium acetate, spirit, and phenol, while boric acid and iodine as a powder insufflation is a popular choice.

(b) Topical antibiotic preparations, chiefly in a liquid base, have enjoyed wide popularity in the treatment of active chronic ear disease. The antibiotic component in the ear drops varies but falls into two main categories - aminoglycosides and beta-lactams - in combination with or without steroid. The following aminoglycoside ear drop preparations are available in the British National Formulary (1986): framycetin sulphate (neomycin B); gentamicin; neomycin sulphate. Compound preparations include neomycin undecenoate (to discourage secondary fungal infestation), neomycin and polymyxin B sulphate, bacitracin and polymyxin B sulphate, framycetin sulphate and gramicidin. The beta-lactam antibiotic group includes penicillin and chloramphenicol, of which penicillin has largely been discontinued as a topical antibiotic because of the development of hypersensitivity.

Topical antibiotic therapy has been extensively used in the treatment of active chronic suppurative otitis media in combination with aural debridement, in both children and adults (Fox, 1964; Federspil, 1969; Mendonca, 1969; Kilcoyne, 1973; Gyde, 1976; Palva and Holopainen, 1978; Fairbanks, 1981; Chui, 1982; Browning et al, 1983b; Supance and Bluestone, 1983; Bluestone and Kenna, 1984; Fairbanks, 1984; Jahn and Abramson, 1984). Neomycin is a particularly valuable agent against Proteus and Staphylococcus aureus but is inactive against Gram-negative anaerobes and has limited action against Pseudomonas aeruginosa because of an increasing degree of resistance. Polymyxin is effective against Ps. aeruginosa and a few other Gram-negative organisms but is ineffective against Gram-positive organisms (Fairbanks, 1984). Like other aminoglycosides, gentamicin and framycetin sulphate are active against Gram-negative bacilli and gentamicin is moderately active against streptococci. None of the aminoglycoside antibiotics are effective against anaerobes.

Aminoglycosides are more active in an alkaline medium (Phillips, 1982). Chloramphenicol ear drops are available in an acid carrier and may produce pain on local application in the ear, although using an ophthalmic preparation can overcome this drawback. Chloramphenicol is active against a wide spectrum of Gram-positive and Gram-negative bacilli except Ps. aeruginosa, but it has a great advantage over aminoglycosides in being effective against anaerobes, particularly B. fragilis (Fairbanks, 1984). However, when chloramphenicol has been applied into the ear some patients have shown skin hypersensitivity. The total duration of topical application of antibiotic ear drops required to eradicate infection in active chronic ear disease, without any adverse effects on cochlear function, is not quite clear nor is the therapeutic value. A lack of large scale controlled trials is mainly responsible for the wide gap in our knowledge of the use of topical antibiotics in active chronic suppurative otitis media. It is not unusual to see recommendations of therapy from a few weeks to a few months (Turner et al, 1966; Mendonca, 1969; Gyde, 1976, 1981; Tambic and Tambic, 1976; Picozzi, Browning and Calder, 1983).
Long-term use of aminoglycoside ear drops, particularly where the round window is exposed, must raise the question of ototoxicity in such patients. Cochlear damage from intratympanic application of aminoglycoside drops has been demonstrated in experimental animals (Kohonen and Tarkanen, 1969; Wright and Meyerhoff, 1984). A case of profound sensorineural hearing loss following 11 months of treatment with framycetin ear drops in chronic suppurative otitis media was reported by Tommerup and Moller (1984). Until more is known about the actual incidence of ototoxicity of aminoglycoside ear drops, caution must be exercised in their use.

One of the earliest controlled trials with 0.3% gentamicin drops in active chronic suppurative otitis media, was reported by Turner et al (1966) who demonstrated dry ears in 85% of patients at the end of 6 weeks' treatment compared to no improvement in the control group. In a randomized double-blind trial of trimethoprim-polymyxin (TP) against trimethoprim-sulphacetamide-polymyxin (TSP) ear drops in active ear disease, Gyde (1981) showed a statistically significant result in patients receiving TSP ear drops. Picozzi, Browning and Calder (1983) in a controlled trial with gentamicin-hydrocortisone drops in active chronic suppurative otitis media reported a statistically significant benefit in the active group (65%) compared to the placebo group (21%). Browning et al (1983b), in what is perhaps the only controlled trial comparing three modalities of medical treatment in active chronic suppurative otitis media, demonstrated that there was no significant difference between aural toilet and systemic or topical antibiotics. The benefits of supplementing hydrocortisone into various antibiotic drops have not been conclusively proven.

Despite several uncontrolled and a few controlled trials of the therapeutic effects of antibiotic ear drops in active chronic ear disease, there is no clear-cut information on the most effective method of applying such drops into the ear, the frequency of application, the optimum number of drops to be used and the ideal contact time between the active chemotherapeutic agent and the inflamed surface area in the middle ear cavity.

(c) Systemic antimicrobial agents: it could be said that almost all available antibiotics have been tried systemically in the treatment of active chronic ear disease as a result of the wide variety of Gram-positive and Gram-negative microbes isolated from such ears. However, their efficacy in controlling the disease has been disappointing, particularly in the diffuse mucosal variety and the results are further clouded by the lack of large scale controlled trials. Thus, Bluestone and Kenna (1984) recommended a full schedule of different types of antibiotics and their dosage in children with active chronic suppurative otitis media, and included penicillin G, broad-spectrum penicillins, anti-pseudomonal penicillins, cephalosporins, clindamycin, vancomycin, and chloramphenicol. Fairbanks (1981) suggested that the antibiotic choice should be related to the organisms isolated:

- Pseudomonas - aminoglycoside ± carbenicillin
- Proteus mirabilis - ampicillin
- P. morgagni - aminoglycoside ± carbenicillin
- P. vulgaris - aminoglycoside ± carbenicillin
- E. coli - ampicillin or cephalosporin
- Klebsiella - cephalosporin or aminoglycoside
- Enterobacter - aminoglycoside
*Staphylococcus aureus* - anti-staphylococcal penicillin, cephalosporin, erythromycin, aminoglycoside

Streptococci - penicillin, cephalosporin, erythromycin, aminoglycoside

*B. fragilis* - clindamycin.

Haverkos et al (1982) reported the use of latamoxef sodium intravenously. Brook (1985) has documented the presence of twice as many beta-lactamase-producing organisms in patients with active chronic suppurative otitis media who have previously received penicillin. Browning et al (1983b), in a controlled trial of medical treatment in active chronic ear disease, demonstrated no significant difference in results between those receiving topical antibiotics, systemic antibiotics (cephalexin, flucloxacillin, or amoxycillin) and simple aural toilet.

Isolation of anaerobes from 33% of 70 cases (Jokipii et al, 1977) and 44% of 130 patients (Sweeney, Picozzi and Browning, 1982) with active chronic ear disease has attracted the use of antimicrobial agents against these organisms in recent years. Three different therapeutic agents have been identified - clindamycin, an antibiotic, metronidazole, an antimicrobial drug which was used against protozoal infestation but now employed increasingly in anaerobic infections, and compound amoxycillin trihydrate and potassium clavulanate (Augmentin), an antibiotic with broad-spectrum activity against Gram-positive and Gram-negative organisms, except *Ps. aeruginosa*, and active against anaerobes. To date there does not appear to be any reported trial of Augmentin in active chronic ear disease.

Clindamycin is well concentrated in bone and besides being active against anaerobes is also active against Gram-positive cocci including penicillin-resistant *Staph. aureus*. Its serious toxic effect is pseudomembranous colitis. In an uncontrolled study of clindamycin in active chronic suppurative otitis media, Khambata (1972) reported a success rate of 74%. However, the results in infected mastoid cavities were disappointing. Cooke and Raghuvanan (1974) in an equally uncontrolled trial demonstrated that 70% of patients not receiving the drug required a drainage procedure, compared with only 35% who had received clindamycin.

Metronidazole has been shown to exert a bactericidal effect on most anaerobic bacteria tested by studies *in vitro* (Prince et al, 1969). Jokipii, Karma and Jokipii (1978), while investigating the tissue concentration of metronidazole in active chronic suppurative otitis media, reported the presence of the drug in the inflammatory exudate within 2 hours or less, of ingestion and it continued to be present in the middle ear mucosa even 12 hours later. High serum levels of the drug were obtained in all patients. A further advantage of the drug is the lack of demonstrable microbial resistance at the present time. Browning et al (1983a), in a controlled trial of metronidazole with and without antibiotics (cephalexin and cotrimoxazole) in active chronic suppurative otitis media, observed that metronidazole 400 mg 8-hourly for 2 weeks, or 200 mg 8-hourly for 2-4 weeks, eliminated the anaerobes in 22% of patients, while a 2.4 g stat dose, or repeated once, successfully eliminated anaerobes in 86% of patients. In combination with an antibiotic, metronidazole eliminated anaerobes in all patients. However, aerobes were unaffected by the treatment and continued to be present in all but one patient.
Suggested line of medical management of active uncomplicated chronic suppurative otitis media

Active tubotympanic disease with an anterior central perforation

(1) The disease is probably inactive by the time the patient has arrived at the clinic; if not
(2) assess the ear under the microscope while, at the same time, obtain a specimen of pus for culture and sensitivity as outlined above. The ear is cleaned by suction aspiration
(3) commence a systemic broad-spectrum antibiotic, that is oral amoxycillin or cephalosporin. If the patient is allergic to penicillin, erythromycin is a suitable alternative
(4) eliminate any nidus of infection in the upper respiratory tract
(5) prevent water from gaining access into the ear. Cotton wool smeared in vaseline is a suitable ear plug; swimming is discouraged
(6) if the ear becomes inactive, myringoplasty is considered.

Active chronic suppurative otitis media with a central or posterior marginal perforation

(1) Assessment of the ear is carried out by examination under the microscope. A swab for both aerobic and anaerobic culture and sensitivity is obtained from the most active area of the disease.

(2) The active ear is carefully debrided with a tube aspirator, removing any small polyp at the same time. The changes observed under the microscope are schematically documented in the case notes.

(3) The patient is instructed in cleaning the ear by self-made small cotton-buds and advised to carry out aural toilet four or five times a day. On each occasion, the ear is mopped dry until the cotton buds are free of inflammatory exudate. A further appointment is made for the following week when the results of culture and sensitivity should be available. The ear is protected from water, as previously described.

(4) If the ear is inactive when seen at the next visit, the patient's name is placed on the waiting list for appropriate surgical treatment following discussion of management with the patient. If however, the ear is still active a course of suitable topical and systemic antimicrobial therapy is commenced depending upon the culture and sensitivity report. If Gram-negative microbes are isolated and are sensitive to aminoglycosides, topical gentamicin and hydrocortisone ear drops are used. The patient is instructed in their usage by instilling four or five drops into the ear, after gently warming the container under warm running tap water, with the patient in the lateral position and the diseased ear uppermost. The tragus is gently pressed inwards several times to promote displacement of the drops into the diseased middle ear and the patient is allowed to remain in the treatment position for several minutes. The topical therapy is repeated three or four times a day with the final application at night in bed and the patient is advised to sleep on the 'good' ear. The topical therapy is continued for 7-14 days depending on the response. Systemic antimicrobial therapy includes oral metronidazole 400 mg 8-hourly for 2 weeks if anaerobes are isolated, together with a broad-spectrum antibiotic against Gram-positive organisms if these organisms are isolated. A course
of cephalosporins or co-trimoxazole is prescribed for 7 days if there is a history of penicillin hypersensitivity. Care must be exercised in prescribing co-trimoxazole to patients over the age of 65.

(5) In the event that the ear becomes inactive when seen during the subsequent visit, the patient's name is placed on the waiting list for closure of the perforation as a 'cold' procedure. Conversely, if the ear continues to manifest activity, diffuse mucosal disease is suspected and immediate surgery is contemplated. Those who refuse surgery are advised to self-mop the ear as above and a suitable hearing aid, to be worn on the dry side, is offered in bilateral disease associated with a significant conductive hearing loss.

**Active chronic suppurative otitis media in a previously modified radical mastoidectomy cavity**

The presence of active mucosal disease in the mastoidectomy cavity, in the middle ear mucosa, or in both, appears to be resistant to medical management and will require a revision procedure.

**Cholesteatoma**

It is generally accepted that medical management has no place in the treatment of uncomplicated cholesteatoma. However, there are a few exceptions in which surgical ablation of the disease may not be advisable.

The following clinical presentations would qualify for such exemption and continued medical management by aspiration debridement at suitable intervals, aimed at controlling infection, appears to be the best alternative:

(1) an elderly patient, over the age of 65 years, who is unfit for a general anaesthetic on account of poor cardiopulmonary function

(2) a small cholesteatoma sac confined to the attic with normal hearing; the keratinous debris can successfully be cleared by aspiration debridement. However, a careful watch is required in case the disease does spread with the onset of infection, although a few ears tend to remain stable for a number of years

(3) those patients who refuse surgery.

**Surgical management**

In this section, emphasis is placed on the general principles of surgical management of uncomplicated chronic suppurative otitis media and the reader is referred to the following Chapter for the details of surgical reconstructive techniques.

The basic principles of surgical management in chronic suppurative otitis media are:

(1) to eradicate active disease and thus promote drainage or healing in an ear with diffuse mucosal disease and cholesteatoma
(2) to prevent recurrence of infection in an ear that has remained inactive, by restoring an air-filled middle ear cavity lined by mucosa

(3) to prevent complications occurring in an active ear

(4) to restore function.

It appears that the overall success rate of myringoplasty, as reported by an experienced otologist, is about 95% (Smyth, 1980(ii)), with failure rates much more frequently observed in larger perforations treated by transcanal and combined approach procedures. The rate of successful outcome following myringoplasty in an active ear is no different to that in an inactive ear (Smyth, 1980(ii)); Sheehy, 1983), although the failure rate is significantly higher in the transcanal approach in infected ears with a small perforation - a defect which involved 50% or less of pars tensa (Smyth, 1980(ii)).

A good deal of controversy still exists in relation to tympanoplasty in children. Lee and Schuknecht (1971), Booth (1974), Smyth, 1980(iii); and Sade et al (1981) claimed that age does not influence the successful outcome in myringoplasty. Smyth (1980(iii)) observed that the overall objective of the treatment of chronic suppurative otitis media in children is to ensure functional restoration, by surgery, with minimum delay after treatment of any upper respiratory problems, so that normal development of speech continues, especially in bilateral disease. Conversely, Plester (1982) defined a minimum age of 5 years, and Dawes (1972) of 10 years, for repair of tympanic membrane defects. Raine and Singh (1983) in a retrospective analysis of 114 tympanoplasties in children between the ages of 7 and 16 years demonstrated a significantly higher rate of failure in children aged between 8 and 12 years. In view of the increased risk of upper respiratory tract infection in younger children, it would appear that repair of the drum head is best deferred until the child is about 10-12 years of age.

It is generally accepted that the biological graft materials act as a scaffold of tissue matrix when applied to seal the perforation and this is subsequently revascularized in readiness for migration of fibroblasts and epithelium. A variety of connective tissue graft materials have been used to close the perforation depending on the choice of individual surgeons. Homologous graft materials include temporalis fascia, dura mater, and homograft tympanic membrane with or without ossicles while autologous temporalis fascia also enjoys popular support. Smyth (1980(ii)) demonstrated no significant difference in success rate between autologous temporalis fascia and homologous dura when the results of the postoperative air-bone gap were compared after 6 months in patients with an intact ossicular chain. Heterologous graft materials have also been used (Jansen, 1973; Siedentop, 1975). The exact choice of material used therefore rests on factors such as ease of handling the graft material at operation, access to the graft tissue, availability of stored material, whether or not a separate incision is required to obtain the graft material and so forth. In some centres, the autologous temporalis fascia is dehydrated to facilitate easy handling during application while others prefer to use fresh fascia. Shenoi (1982) has drawn attention to the gross alterations in biological characteristics of the protein matrix within the fascia when dehydrated by unphysiological heating. Walby et al (1982) observed the effects of surgical preparation of autologous temporalis fascia in tissue culture. Scraping loose connective tissue from the fascia or allowing it to dehydrate caused significant reduction in fibroblast growth in tissue culture, while both procedures completely abolished it. Until recently, the middle ear has been
regarded as a 'privileged site' for transplantation of allografts. However, Frootko (1985) has
demonstrated the rejection phenomenon in humans when heterologous dura was used in
myringoplasty despite alteration in its antigenic properties as a result of different methods of
storage. Kuipers, Veldman and van den Broek (1985) described the possibility of
immunotolerance within the middle ear in experimental animals to account for the success
following allograft tympanoplasty.

The exact position of the graft in relation to the perforation - onlay or underlay - has
attracted much discussion. Each method appears to have advantages and disadvantages. Thus
the onlay technique has to its credit the advantage of using a transcanal approach and
avoiding an external incision in smaller defects, is less time consuming, with both easier
preparation of the graft bed and subsequent application of the graft. Included among the
disadvantages of this technique are the risk of trapping squamous epithelium and consequent
cholesteatoma pearl formation, lateralization of the graft, anterior blunting and dermoid
inclusion when repairing an anterior perforation involving the fibrous annulus.

The advantages of the underlay technique include an opportunity to inspect and test
the mobility of the ossicular chain, the squamous epithelium of the meatal skin and drum
remnant remain lateral to the graft, any intratympanic adhesions preventing re-aeration of the
reconstructed tympanic cavity can be divided, and the procedure can be used in those whose
previous onlay operation has failed. Among the disadvantages are the risk of medial prolapse
of the graft, and retraction of the anterior edge.

The surgical approach in uncomplicated chronic suppurative otitis media depends on
the extent and the nature of the disease - the presence of active diffuse mucosal disease of
cholesteatoma or a small central perforation in an inactive ear, anatomical variations in the
mastoid segment and external ear. The following approaches have been widely used:

(1) transcanal

(2) endaural with or without mastoidectomy

(3) postaural with or without mastoidectomy; combined approach tympanoplasty (intact
canal wall tympanoplasty) with posterior tympanotomy

(4) circumferential tympanomastoid access.

Suggested line of surgical management in uncomplicated chronic suppurative otitis media

Tubotympanic disease with an anterior central or marginal perforation

A small anterior central perforation

A transcanal approach with an onlay technique may suffice. In the presence of an
exaggerated anterior canal hump, an endaural approach together with reduction of the hump
may be advisable or, alternatively, a postaural approach with an underlay technique.
Anterior marginal perforation would require an underlay technique with the anterior edge of the graft buried deep to the meatal skin to avoid dermoid formation (either endaural or postaural approach).

Central or posterior marginal perforation

A small central perforation may be treated by the transcanal route using an onlay technique, while large central and posterior marginal perforations are best dealt with by an underlay technique through either an endaural or postaural route. Sade et al (1981) have demonstrated damage to the ossicular chain in about 40% of patients with a posterior-superior perforation while only 3% with anterior perforation had damaged ossicles. Furthermore, the above authors recorded that the presence of active disease at surgery predisposed to a greater incidence of ossicular chain necrosis (45%) compared with those with dry ears (10.6%). The ossicular chain must be inspected in larger central and posterior marginal perforations.

Diffuse mucosal disease

Eradication of the disease from the mastoid and the middle ear is essential and involves mastoidectomy with tympanoplasty, either through an endaural or postaural approach.

Active disease in a modified radical mastoidectomy

It is estimated that up to 30% of the mastoid cavities following modified radical mastoidectomy continue to discharge despite aggressive local treatment (Janzen, 1981). Sade, Berco and Brown (1981) estimated cavity problems in about 20% of marsupialized mastoids. Furthermore, Sade et al (1982) have identified four factors which determine a dry cavity postoperatively:

1. small and medium-sized cavities are much more likely to be dry
2. height of facial ridge: a low or no ridge is associated with a greater incidence of a dry cavity
3. external auditory meatus: a larger meatal opening has a greater incidence of a dry cavity
4. the presence of air in the middle ear cavity, thereby excluding the eustachian tube opening from the cavity produced a drier cavity.

Rambo (1979) concluded that retained infected mucosa in the mastoid bowl predisposes to a discharging cavity.

The surgical management of a draining mastoid cavity therefore includes revision mastoidectomy with particular attention directed towards exenteration of all infected cells in the mastoid tip, Trautman's triangle, perifacial cells, retrosinus cells, cells in the root of zygoma, and perilabyrinthine cells followed by creating a low facial ridge, closing the perforation in the drum head and creating a meatoplasty. Obliteration of the mastoid cavity,
following the above procedure by a suitable soft tissue flap, helps to achieve a dry cavity (Palva, 1979; Smyth, 1980(iv); Bennett, 1981; Janzen, 1981).

Cholesteatoma

Surgery is the only mode of treatment for aural cholesteatoma except in those already identified as suitable, for differing reasons, for medical management. The principle is the same as that for a chronic discharging ear, that is eradication of the disease and converting a potentially dangerous to a relatively safe ear. The surgery of cholesteatoma has witnessed a profound change during the lifetime of some of our most eminent otologists. Earlier pioneers in the late 19th and early 20th century successfully achieved the principle of treatment by radical and modified radical mastoidectomy. With the introduction of the operating microscope the era of 'canal-up' (combined approach tympanoplasty with posterior tympanotomy) emerged. The rationale behind such a procedure was:

(1) to avoid an open cavity with its inherent problems of retention of epithelial debris and infection

(2) to facilitate functional reconstruction

(3) a hearing aid could be provided in a dry ear in those in whom it might still be needed.

However, as the long-term results of canal-up procedures began to emerge, it became evident that failure to eradicate the disease occurred in 13.43-36% of cases (residual disease) and with 5-13% showing recurrent disease (retraction pockets). Such results challenged the validity of this operation as a routine procedure in every ear with cholesteatoma (Wright, 1977; Charachon, 1978; Smyth, 1980(v); Sade, Berco and Brown, 1981; Sheehy and Robinson, 1982; Cody and McDonald, 1984; Sanna et al, 1984). Residual disease and recurrent disease are defined by Sheehy (1978a) as squamous epithelium left behind, either inadvertently or on purpose by the surgeon, and cholesteatoma developing in a retraction pocket in the epi- or mesotympanum, the facial recess, or from a graft failure respectively. Failure to eradicate the disease has led to the concept of staging the surgical procedure. During the first stage, an attempt is made to obtain a dry ear by removing the cholesteatoma followed by tympanoplasty. At the second stage, between 1 and 2 years later, the ear is re-explored and reconstruction of the sound transformation mechanism is attempted which, in effect, provides an opportunity to identify any residual disease. The canal-up approach requires an experienced operator who is well versed with the anatomy of the temporal bone and also patients who would be prepared to attend for long-term follow-up. The danger of atrophy of the posterior bony canal wall in the canal-up approach resulting ultimately in a retraction pocket has been highlighted by Sade, Berco and Brown (1981). Contraindications for the canal-up procedure have been summarized by Sheehy (1983) and include the only hearing ear, the presence of a labyrinthine fistula, extension of the cholesteatoma into an inaccessible area, and when the cholesteatoma has destroyed one-third or more of the posterior bony wall.
A further modification of the canal-up procedure has been described by Tos (1982) and consists of an extended atticotomy with reconstruction, for attic disease, and removal of the deep posterior meatal wall for access to the sinus tympani.

Due to the disappointing incidence rate of both residual and recurrent disease, there has been a shift of opinion in recent years towards the 'canal-down' procedure (modified radical mastoidectomy) combined with obliteration of the cavity and tymanoplasty (Smyth, 1980(vi); Smyth and Hassard, 1981; Sade, Berco and Brown, 1981; Ojala and Palva, 1982; Parisier et al, 1982; Sade et al. 1982; Hough, 1983; Palva, 1985). The incidence of failure to eradicate the disease varies from 4.7% to 13% (Sheehy and Patterson, 1967; Turner, 1970; Austin, 1976; Ojala and Palva, 1982). Smyth and Hassard (1981) reported no significant difference for residual disease in either of the procedures, although when the hearing gain is compared in canal up and down procedures, the results are superior in the canal-down procedure in the presence of a functional ossicular chain.

In summary, the choice of operative procedure in uncomplicated aural cholesteatoma depends to a large extent on the experience of the operator, the extent of the disease, the size of the mastoid bowl, the preoperative hearing, and whether or not the patient can be followed-up postoperatively.

**Retraction pockets**

Shallow posterior retraction pockets are best managed by periodic suction aspiration under the microscope in the outpatient department or office, as they are usually self-cleansing (Sade, Avraham and Brown, 1981; Sade, 1982). If they should become infected and fail to respond to medical management then surgical excision of the pocket followed by myringoplasty is indicated.

Deeper retraction pockets, particularly if they are persistently infected, call for surgery which usually involves excision of the deep pocket together with eradication of the squamous lining from the sinus tympani. Often there is associated osteitis of the deep posterior meatal margin, signalled by the presence of granulations, which requires removal of the deep posterior meatal margin (marginectomy). Reconstruction of the defect in the drum head and deep posterior meatal margin follows and a ventilation tube is inserted in the anterior quadrant of the tympanic membrane. At a second stage, a suitable ossiculoplasty is considered (Sade, Avraham and Brown, 1981; Sade, 1982).

The author has found the above approach both practical and satisfactory.

**Total obliteration of the mastoid and external auditory canal**

Total obliteration of mastoid, middle ear and the external auditory meatus has been employed as an effective alternative surgical procedure in the treatment of chronic discharging ear with or without cholesteatoma in highly selected patients (Rambo, 1958; Gacek, 1979; Schuknecht and Chandler, 1984). The indications for the procedure include an ear with absent auditory function; severe mental retardation preventing postoperative care of the cavity; and dural herniation with or without cerebrospinal fluid leakage (Schuknecht and Chandler, 1984). Contraindications include the possibility of residual cholesteatoma developing within the
cavity; the presence of osteonecrosis; and metabolic disorder such as diabetes mellitus (Gacek, 1979). Pedicled grafts and free abdominal fat grafts are used to obliterate the cavity. The results of the procedure in six patients showed no evidence of recurrence when seen between 5 and 10 years later (Gacek, 1979) and in a total of 44 cases spread over a period of 20 years, there was recurrence of cholesteatoma in 6% (Schuknecht and Chandler, 1984).

**Management of cholesteatoma in children**

Aural cholesteatoma in children is characterized by a rapidly growing disease which is much more extensive within a well pneumatized mastoid bowl when compared to adults (Jansen, 1978; Jahnke, 1982; Tos, 1983). There is some evidence to suggest that such a difference in behaviour may be related to the correlation between the bony growth and the formation of air-filled spaces (Wullstein, 1978). The incidence of aural cholesteatoma in children is much lower compared with adults; the ratio of adults to children is 5.6:1 (Sheehy, 1978b) and 4:1 (Tos, 1983).

The principles of surgical treatment are exactly the same as those in adults. However, based on the extensive nature of the disease in children, at least in some centres, a natural reluctance has emerged in performing a canal-up procedure. The advocates of the canal-up procedure claim that a canal-down approach would succeed in creating a large mastoid cavity with associated difficulties in postoperative management. A study of the results of the canal-up approach demonstrates a 51% incidence of residual disease, twice as high as that in the adult, in 82 children aged between 4 and 15 years, although the location of the residual disease and the hearing results were identical in the two groups (Sheehy, 1978b). The overall incidence of residual and recurrent disease (9% and 8%) and improvement in hearing was the same in both children and adults (Smyth, 1980(iii)), although in children who were included in a planned second stage of canal-up procedure, there was a significantly greater incidence of residual disease in the mesotympanum. Jansen (1978) reported an incidence of 7.5% recurrence with the canal-up approach. It is claimed that even if residual and recurrent disease should develop, no serious complication has been witnessed so far and that the recurrent disease would declare itself either by destroying the posterior canal wall or by forming a subperiosteal abscess. It is, however, widely accepted that if the canal-up approach is contemplated, it should be carried out as a two-stage planned procedure. Tos (1983) reporting on a long-term study of the modified canal-up procedure demonstrated a recurrence rate of 5% in his personal series, while 23% recurrence was observed if the procedure was carried out by his trainees.

Palva, Karja and Karaja (1977) using a canal-down approach and obliteration of the mastoid reported residual disease in 5%, and cavity problems in 8% of 65 children. Gristwood and Venables (1982) adopted a limited canal-down technique of atticotomy and antrotomy in 202 children and reported an incidence of 19% of residual disease at 10-year follow-up.

In summarizing the overall results of the two different approaches, it would therefore seem that the selection of any particular surgical procedure in children with aural cholesteatoma depends primarily on the training and experience of the operator and a need for long-term follow-up of patients. It is evident that if a canal-up approach is planned, it
should be staged. Eustachian tube function does not appear to influence the outcome of surgery (Sheehy, 1978b; Smyth, 1980(iii)).

**Cholesteatoma in the mesotympanum with an intact drum**

There is a good deal of speculation on the exact aetiology of this entity, although the congenital theory appears to have gained wide acceptance. The incidence of the disease is low; 3.7% was reported by House and Sheehy (1980) from a total of 1024 operative procedures for aural cholesteatoma. The disease is commonly observed in younger children and is characterized by the absence of symptoms except in a few in whom persistent conductive hearing loss is the presenting feature. Frequently, the only finding on examination of the ear is the presence of a whitish mass medial to the tympanic membrane. Tympanometry may suggest the presence of ossicular chain discontinuity. Diagnosis is confirmed at surgery and the type of surgical procedure depends on the extent of the disease varying from tympanotomy and enucleation of the cyst to both canal-up or down approaches (Derlacki, 1973; House and Sheehy, 1980; Cross, 1981; Sanna and Zini, 1984; Wang et al, 1984). An incidence of 19% residual disease following canal-up procedure was reported by House and Sheehy (1980).

**Functional reconstruction**

This is attempted to restore a conductive hearing loss caused both by perforation in the tympanic membrane and ossicular chain discontinuity. The former would have been corrected by successful closure of the drum head defect. There is an overwhelming view in favour of reconstructing the ossicular chain as a second-stage procedure, although a few surgeons favour primary reconstruction during closure of drum head defect, particularly if a composite homograft tympanic membrane with ossicles is used. A wide range of both natural and synthetic materials have been employed in the reconstructive techniques of the ossicular chain and varies from auto- and homograft ossicles, bone chips, and cartilage to synthetic biomedical plastics and ceramics with varying degrees of success depending on the nature of the ossicular chain defect. The reader is advised to consult the next chapter for details of reconstructive techniques.

**Complications of surgical management**

For a full list of complications following surgical management of chronic suppurative otitis media with or without cholesteatoma, the reader is advised to consult Chapter 12.

**Tuberculous otitis media**

The true incidence of tuberculous otitis media is unknown in view of the highly selected material in various reports. Lucente et al (1978) reported that tuberculosis still remains one of the most common lethal infectious disease in the USA. Tuberculosis of the middle ear and mastoid is estimated to be present in fewer than 1% of ears.

Tuberculosis is a rare disease among the indigenous population of the UK, although within the ethnic minority of Asian immigrants the incidence of non-respiratory tuberculosis is more than 50% higher than in the indigenous white population (National Survey of
Tuberculosis Notifications in England and Wales, 1978-79). It would appear from the literature that the clinical presentation of tuberculosis of the middle ear has altered over the last three to four decades and multiple perforations of the drum head which were thought to be the characteristic feature are no longer seen (Wallner, 1953; Lucente et al, 1978; Plester, Pusalkar and Steinbach, 1980; Windle-Taylor and Bailey, 1980; Glover, Tranter and Innes, 1981). The typical feature of the disease at presentation is profuse otorrhoea, most commonly painless (Wallner, 1953; Lucente et al, 1978; Windle-Taylor and Bailey, 1980; Glover, Tranter and Innes, 1981) but painful in a few (Plester, Pusalkar and Steinbach, 1980), which fails to respond to both topical and systemic antimicrobial therapy in combination with suction aspiration. In all patients there was a disproportionate hearing loss compared with the clinical findings and the majority had pale exuberant granulations. Complications were significantly higher (facial palsy, sensorineural hearing loss, labyrinthitis) when compared with non-cholesteatomatous suppurative otitis media.

The spread of the disease into the middle ear is thought to be either through the eustachian tube or haematogenous. In the majority of the above reports, the tympanic membrane demonstrated a single perforation and only one patient had two perforations.

Diagnosis is based upon a high index of suspicion and, in particular, a history of previous exposure to the disease or a past history of active disease. The presence of a discharging ear in a patient from the Asian ethnic minority should alert the clinician to the possibility of tuberculosis. Bacteriological culture is usually time consuming and Ziehl-Neelsen staining is unreliable. Final diagnosis is established by histology of the granulation tissue, which may need to be repeated.

The treatment is by modern antituberculous chemotherapy and usually involves a course of multiple chemotherapeutic agents to prevent development of resistance to the organisms. However, surgery may also be required, not only to remove sequestra but also to allow adequate drainage.

**Chronic suppurative otitis media: some unusual presentations**

**Immune deficiency**

Immune deficiency may be idiopathic or secondary to various immune depressant drugs when the host immune defence is deliberately compromised to prevent rejection of transplanted organs or as planned treatment in leukaemia.

The idiopathic group, of which hypogammaglobulinaemia is the best example, is characterized by a deficiency in the IgG fraction of serum globulin which often presents with recurrent upper respiratory tract infections and otitis media at an early age. In some of these patients, a chronic discharging ear could well be the sequel of such recurrent middle ear infections, a clinical dilemma also observed in IgA deficiency. If the condition is not recognized, all attempts of combined medical and surgical treatment will result in repeated failure. Recognition of such immune deficiencies is of paramount importance. Sasaki et al (1981) reported the management of chronic discharging ears in such patients and included:
(1) canal-up approach to minimize wound contamination

(2) if canal-down procedure is preferred, stabilization of the cavity is achieved by skin grafting

(3) appropriate correction of IgG and IgA fractions by pre- and postoperative replacement therapy guided by repeated plasma estimations of the above fractions

(4) bactericidal antimicrobial therapy during, pre- and postoperatively.

In the drug-induced immune deficient patient associated with chronic suppurative otitis media, where the patients are quite ill, the author has successfully carried out myringoplasty with an onlay technique under a local anaesthetic. Pre- and postoperative antibiotic cover was found to be essential.

Chronic ear disease is sometimes observed in Job's syndrome (also referred to in some centres as lazy leucocyte syndrome) and is associated with recurrent 'cold' staphylococcal abscesses, purulent nasal discharge and sinusitis, pulmonary infection and elevated IgE in peripheral blood. A defect in neutrophil granulocyte chemotaxis is thought to be the cause of recurrent infection (Davis, Schaller and Wedgwood, 1966).

**Wegener's granulomatosis**

Wegener's granulomatosis is characterized by the presence of granulomatous deposits in the upper and lower respiratory tracts together with multi-system involvement, particularly the kidneys. Histologically, it presents as a vasculitis with granulomatous changes and is thought to be a hypersensitivity disorder.

Middle ear infection, either as a primary or secondary involvement of the disease, has been described (Karmody, 1978). Secondary involvement is much more common and results from infection in the nasal fossa or the sinuses and commonly presents as middle ear effusion. Kornblut, Wolff and Fauci (1982) reported that 45% of 60 patients with Wegener's granulomatosis had either active or resolved infective aural pathology and a few had chronic suppurative otitis media with *Staphylococcus aureus* and *Pseudomonas aeruginosa* predominantly in the exudate. In one patient with chronic suppurative otitis media, surgery failed to control the disease until the underlying disorder was treated. In another, granulomata were discovered over the tympanic membrane; biopsy proved the diagnosis. Fauci et al (1983) described the largest series of prospective clinical and therapeutic trial in 85 patients with Wegener's granulomatosis followed-up for 21 years and nearly 30% had middle ear infections.

Diagnosis is established by being aware of the possibility of Wegener's granulomatosis in patients with recurrent middle ear infection/discharge associated with persistent mucopurulent rhinorrhoea and an elevated erythrocyte sedimentation rate (ESR). Final diagnosis is by histology on suspected lesions within the nose.

Treatment is by combination therapy with cyclophosphamide and prednisolone and details of the regimen have been fully described by Fauci et al (1983). Middle ear infection improves parallel with the response to systemic treatment.
**Histiocytosis X (Langerhans cell histiocytosis)**

Coutte et al (1984) reported 65 patients with histiocytosis X and recurrent otitis media was the presenting symptom in 10 children. Five children had aural polyps and nine had cholesteatoma on otoscopy. An elevated ESR was of particular significance in suspecting the disease; the diagnosis was made on biopsy. Treatment is by a combination of steroids and chemotherapy (vinblastine sulphate).