A CONTRIBUTION TO THE ETIO-PATHOGENESIS OF CHRONIC MIDDLE EAR EFFUSIONS.

by

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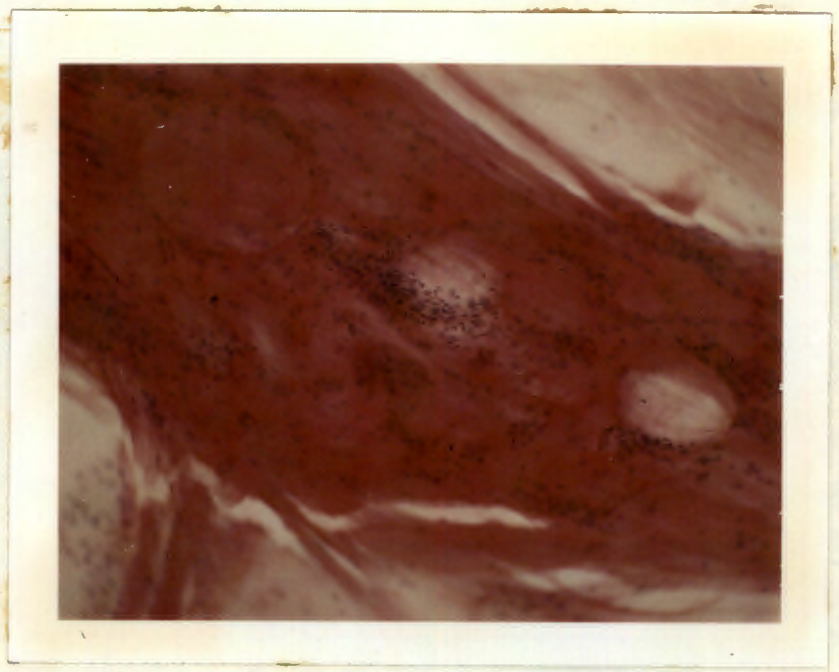


CYTOLOGY OF MIDDLE EAR FLUID.

Brightly staining mucicarmine positive material, probably mucous, trapping numerous histiocytic cells.

TO MY DAUGHTER RENATE, WHOSE OTALGIA

DURING INFANCY STIMULATED THIS ENQUIRY.

CONTENTS.

Historical note.

This is not a new disease. It was well described by otologists in the previous century. A German otologist, Kramer, in 1838, described the condition fully and clearly (Hoople and Bradley, 1959). He comments, "It is evidently of most frequent occurrence during moist autumns and springs and in moist climates, e.g. in sea towns from which places the greater part of those patients have come to me. Under these circumstances, I cannot understand how the so-called English aurists, who must very frequently meet with the disease in a foggy city like London, should have scarcely any notion of the proper diagnosis of the complaints, and still less of any rational mode of treatment."

Politzer in 1869 gave a very full description of catarrhal otitis media. He considered it a common condition and described a vulcanite eyelet for insertion after myringotomy. He commented that it failed to keep the incision open like the aluminium or gold cannulas recommended by Voltolini, or the whalebone pegs, lead wires and silver cannulas of Bonnafont. James Hinton in 1874, published his Atlas of the Membrane Tympani with

CHAPTER I.

Introduction.

One will be forgiven if one adds another term to the long list of names purporting to describe the same condition. Some of the names appearing in the literature of the past ten years are:-

Sterile otitis media.
Hydrotympanum (Harcourt and Brown).
Glue ear.
Indolent otitis media (Fishman et al).
Serous otitis media.
Non-suppurative otitis media.
Catarrhal otitis media.
Transudative otitis media.
Mucinous otitis media.
Allergic otitis media (Shambaugh).
Unresolved otitis media (Goodhill).
Transudatory secretory otitis media (Bendek).
Tubotympanitis (Senturia).
Chronic viscous middle ear effusion.
A recent addition is 'the atelectatic ear'
(Round Table discussion: Third Workshop on Microsurgery of the Ear. Arch. Otolaryng. 89: 199, 1969).

This surely signifies the existing confusion regarding the true nature of this condition, what it really constitutes, what the sequelae are and what its pathology is.

beautiful illustrations of secretory catarrh.

As long ago as 1891, St.John Roosa stated "after many years of careful study of diseases of the ear, I think it may be said there are but two classes of cases of aural disease in which we may not expect very good results from treatment and care. Nearly all others are singularly treatable when their course is properly regulated. By these two classes I mean chronic non-suppurative inflammation of the middle ear and the affections of the labyrinth or internal ear." This thesis is confined to the study of the former group.

We are still more or less where we were 12 years ago when Bateman said "Secretory otitis media is to me a clinical entity rather than a pathological definition. I do not know the pathology ..... in time the nature of the disorder will be understood, but at present the etiology and the pathology are relatively unexplored and yet to be investigated by modern pathological techniques."

Only two facts were clear at the outset of this study, namely that it was a very common condition and that the treatment was very uncertain, with frequent relapse.

Some sort of discipline is necessary when discussing this disease. Certainly not all conductive deafness in childhood, even that associated with upper respiratory infections, is necessarily secretory otitis media. Senturia (1963) feels that a varied pattern of chronic ear disease, probably of widely different etiology, is included by these terms. In order to discuss intelligently the clinical and pathological picture seen in this group of diseases, it is necessary to agree on nomenclature. Senturia suggests that all middle ear effusions be grouped under a general term - otitis media with effusion - until such time as we understand the pathogenesis of the many varieties of effusions.

For the purpose of this study, I defined 'secretory otitis media' as a chronic conductive deafness occurring almost exclusively in childhood, characterised by an effusion in the tympanum, usually of high viscosity. There is immediate relief of symptoms after myringotomy and aspiration but a very great tendency to relapse.

It is suggested that this disease be called chronic middle ear effusion in childhood. This will be motivated clinically, pathologically and biochemically

towards the end of this thesis.

Chalat (1966) mentions 7 factors as affecting our uncertain approach to the patient with secretory otitis media:-

1. The diagnosis may not be easy.
2. The exact pathologic mechanisms creating the disease are obscure.
3. The associated hearing phenomena are poorly understood.
4. There is lack of uniformity in accepted treatment.
5. Unpredictable prognosis.
6. The unexplained increased incidence. This is the most common abnormality seen by otologists in the paediatric patient.
7. Prevention is likely to be impossible.

What about the etiology? The most widely prevailing concept is that of tubal occlusion with a resultant 'hydrops ex vacuo'. The Holmgren's in Sweden, were great protagonists of this theory in the 1930's. They were spiritedly opposed by Blegvad (1932, 1941). He pointed out that the tube is never completely occluded

and may be readily inflated with Politzer's method. He believed the effusion found by Holmgren was an inflammatory reaction to the operative trauma.

Shambaugh (1967) firmly accepts allergy as being the basic etiology. Other authors such as Dohlmann (1943), Jordan (1949), Solow (1958) and Derlacki (1951) concur. This is not borne out clinically and pathologically (Robison and Nicholas, 1951; Suehs, 1952; Ivstam, 1954) and by one's own observations reported later.

An infectious origin of the fluid was unlikely because bacterial cultures were consistently negative. Viral etiology was not convincingly disproved and needed further investigation. Further, the apparent recent increase in secretory otitis media was thought to be due to the introduction of antibiotics.

What was the significance of the eustachian tube? Shambaugh (1963) called this one of the unsolved problems of otology.

Secretory catarrh is believed to be such a serious problem that Gordon Hoople (1950) termed it "a challenge to otolaryngology".

It was decided to conduct an investigation along the following lines:-

a) To collect a clinical series to aid in the definition and description of a clinical entity which is a potent cause of deafness in children. At the same time, various forms of therapy could be investigated.

b) Investigate the basic pathology by histological, cytological and radiographic methods.

c) Investigate the function of the eustachian tube and the patho-physiology of the middle ear clearance mechanism.

d) Determine whether viruses or mycoplasma were etiologically involved.

e) Formulate an acceptable concept explaining the various features of this disease.

CHAPTER II.

CLINICAL PICTURE. ANALYSIS OF A CLINICAL SERIES OF 100 CASES.

There has been increased awareness of this disease on the part of otologists the world over in the last decade. The symptoms are vague, protean or meagre, the signs obscure and difficult to elicit. It is therefore a diagnosis for the specialist, but a high index of suspicion should be cultivated in the general practitioner, primary school teachers and speech therapists, and even the general public.

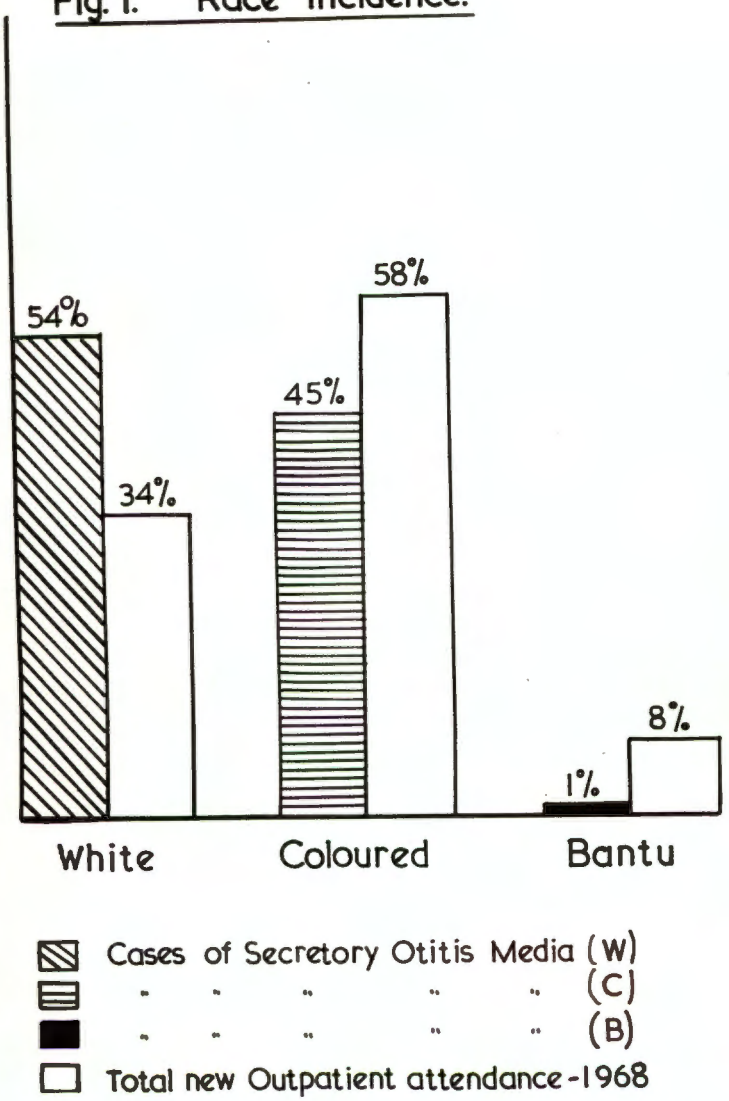
Incidence.

There has been a fairly generalised impression among otologists in all parts of the globe that secretory otitis media has become a much more common condition since the early 'fifties. This has been blamed on the advent of antibiotics. The evidence is, however, purely circumstantial and the increase could, with equally unsound scientific foundation, be blamed on such developments of the same period as atomic bombs, supersonic flight, etc.

Two factors can explain this apparent increase in prevalence in serous otitis media, namely the previously noted increased awareness on the part of otolaryngologists and secondly, that the introduction of antibiotics has almost eradicated the serious acute infections of the middle ear cleft and its complications, thus leaving us to behold and contemplate the non-serious, non-dramatic conditions. These cases were probably not taken seriously previously, being dismissed as tubal catarrh or allergy.

We do know that it is a very common condition. Chronic middle ear effusions are seen every day in the outpatient departments of the hospitals and in the offices of every otologist. Myringotomy was performed for this condition on 236 patients and grommet tubes were inserted in 174 patients in Groote Schuur Hospital during 1968 alone. To obtain a clearer picture of the incidence locally, it is intended to survey a few thousand children in Cape Town primary schools by audiometry. The schools will be selected to cover various socio-economic and race groups. Falbe-Hansen (1954) examined 2550 pupils in 4 Copenhagen schools. Two hundred and ninety five (12%)

Fig. 1. Race Incidence.



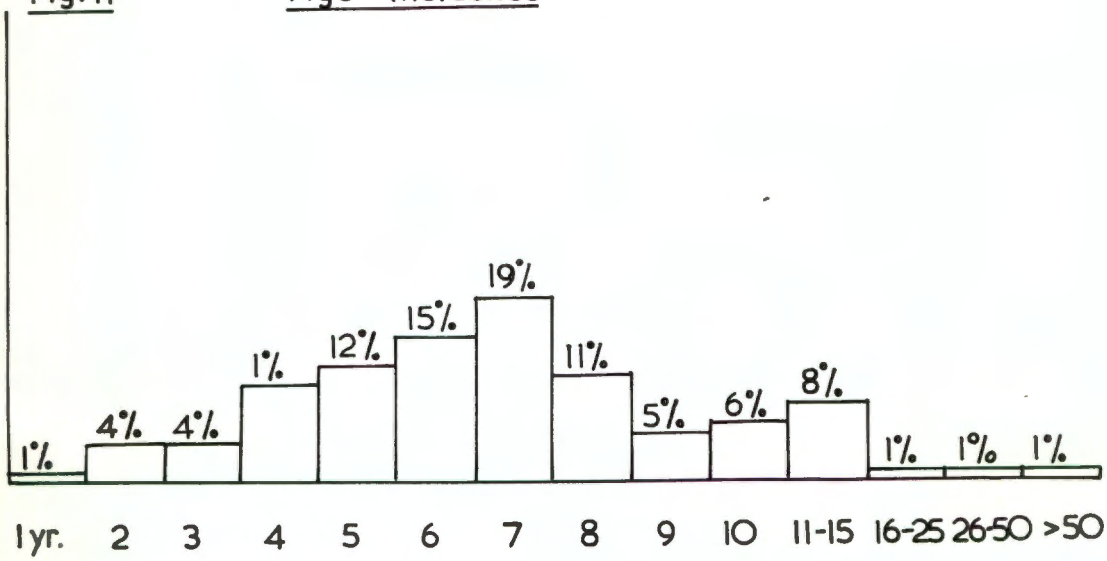
had hearing defects. Secretory otitis media constituted by far the larger proportion of these children. Hoople (1956) considered that secretory otitis media was found in 3-4% of all ear, nose and throat patients. Malcomson (1963) found deafness due to effusion in 10% of all children admitted for removal of tonsils and/or adenoids.

Race Incidence.

In this series of 100 unselected patients seen in Groote Schuur Hospital Outpatient Department during 1968, the race distribution is shown in Fig.1. The most striking feature here is the almost complete absence of Bantu patients suffering from secretory otitis media. This aspect is intriguing and will certainly be investigated further. This hospital serves a large Bantu community and on the basis of population one would have expected a far larger percentage than the one solitary Bantu representative. Is there a difference in tubal structure and function? This is a distinct possibility that should be followed up.

Taking into consideration the total outpatient attendance, the incidence is highest in the Whites and lowest in the Bantu, with the Coloureds in an intermediate

Fig. 11 Age Incidence



position. This also corresponds broadly to the socio-economic status of these groups. The symptomatology of middle ear effusions is not urgent or severe and it could easily be ignored or overlooked by many people. Jarvis (1965) found no correlation between nasal morphology and vasomotor rhinitis or sinusitis, but there was a correlation in the case of atrophic rhinitis. In an interesting study he calculated the nasal index (the percentage ratio of the nasal breadth to the nasal height) for the various racial groups:

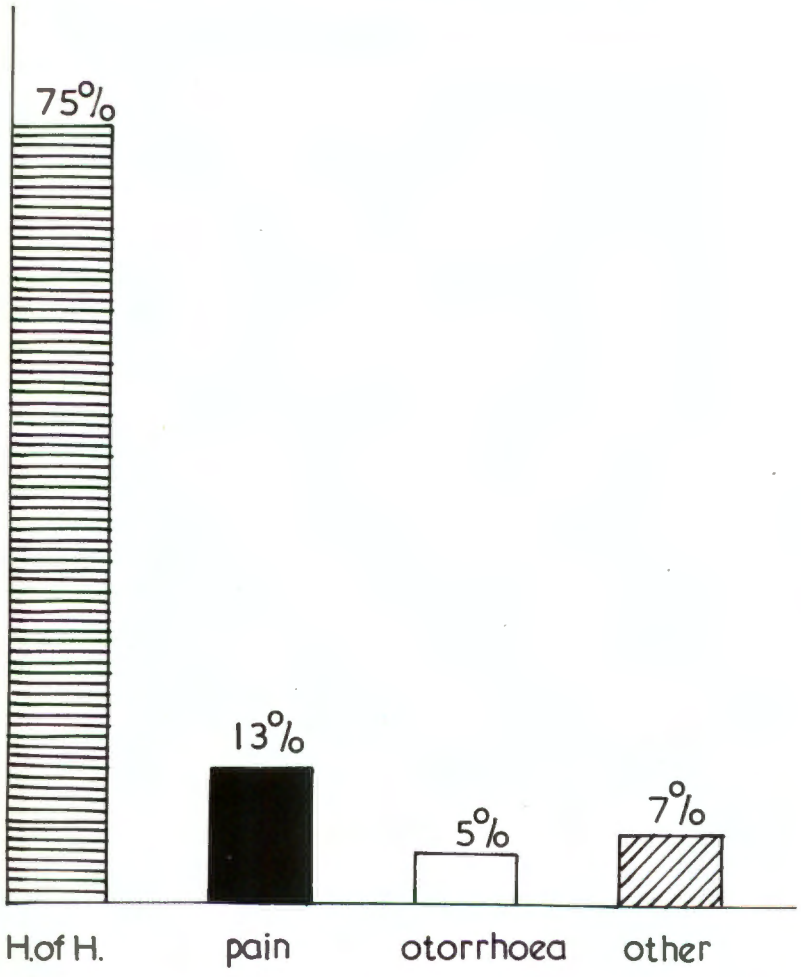
European	67
Coloured	81
Bantu	95

This aspect, together with tubal morphology, requires further elucidation.

Age Incidence.

This is undoubtedly a disease of childhood, 89% of our cases having presented before the 11th year and 97% before the age of 16. (Fig. II) The peak years are from 4 to the 8th year, this period accounting for 67% of all cases. The 7th year stands out with 19% of cases. This is due in large measure to the awareness of school teachers and the efforts of speech therapists who routinely visit the schools. One can only surmise

Fig. III Presenting Symptoms



as to the numbers that still go undetected.

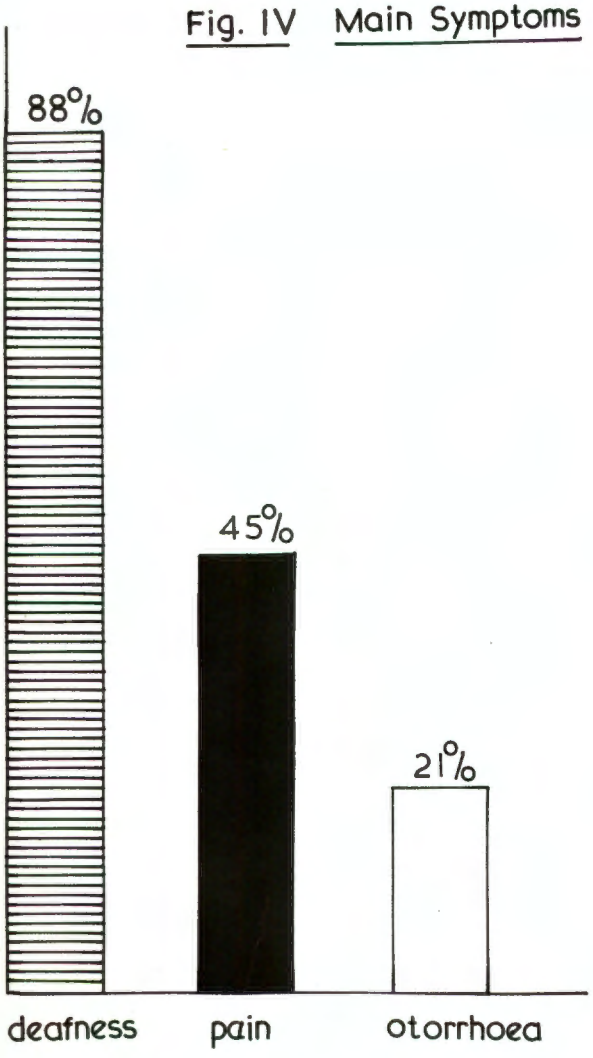
The age groups 16-25, 26-50 and above 50 are each represented by 1 patient. The oldest patient being a 72 year old Coloured male. For the purpose of this study the age was taken at onset or probable onset of symptoms and not when the child was brought for medical attention. These two events may be many months or even years apart.

In three-quarters of cases the symptom eventually bringing the child to the specialist will be some degree of deafness. In only 13% was the main complaint pain and 5 patients presented themselves because of intermittent otorrhoea. The remaining 7 patients had secretory otitis media as an incidental finding. They presented with frequent upper respiratory infections, recurrent sore throat, blocked nose and tinnitus. (Fig.III).

Symptoms.

Direct questioning elicited deafness as a symptom in 88% of patients. Frequently the parents were unaware or uncertain of the defect, but the child having entered school was not progressing satisfactorily or the speech was poor. The speech therapist was consulted who discovered the hearing loss.

Fig. IV Main Symptoms



Many intelligent children compensate well for their defect and go undetected. Their performance could be even further improved if their hearing defect was corrected.

Pain.

Forty-five per cent had pain at some stage over the years. Usually the pain is not very severe and intractable, but of a mild and intermittent nature effectively relieved by aspirin. This is often precipitated by an upper respiratory infection and accompanied by increased deafness.

Otorrhoea.

Twenty-one patients had otorrhoea either at the onset or at some stage during the course of the disease. The otorrhoea is mucoid or mucopurulent in character and frequently shortlived. (Fig.IV).

Other Symptoms.

Occasionally a patient may complain of tinnitus, dizziness or echoing of his own voice in his head. Other non-otologic symptoms complained of were frequent upper respiratory infections 32%, nasal obstruction 37%, recurrent tonsillitis 17%.

Allergy and Antibiotics.

The vexed question regarding the etiologic importance of allergy and antibiotics plague the otologic literature. An attempt was made to assess the role of these two factors in the causation of secretory otitis media.

Allergy.

Each child and its parents were carefully questioned regarding the presence of allergic symptoms in either parent or other siblings. If none were volunteered, specific questions were directed towards such conditions as asthma, hayfever and skin rashes. An allergy was subjectively diagnosed in the families of only 3 patients and in only 5 patients themselves was there a reasonably certain history of some manifestation of allergy.

This extremely low incidence will be correlated with the findings on the cytology of the middle ear fluids and the histology of the middle ear mucosa and contrasted with widely held beliefs. (Koch, 1947; Jordan, 1949; Derlacki, 1951; Solow, 1958; Lecks, 1961; Shambaugh, 1967). This incidence of allergy (5%) is probably about that of

the general population of Cape Town and lower than that estimated for the general population of the United States (+ 10%).

On the basis of this study, allergy will be completely rejected as of etiologic significance in secretory otitis media.

Antibiotics.

The apparent increase in secretory otitis media noted by surgeons all over the world coincided with the widespread introduction of antibiotics. Added to this it was noted that the effusions were overwhelmingly sterile. Thus it was reasoned that this represents the stasis but not resolution of an infective process by inappropriate antibiotic therapy or by insufficient dosage of the appropriate antibiotic. (Suehs, 1952; Singleton, 1956; Woodward, 1956).

All the patients in this series were carefully questioned on whether they had received antibiotics during the preceding 3 years. Most patients understood exactly what antibiotics were, but those from the poorer socio-economic strata were asked first of all whether they had taken drugs such as penicillin, terramycin. If they were

not absolutely certain, they were asked whether they had visited any private doctor, any clinic or health centre or any hospital out-patient department during the past 3 years.

In this manner one had no difficulty in establishing that 92% had not been exposed to antibiotics to any significant degree. Only 6% had prolonged exposure and 2% were doubtful and were also grouped with the antibiotic exposed group. Kersley and Wickham (1966) conclude that there is nothing to suggest in their series (over 200 cases) that inadequate antibiotic treatment of acute otitis media is an etiological factor in the deafness of exudative otitis.

Thus it is unequivocally concluded that the exhibition of antibiotics does not significantly contribute to the prevalence of serous otitis media as seen in Cape Town.

Clinical Examination.

The clinical features of the disease are well documented and will not be elaborated upon. A few salient points will be emphasized.

Kenneth Harrison (1967) notes that there is increased desquamation of epithelium from the surface of the tympanic membrane due to the stimulating effect of the secretory otitis media on the squamous epithelium. His description of the drumhead cannot be improved upon and will be given verbatim.

"At an early stage the skin epithelium has a crinkly, silvery appearance and dry desquamation may be seen. The desquamation may mix with wax or become soggy and whitish and when removed the skin underneath is reddish and moist.

The tympanic membrane may show only injection of the annular and radial blood vessels and a faint yellowish hue. There is often bulging of the posterior part of the tympanic membrane because of effusion.

One commonly sees collapse of the membrana flaccida and part of the posterior membrana tensa. Sometimes the whole tympanic membrane is gossamer like in texture and quite lax, lying collapsed against the medial wall of the middle ear. The tympanic membrane then appears very thin, revealing the middle ear structures. The cause of the thinning is obscure. Politzer (1867) stated that

atrophy had taken place. Other authorities have stated that the middle coat of the tympanic membrane has been destroyed. When recovery takes place the tympanic membrane is seen to be within normal limits."

He also mentions the 'blue-drum'. This is an advanced stage with velvety granulations in the hypotympanum, the histology being cholesterol granuloma.

Probably the most important physical feature is the reduced mobility and the sluggishness of the tympanic membrane when examined through the Siegle pneumatic speculum. This is a constant finding and one can categorically state that there cannot be an effusion in the face of normal mobility. The converse is not necessarily true. In the presence of an effusion there is always some degree of sluggishness, but sluggishness does not always indicate an effusion. Chalat (1966) complains that even with the help of the binocular operating microscope at the time of surgery he was not always certain of the presence of fluid. This is so because fluid cannot often be seen, a fluid line and bubbles being rare in this condition. He would have been much more certain of his diagnosis had he used a pneumatic speculum at the clinical examination.

SECRETORY OTITIS MEDIA.

1. Name: _____ Age _____ Race _____ Sex __ Folder No: _____
   Address: _____

2. HISTORY:
   Family: _____ Personal: _____
   Presenting Symptoms: _____ Onset: _____
   Allergy: _____
   Antibiotics: _____
   Symptoms:- Deafness: _____ Pain: _____
   Otorrhoea: _____
   Upper Resp.Infection _____ Nasal Obstr. _____ T^S + A^S _____

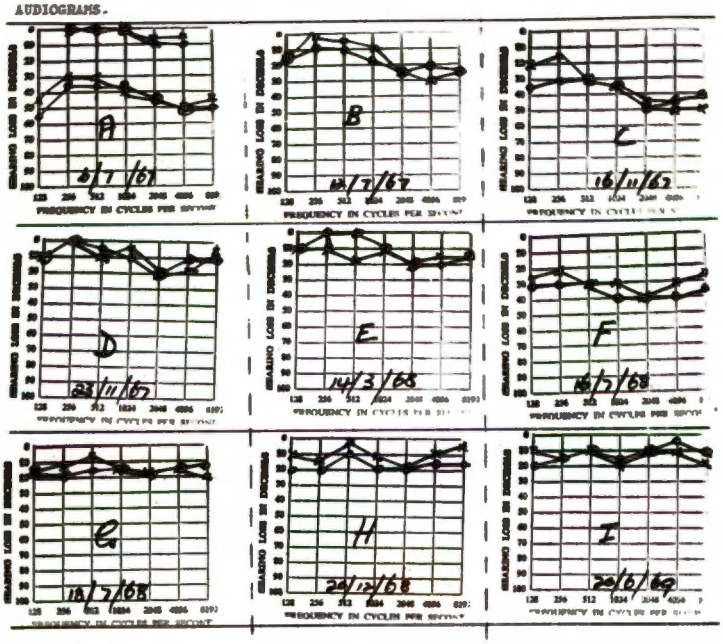
3. EXAMINATION:
   (a) T.M. Appearance of drum: _____ (b) Other- especially A^S _____
   Mobility: _____
   Fluid: _____
   T.Fork Tests: _____

4. SPECIAL EXAMINATIONS:
   (a) X-Rays - Mastoids _____ (d) Other _____
   Sinuses _____ (e) Throat Swab _____
   P.N.S. _____ (f) Immune Globulins _____
   (b) Clearance Studies _____ (g) Serum Proteins _____
   (c) Fluid: Smear _____
   Biochemistry _____
   Bacteriology _____

5. TREATMENT:
   A^S _____
   Myringotomy: 1. _____ 2. _____
   3. _____ 4. _____
   5. _____
   S.G. Tubes: _____
   Mastoidectomy: _____ Other: _____

Pro forma as utilised for this clinical series. (above)
Audiograms are recorded on the converse side of the form.
(see below)

AUDIOGRAMS.



A. 6.7.67
A-B gap in excess of 30 db.

B. 12/7/67.
Prompt improvement after myringotomy.

C. 16/11/67.
Gradual relapse.

D. 23/11/67.
Grommets inserted.

E. 14/3/68.
Grommets rejected.

F. 16/7/68.
Effusions recurred.

G. 18/7/68.
Grommets re-inserted.

H. 20/12/68. Grommets rejected.

I. 20/6/69.
Hearing maintained 6 months later.
Fully mobile tympanic membranes.
Considered to be cured.

Special Investigations.

Far and away the most important is audiometry. This is a simple investigation in a child of 3 years and upwards, and is done at the time of the first consultation. Audiometric examinations are repeated at intervals to assess the status of the middle ear and the efficacy of treatment.

I have found this a very reliable pointer and it has become one of the cornerstones in the diagnosis and management. I do not agree with Brooks (1968) who found pure tone audiometry not reliable because he could not regard a particular level as critical. He prefers compliance tests with the acoustic impedance meter "because it is objective and simple".

Surgical treatment is not indicated if there is less than a 20-25 db AB gap. It is very doubtful that one will find fluid under those conditions.

A hearing loss greater than 25 db is very strong evidence for the presence of fluid and surgical treatment is inevitable.

A.C. a White boy aged 9, Hospital No.200171 is a typical example. (See pro forma opposite).

Our audiograms have been recorded by four different audiometricians employing a Madsen OB 60 or an Amplivox 83, both calibrated to ISO standards. Results have been uniformly consistent.

The recordings obtained have been reliable and consistent with the clinical findings.

We have not observed the superior hearing phenomenon described by Barany (1910) and mentioned by Chalat (1966). This is an audiometric finding that many children hear at -15 to -20 db by bone conduction. This implies that children within the normal range AC hearing may have significant AB gap.

X-ray Examination.

Conventional x-rays of the mastoids were done in 68 patients. The standard views done were Townes, basal, Schüllers and Stenvers.

This is the largest and most exhaustive series reported anywhere and the results and conclusions are discussed in a separate chapter. It showed an almost uniform small contracted infantile mastoid air-cell system in the affected ear.

Sinuses and post nasal space were x-rayed when

deemed necessary. This showed a surprisingly low incidence of sinusitis, only 4% having pus or mucoid material at antrum puncture. This agrees very closely with the findings of Kersley and Wickham (1966).

Clearance studies of the middle ear by a system called tympanography was performed in a series of 37 patients. The object was to demonstrate:

a) eustachian tube obstruction or otherwise, and

b) the physiologic clearance mechanism of the middle ear.

The conclusions are reported in the appropriate chapters.

Fluid studies.

Fluid aspirated with the specially designed suction apparatus (Fig.XIV) was subjected to various tests.

Smears were made on glass slides, immediately fixed with Papanicolaou fixative and stained for cytology.

Thirty-three middle ear aspirates were cultured for mycoplasmas and viruses; 10 pharyngeal swabs and 9 specimens of adenoidal tissue were cultured for mycoplasmas.

Biochemistry was not attempted on the specimens as it is considered to have been done adequately by other workers.

Very little is known of the histology of chronic middle ear effusion in children. Specimens are very difficult to obtain, but 12 satisfactory pieces of tissue were obtained for histologic study.

The blood serum electrophoretic pattern was examined in 6 cases. All showed a normal pattern.

Treatment.

a. Medical.

Medical treatment as definitive treatment is only given in cases of a mild nature, i.e. with a hearing loss of 20 db and less, and a very short history. In other words, where one is not convinced of the presence of fluid.

Medical treatment is always given as an adjunct to surgical treatment. It consists mainly of decongestant therapy, and if necessary, antibiotics.

If used at all, decongestants should be administered vigorously. Ephedrine 0.5% in normal saline nasal drops should be taken liberally 6 times a day. If the nose is blocked, one administration should be followed a few minutes later by a second dose. The first decongests the nose and the second penetrates to the post nasal space.

Systemic decongestants such as eskornade or actifed are given concommitantly.

If there is evidence of infection such as rhinitis, pharyngitis, sinusitis, tonsillitis, an attempt should be made to culture the organism and establish antibiotic sensitivity. In general, antibiotics do not influence the course of secretory otitis media.

During this period of conservative treatment the patient is instructed and encouraged to perform the Valsalva manoeuvre at regular intervals. Definite rules should be made, such as auto-inflation 6 times per day 5 minutes after instillation of the nose drops.

The believers in allergy as the fundamental cause search for the allergen, desensitize and give prolonged antihistamine treatment - up to 2 years. (Dohlmann, 1943; Jordan, 1949; Derlacki, 1951; Solow, 1958; Weekes, 1958; Shambaugh, 1967). These authors have all assumed an allergic etiology. No one has ever presented pathologic evidence to justify this assumption.

On the same tenous basis corticosteroids have been given systemically for this eventual benign disease. (Heisse, 1963; Oppenheimer, 1968). This form of maltreatment must be strongly condemned.

Davidson (1958) states that 11% of his patients had definite hypothyroidism and were given tri-iodothyronine. Nine per cent were overweight and improved after weight reduction.

In cases with low gamma globulin levels, gamma globulin is given by intramuscular injection.

b. Surgical treatment.

Paracentesis is indicated in all but the mildest cases. If fluid is suspected and the air bone gap is 25 db or more, surgery is a sine qua non.

A general anaesthetic is administered through an endotracheal tube. The post nasal space is digitally examined even though the adenoids might have been removed previously. Any adenoid pad is curetted away. Special care is devoted to the lymphoid tissue around the tubal opening. In 40 cases in this series, the adenoids were removed at the time of myringotomy. In 9 cases it had already been done previously and another 5 had to be redone.

The tonsils are also removed if indicated and antrum lavage performed if the physical and x-ray examination warrant it.

So far, the views expressed are almost universally

accepted. The object of surgery is to eradicate upper respiratory tract infections and promote aeration of the middle ear cavity. (Theobald, 1958; Lemon, 1962; Carter, 1963; House et al., 1964; Kersley and Wickham, 1966). However, when the middle ear itself is approached the uncertainties arise, although all workers will agree that myringotomy and aspiration of the fluid will almost immediately result in a gratifying improvement in hearing.

Technique.

The Zeiss binocular microscope is placed at the head of the operating table and the patient's head turned to one side. The ear is draped with a sterile towel. No skin disinfectants such as hibitane are used in the preparation of the external auditory meatus. The canal is filled with normal saline and this is removed by suction. Wax and skin debris is also sucked out or removed with crocodile forceps. Skin antiseptics were initially excluded because small droplets would inevitably remain behind and become admixed with the aspirate and interfere with virus and bacteriology studies. One feared contamination by skin flora but results proved very enlightening. We were congratulated by the bacteriologist on the sterility of our specimens! Only twice did they grow fungus.

With a Politzer myringtome under 10 x magnification, a preferably small myringotomy is made. The site chosen is that which is the easiest to see and the easiest in which to insert a ventilation tube. This is the anterior inferior quadrant which is at a right angle to one's vision and where the light cone would be if present.

It was soon found that in the generally accepted site - the posterior inferior quadrant - it would be very difficult to insert a teflon button, due to the slope of the tympanic membrane in that area.

Sometimes the bony anterior canal wall bulges into the lumen and obstructs the view of the site of predilection. At other times, in very advanced cases with severe atrophy of the middle layer of the tympanic membrane, the latter lies collapsed against the promontory and other middle ear structures. There is thus no cavity to cut into, only a thin, flimsy, mobile membrane draping bony protuberances. In this case one searches carefully for any pocket in the middle ear. It has always been possible to find some small cavity and a degree of elasticity in the tympanic membrane far anteriorly, near the rim, either inferiorly or superiorly. The myringotomy is then done in this site.

The Effusion.

As observed by Jacob Sade (1966), we found that the fluid usually welled up out of the incision indicating that at this stage there is no negative pressure. The character varies from a thin, serous, amber coloured fluid through a tenacious viscid whitish mucopurulent effusion, to a rubbery semi-solid jelly that cannot go through the most efficient suction apparatus. It has to be removed piecemeal in a combined operation with cupped forceps and suction. The latter is so thick that it can best be fixed in formalin and sectioned for examination of the cell content rather than spread on a slide for cytological examination à la Papanicolaou.

At this stage our special suction apparatus with the trapping cup is attached. The incision in the tympanic membrane is the correct size when it barely admits the largest of the suction tips. Contact is avoided between meatal skin and suction tip to minimise contamination.

To facilitate removal of the very viscid secretions, various plans have been devised, such as the injection of alpha chrymotrypsin (Coyas, 1963; Mawson, 1967), or urea (Bauer, 1968) into the tympanic cavity. Liquefaction is

supposed to result in more complete removal.

Our objection against this method is that even in the unlikely event of this effecting a complete removal, it still does not prevent the reaccumulation of effusion.

Most surgeons consider myringotomy and aspiration as adequate treatment (de Villiers, 1968; Dickie-Clarke, 1968; Chalat, 1966). Scrutiny of the results of treatment in the present series shows that 18 patients had myringotomy, 3 were cured, 14 were not cured and in one the outcome was still uncertain. Nine patients had 2 myringotomies performed and none were cured. Four patients had a third myringotomy done, one was cured and 3 were not cured. Seven patients had 4 or more myringotomies, 2 were cured and 5 were as bad as ever.

Overall, 38 patients were treated by myringotomy or repeated myringotomy, resulting in only 6 cures with 31 definitely not improved and one doubtful result. (See Table I). A cure is defined as normal hearing or air conduction within 10 db of bone conduction, and a mobile tympanic membrane after at least 6 months have elapsed after myringotomy and aspiration, or since rejection of the grommet tube,if used.

Table I. Results

Myringotomy	Cured	Not Improved	Uncertain	Total
First	3	14	1	18
Second	0	9	0	9
Third	1	3	0	4
Fourth or more	2	5	0	7
	6	31	1	38
	15.7%	81.5%	2.7%	100%

The next group comprises 52 patients who had as a primary surgical procedure the insertion of a grommet ventilation tube. The results were 36.5% cured, 27% not improved, and in another 36.5% of cases the outcome could not yet be assessed as they either still had their tubes in or insufficient time had elapsed since rejection of the tubes.

Table II. Primary Insertion of Shepard's Tube.

Cured	Not Improved	Uncertain	Total
19	14	19	52
36.5%	27%	36.5%	100%

The successful group of 36.5% can only further improve as time goes by due to cases in the uncertain group crystallising into cured cases. Hypothetically the cure rate may eventually rise to 73%.

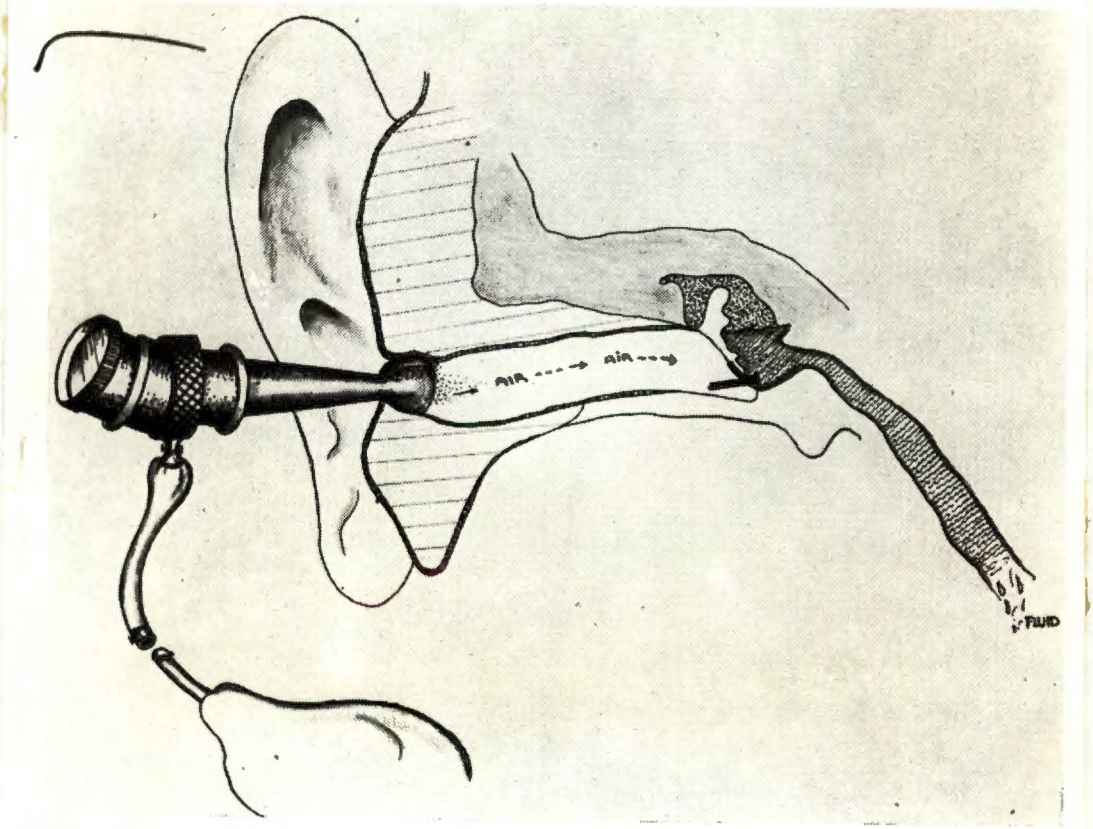


FIG. V. (After Feuerstein). This most important step clears the blocked eustachian tube and is repeated at each post-operative visit. Considered a dangerous procedure by some (Mawson, S.R. and Brennand, J., Proc. Roy.Soc.Med.(1969), 62, 460) after a fatality in Scandinavia. In the E.N.T. Department, Groote Schuur Hospital, this procedure has been used in literally thousands of cases without ill effect and is therefore considered perfectly safe.

The final group consists of patients who previously had had either one or more myringotomies, or one or more insertions of grommet tubes. Of 34 patients, 4 (11.7%) were assessed as cured, 6 (17.6%) had relapsed, while 24 (70.7%) were still uncertain as to their outcome.

Table III. Secondary Insertion of Shepard's tube.

Cured	Relapsed	Uncertain	Total
4	6	24	34
11.7%	17.6%	70.7%	100%

Although the present cure rate in this group is only 11.7% the theoretical maximum is 82.4%. On the other hand, with 17.6% definitely relapsed, the potential relapse rate is 88.3%.

It is obvious that the present series needs much longer observation.

At operation a reasonable attempt is made to aspirate most of the exudate. We do not believe liquefying agents or a second myringotomy incision is indicated to effect more complete removal. No method will clear it completely. It is most important to clear the eustachian tube by reverse politzerisation. (Fig. V). The external meatus is then half filled with an antibiotic/steroid solution and this is also insufflated. It will never displace a properly placed tube.

Post-operative Treatment.

Insufflation is repeated at each post-operative visit where it also serves to confirm that the tube is still in situ and patent. The visits are mostly every 2-4 weeks, depending upon circumstances. Later visits may be at 3 monthly intervals. Decongestants and antibiotics are given only when indicated.

At this stage important conclusions have been reached:-

1. The first is that myringotomy alone is a very poor treatment. Seven patients in this group had 4 or more myringotomies but the relapse rate was still a staggering 81.5%.

2. The best results were obtained where Shepard's grommet tubes were inserted as a primary procedure at the time of the first myringotomy. Here the cure rate is 36.5% with a theoretical optimum cure rate of 73%.

3. The third group, where a teflon tube was inserted only after failure of previous myringotomy or a previous tube, appear to have an outlook midway between the first two groups.

4. Archard (1967) concluded that simple myringotomy and suction is valueless and also harmless as a form of treatment. Our findings indicate a different conclusion. Simple myringotomy is a harmful procedure as it has an 81.5% failure rate, even after repeated myringotomies which push the patient into the third group with an 88.3% potential relapse rate.

One therefore feels strongly that at the first procedure a teflon vent should be inserted.

Why should a simple myringotomy be harmful? The surgical procedure in itself cannot be harmful. The explanation is probably because so many months go by before relapse is again diagnosed. During this time the disease has become much more established, the changes in the mucosa much more marked and chronic (fibrosis, thickening and gland formation) and eustachian tube function much more impaired. It is evident that a further myringotomy or insertion of a tube at this stage has a greater likelihood of failure.

Other Surgical Measures.

Cortical mastoidectomy or tympanotomy has been advocated by various authors (Hitschler, 1955; Thomson, 1963; Mawson, 1964; Korthals Altes, 1966).

Chronicity, the 'blue' drum, and radiological evidence of dissolution of the bony walls of the mastoid cells are supposed to be indications for this far-reaching intervention. What it is supposed to achieve is not at all clear.

In the present series this was undertaken in 15 cases. This yielded very valuable macroscopic evidence showing how the whole middle ear cleft, including the air cell system, (albeit underdeveloped) was filled with thick glue-like exudate. This only underlined the futility of trying to aspirate all the fluid through a small incision in the tympanic membrane. The most important byproduct was the biopsy material for pathologic study.

From a therapeutic point of view the results are not exciting. In all instances a grommet tube was also inserted at the end of the procedure. The results were no better than had a myringotomy and tube alone been used. The findings of cholesterol granulomata histologically was quite unexpected, there usually being no macroscopic evidence to suspect their presence whatsoever.

Summary.

Secretory otitis media is a disease of childhood, the peak incidence being around 6 and 7 years. It is almost

evenly distributed amongst the White and Coloured population. It is extremely rare among the Bantu. Males and females are equally affected.

The usual presenting symptom is hardness of hearing, frequently discovered at school. Other symptoms are bouts of mild otalgia and otorrhoea occasionally.

Allergy and incorrect use of antibiotics do not figure in the etiology of this disease.

The otoscopic findings are a dull, sluggish tympanic membrane which may be retracted or full. A very constant finding is a hearing loss by air conduction in excess of 25 db.

The treatment is decongestion, eradication of nasopharyngeal infection and insertion of a teflon vent into the middle ear as a primary procedure.

CHAPTER III.

HISTOPATHOLOGY AND CYTOLOGY.

The great technical difficulty in obtaining specimens in secretory otitis media seriously hampers histopathologic study. Consequently, only a handful of authors the world over have any experience, albeit limited, of the histologic picture of this disease.

The material reported on by Senturia (1963) and Friedmann (1963) seems to be derived mostly from radical mastoidectomies and animal experiments - dogs and guinea pigs respectively. Thus it is applicable only by inference. Bendek (1963), Feuerstein (1966) and Sade (1966) report on biopsies taken from the middle ears of patients actually suffering from secretory otitis media. It is very evident that the histopathologic features of the various stages of this disease, and in the various sites in the middle ear cleft, have not yet been adequately described.

The Normal Middle Ear Lining.

To describe the abnormalities, one must first know what the normal middle ear lining consists of. Here again one finds diverse opinions and confusion. Ojala (1950)

quotes von Tröltsch, Toynbee and Zaufal as comparing it with the serous membranes, and Voltolini with the ependyma of the ventricles. Wittmaack (1918) calls it a mucoperiosteum. Krainz (1924) says it has no function typical of mucosa and suggests the term endosteum pneumaticum. Singer (1933) concurs with Krainz but then adds,very significantly,that at least under inflammatory conditions the epithelium may acquire the ability to secrete mucous "which in some measure it may even possess normally". Beck (1926) quotes Henle, Kölliker, Schafer and Goerke as holding the view that the middle ear cavities are lined by a thin mucous membrane.

Buch and Jorgenson (1964) considered it purely a matter of definition as to whether the middle ear wall is to be called 'mucous' or not. As we know, it does not contain glands and the 'stratification' of the walls is considerably simpler than that normally seen in mucous membranes. The flat cuboidal cells of the tympanic cavity may be of mesodermal origin and these areas might, with equal right, be considered lined with 'synovial membrane'. The respiratory epithelium must be considered of entodermal derivation. They found respiratory epithelium "in places" in the tympanic cavity.

The description of the lining membrane, as given by that otologic giant of the previous century, Adam Politzer, was subsequently adhered to with minor variations by most authorities (von Möllendorf, 1949; Ham and Leeson, 1961; Maximow and Bloom, 1952; Friedmann, 1963). Politzer (1893) described the epithelium in the interior portion of the cavity as ciliated and cylindrical, but passing upwards it gradually changed into ciliated pavement variety. The subepithelial tissue was composed of two layers, the innermost considered to be periosteum. He found glandular elements only in the anterior part of the tympanic cavity in the region of the tube and occasionally upon the promontory. These are not constant and are never found in the posterior part of the cavum tympani or mastoid cells.

Ojala (1950) says that at the end of foetal development the middle ear cavities are lined by mucous membrane consisting of epithelium and tunica propria of varying thickness and differentiated from myxomatous tissue. Under it is a submucosa which consists of undifferentiated myxomatous tissue and is bounded by the periosteum. The mucous membrane as a whole has no mucosal function proper, though certain circumscribed islets may be active. Its

Chief function is to line the surface, thus the trophic stimulus is slight. The mucous membrane does not differentiate and atrophy sets in until the subepithelial tissues consist practically of periosteum. Under inflammatory conditions the epithelium seems to be able to regain its endodermal properties, the atrophy being to some extent reversible. To simplify the histologic description, the periosteum is regarded as submucosa and included in the mucous membrane, which corresponds with Wittmaack's conception.

Witmaack considered the presence of ciliated epithelium in the tympanum as always pathological, except in the immediate neighbourhood of the tubal orifice. According to him, as a result of inflammation, ciliated epithelium extends from the tube throughout the tympanum and antrum, and even to the cell system.

Sade (1966) finally proved, in a convincing manner, that the middle ear is clothed by a true mucosa. He used special decalcification and staining techniques and found (a) ciliated epithelium was always present roughly covering one to two-thirds of the middle ear lining and that the antrum and mastoid cavities contain no cilia in the normal ear. (b) Three types of secreting elements

were found. Mucous was seen in all ears as a blanket over and between the cilia.

1. Glands are seen in the tynpanic cavity in most ears.
2. Goblet cells were observed in 10% of all ears.
3. The most widely distributed source of mucous seen in all ears is the ordinary epithelial cells ciliated and non-ciliated. Intra- and inter-cellular mucous droplets are widely seen in these cells.

The Pathologic Picture.

Here the reported material is very sparse indeed, the inaccessibility of the middle ear mucosa hampering histopathologic study. Friedmann (1963) notes that when the pathology is discussed in the relevant literature it refers to the cytology, bacteriology and possibly biochemical aspects of the fluid aspirated. Some authors (Hoople, 1950; Suehs, 1952; Singleton, 1956) purely on the basis of consistency and macroscopical appearance of fluid, under 'pathology' distinguish two types, namely, the serous variety which is watery and clear, and the mucoid variety which is gelatinous and turbid.

Bendek (1963) reports on the histopathology of 40 cases of secretory otitis media. He obtained the specimens from the promontory mucosa through the myringotomy

incisions. He compared it with tissue samples taken from the same area in patients suffering from chronic suppurative otitis media. The salient findings were that the histologic picture of the two conditions were essentially the same, namely: evidence of secretory and squamous epithelium and large amounts of fibrocartilaginous tissue in addition to chronic inflammatory cells. He concludes that not only transudation but secretion provides a source of middle ear fluid in this chronic non-purulent inflammatory condition. (Footnote).

Feuerstein (1966) does not state how many tissue samples he examined. He obtained biopsy specimens through a myringotomy from the promontory, just anterior to the round window. He found clear evidence of chronic changes, i.e. a markedly thickened submucosa with round cell infiltration. Squamous epithelial metaplasia was found in one case.

Sade (1966) reports on the histopathology of 20 biopsy and 3 autopsy specimens. The material was stained

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Footnote: If the histopathology is the same as chronic suppurative otitis media then surely one should, with even more justification, conclude that the origin of the fluid is exudation and secretion.

for mucopolysaccharides and proved without exception to harbour more abundant and larger mucous-producing glands than those seen in normal mucosae. A few scattered lymphocytes were seen in all biopsies but eosinophiles were conspicuously absent. The submucosa tended to be thickened and infiltrated with polymorphs and lymphocytes. True papillae containing a vascular core were found in the hypotympanum in one case. Other regions showed polypoid formations and some structures showed active mucous secretion. Cases with serous secretion were thought to be due to serous glands, i.e. staining P.A.S. negative.

Methods and Result.

Obtaining tissue. The obscurity of the pathologic picture of secretory otitis media is in a large measure due to the inaccessibility of the middle ear mucosa. Material may be obtained by:

a) biopsy with a Wüllstein cup forceps through a myringotomy from the promontory in front of the round window. The author found it physically impossible to obtain a useful specimen through a normal sized myringotomy opening, which should subsequently firmly hold a grommet button. Even with the best instrumentation and 10 x magnification this procedure produces a large perforation and possible intra-

tympanic damage. A large raw denuded surface is produced with bleeding - ideal conditions for adhesions. After all these hazards one ends up with a minute fragment of traumatized tissue, too small and unsatisfactory for pathologic study. This method was used by Feuerstein (1966) and Sade (1966).

b) A formal tympanotomy by the permeatal or post auricular route can be performed. This has been used as a therapeutic procedure by Mawson (1964) but it is difficult to justify.

I utilised this approach in 2 cases but did not like the damage wrought to the middle ear by taking a worthwhile biopsy. One found that it was not simple to insert a grommet tube into the flaccid drum and blood-filled tympanic cavity after the tympanic membrane had been replaced.

c) In view of the above, it was decided to select chronic relapsing cases who had had extensive therapy without success and perform a cortical mastoidectomy. As a therapeutic measure this was used by Hitschler (1955), Thomson (1963) and Korthals Altes (1966). These strict criteria limited the number of specimens to 12.

The Histologic Features.

The epithelial lining found varied from flat to

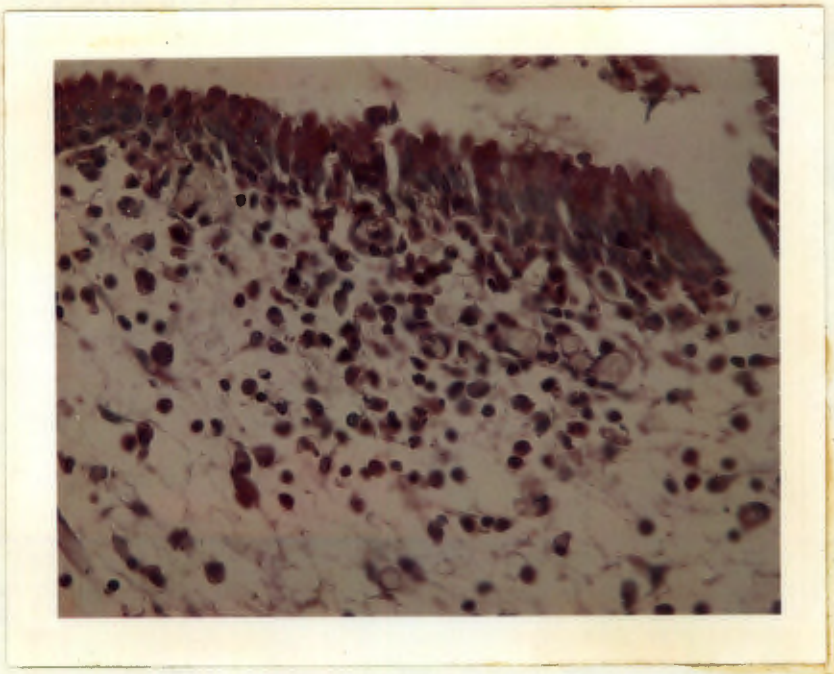

FIG. VI. Photomicrograph middle ear mucosa. P.A.S. stain. Mucin produced by the columnar epithelium is P.A.S. positive. Note sub-epithelial oedema and inflammatory cells, mostly lymphocytes and plasma cells and a few histiocytic cells.

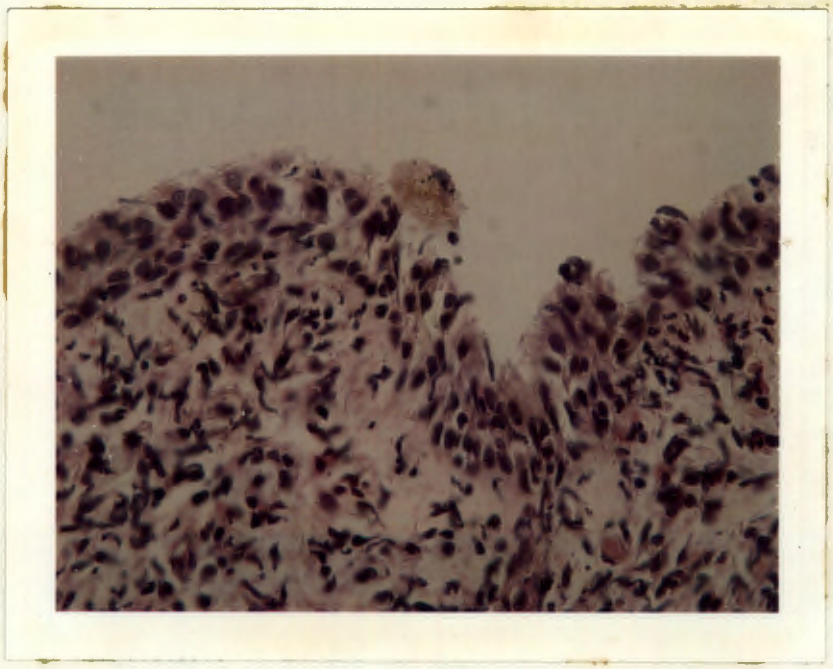

FIG. VII. H. & E. stain. High power photomicrograph middle ear mucosa. Mild oedema and scattered mononucleated inflammatory cells in the propria beneath.

cuboidal or low columnar and may be double layered. In no specimen was there any evidence of squamous metaplasia. This concurs with Senturia (1963) who states that when squamous epithelium is found in the middle ear, it is the result of ingrowth through a tympanic perforation rather than metaplasia of the epithelial lining.

The subepithelial tissues frequently contain glands or gland-like structures. They occur singly or form clusters and may be filled with a homogenous mucoid secretion which gives a positive P.A.S. reaction. Mucous cysts are seen to contain polymorphs or macrophages.

A marked feature not previously described is inflammation. The degree of inflammation may vary. The tissues may be markedly inflamed with polymorphs predominating, but lymphocytes and plasma cells also feature prominently. Alternatively, the accent may be on lowgrade inflammation and fibrosis. Here lymphoid cells are fairly abundant as well as plasma cells, and there are occasional mast cells. The inflammation may be focal in nature, e.g. plasma cells crowding around mucous glands or cysts. Subepithelial oedema or fibrosis may be seen, and in one case marked deposition of adipose tissue. (Fig.IX).

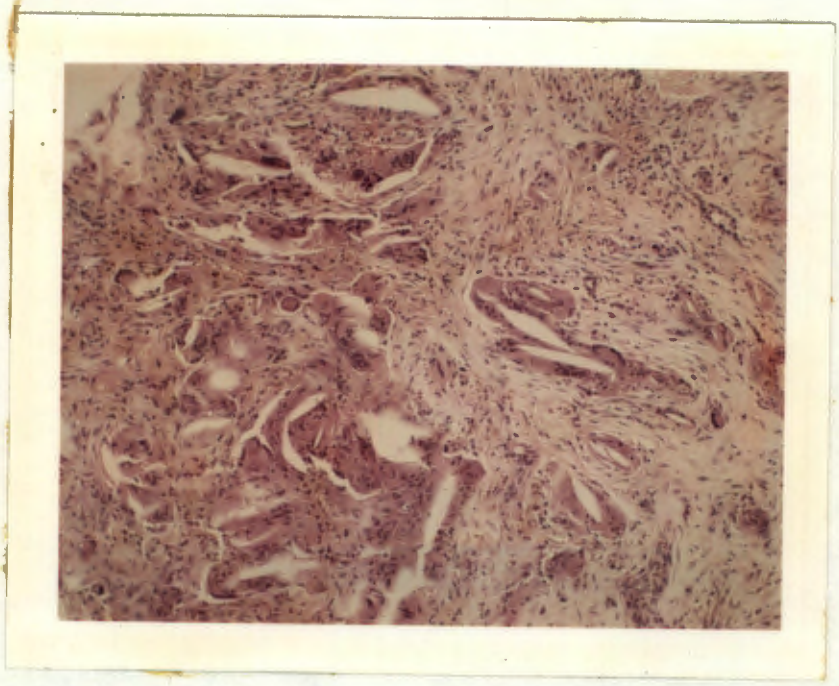

FIG. VIII. H. & E. Stain. Foreign body giant cells around cleft like spaces, presumably due to cholesterol deposition.

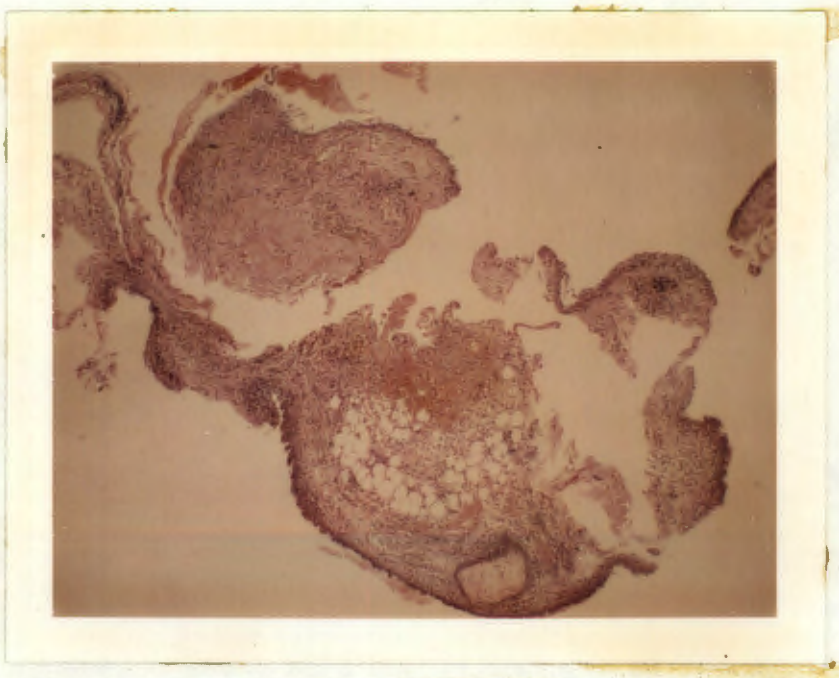

FIG. IX. H. & E. Stain. Proprial adipose infiltration and fibrosis in smaller fragment above.

A remarkable feature seen in 33% of cases studied is the so-called cholesterol granuloma. (Fig.VIII). This is usually described as a feature of idiopathic haemotympanum. (Korthals Altes, 1966; Thomson, 1963). Special staining show these granulomas to contain cholesterol, fibrin and haemosiderin, e.g. breakdown products of blood. In pathological conditions, fats and fatty substances enter extracellular spaces. Cholesterol assumes the crystalline form in the interstitial spaces - elongated diamond-shaped needles. These crystals, which do not normally occur in the organism, act as foreign bodies and incite a clearing process. They are surrounded by giant cells of the foreign body type and by granulation tissue. The true incidence is probably very high because the above samples were taken at random and the condition was not suspected macroscopically. The precise importance of cholesterol clefting is uncertain but it surely indicates chronicity of course. It is difficult to visualise resolution of these foci. The end result is most likely further fibrosis.

Cytology.

The middle ear fluid was aspirated and trapped

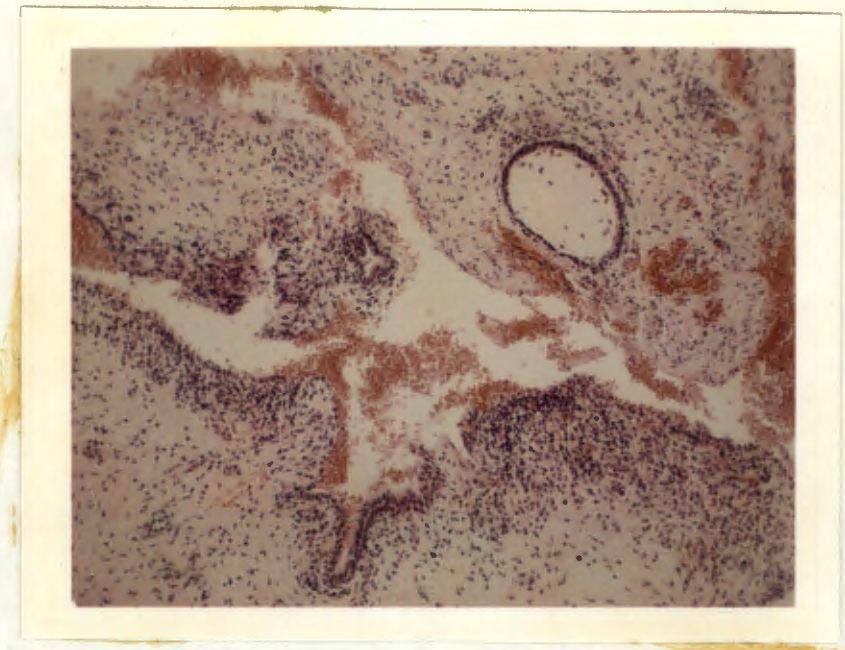

FIG. X. Mastoid mucosa in secretory otitis media. Oedema, plasma cell and lymphocyte infiltration. Sub-epithelial dilated cystic gland.

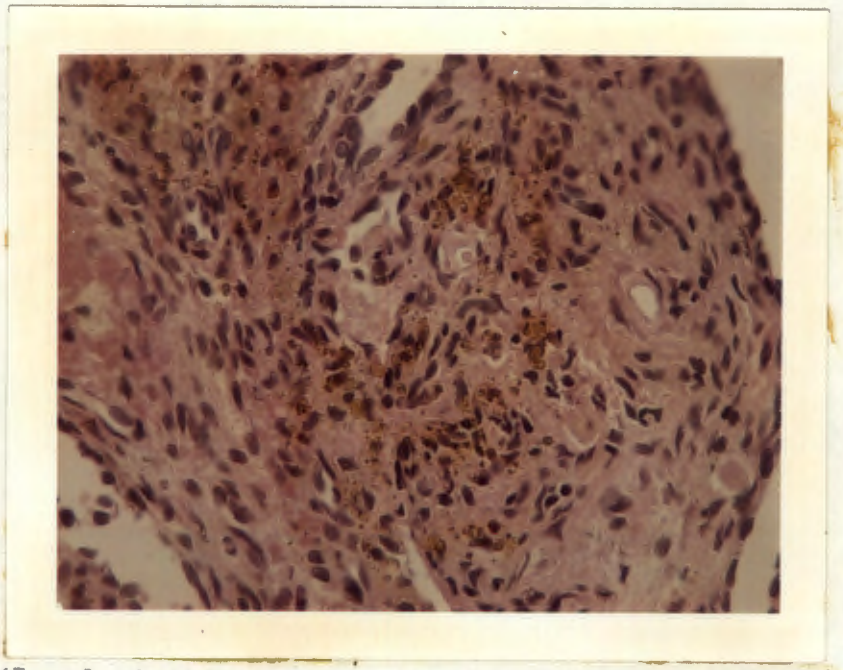

FIG. XI. A striking granulomatous and foreign body giant cell response around clefts. Also noted is haemosiderin, a relic of haemorrhage in the past.

in the dependant perspex vial as previously described. From this vial it was transferred to a glass slide and spread thinly. It was then immediately fixed with an aerosal fixative as for the Papanicolaou technique.

The extremely viscous rubbery effusions were partly delivered through the myringotomy incision with the suction tip and cupped forceps. Staining is carried out with mucicarmine or periodic acid Schiff (P.A.S.) stain which are specific for mucous or haematoxylin and eosin (H + E) stain. A total of 58 smears were made.

Löwy (1938) found that the number of cells varied greatly up to 1000/mm^3. Jordan (1953) found some neutrophiles and an occasional eosinophile in the smears. King (1953) counted roughly equal numbers of neutrophiles in all middle ear fluids examined by him.

Ojala and Palva (1955) found large macrophages in addition to other inflammatory cells in middle ear fluids. Suehs (1956) observed that the thin serous fluid contains only a few neutrophiles, whereas tenacious fluid showed them in greater amount.

The amount of fluid was estimated by Löwy to vary between 0.2 to 0.6 ml., by Suehs between 0.1 to 0.4 ml.

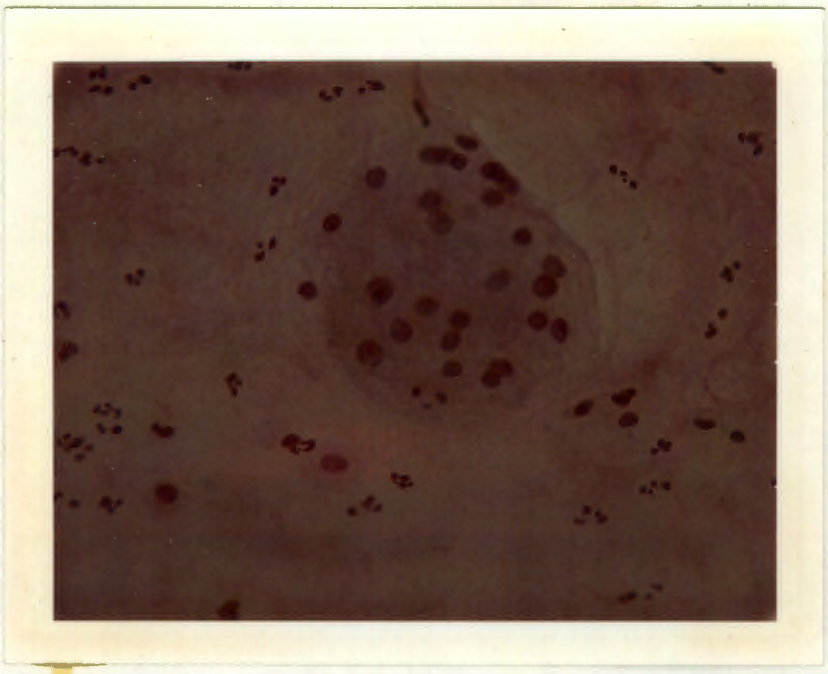

FIG. XII. Cytology middle ear fluid. Mucicarmine stain. Histiocytes and a few polymorphs embedded in a background of mucicarmine positive material, probably mucous.

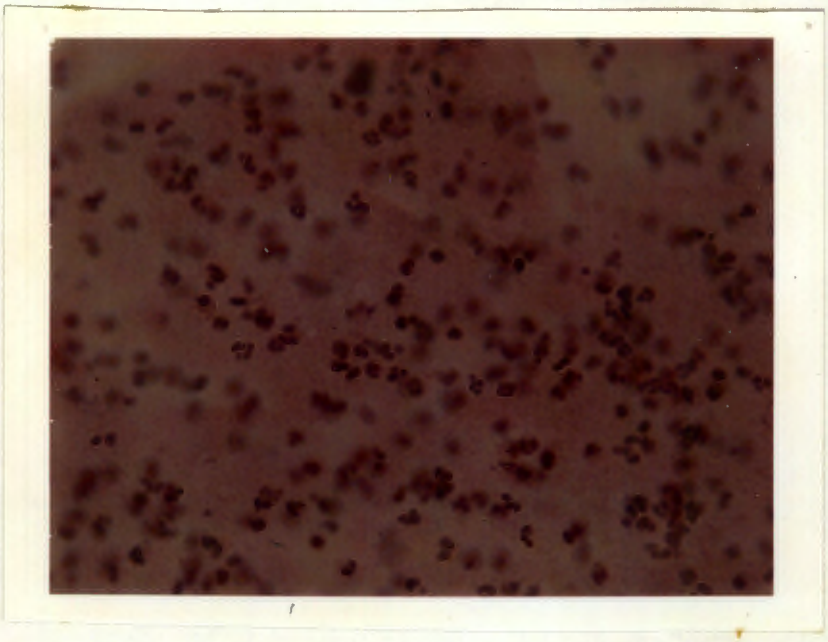

FIG. XIII. H. & E. Stain. Florid inflammatory character of the fluid as evidenced by large numbers of inflammatory cells, mostly polymorphs, some degenerate.

and Lahikainen (1953) found that the majority of the 734 samples were 0.2 ml. and 84% were not more than 0.3 ml. Carlson and Lökk (1955) aspirated 0.02 to 0.2 ml.

Results.

The background material stains well with mucicarmine or P.A.S. indicating that this is probably mucous. This is well seen in practically all the smears.

The cell type and composition can be broadly classified as follows:-

1. Polymorphs, the predominant cell-type, accounting for 90% of the cells present. This occurred in 27% of our series.
2. Histiocytes or macrophages; the predominant cell-type is seen is 23% of our slides.
3. Commonly there is a mixture of cell-type present; polymorphs which may be degenerate in part, histiocytes and fibroblastic-looking cells, lymphocytes, plasma cells and rarely epithelial cells. This is seen in 42% of slides.
4. The effusion may be largely acellular, only a very occasional cell being found. This occurs in 8% of cases.

Not a single eosinophile was seen in any of the slides.

Conclusion.

The picture is overwhelmingly that of inflammation. The degree, stage and activity is very variable. The mucicarmine or P.A.S. staining material, probably mucous, is a constant feature. This mucus is a secretion by glands in the mucosa of the middle ear cleft. The absence of eosinophiles is striking. The inflammation is therefore probably viral or bacterial and not allergic or traumatic.

Cholesterol clefting is not a rare occurrence as previously thought but present in probably more than one-third of cases. I suspect that it may be present in every chronic relapsing case.

CHAPTER IV.

BACTERIOLOGY AND VIROLOGY.

For decades it has generally been accepted that secretory otitis media is a sterial condition, or at least yields no growth on culture. Some of the many synonyms for the condition are 'sterile otitis media', 'allergic otitis media', 'hydrops' of the middle ear or 'hydrotympanum'. Thus the various authors have tried to indicate their non-infective concept of this disease.

Forschner (1925) did bacteriological examinations of 40 specimens of serous fluid and found most of them to be sterile. The absence of bacterial cultures was attributed to the hypovirulence of the bacteria. He also reported a predominance of polymorphonuclear cells. Forschner observed that most of the patients developed the effusion after an inflammatory process in the nasopharynx and suggested that the fluid in the middle ear was of an inflammatory nature.

Löwy (1938) reported his findings in the fluids obtained from 60 patients. Forty-two specimens were cultured of which 38 were sterile and 4 were considered to be contaminated.

Many investigators were unable to culture bacteria from the mucoid or serous effusions or considered the growth obtained as contaminants. (Hoople, 1950; Robison and Nicholas, 1951; King, 1953; Suehs, 1956; Fishman et al. 1960).

This evidence is accepted as beyond doubt and is therefore not duplicated in this study.

Virology.

Attention has recently been focussed on viruses as possible causative organisms. If an inflammatory exudate is consistently bacteriologically sterile and antibiotics have not been used, it is fair to suspect viruses. Further, the association of otitis media with viral upper respiratory tract infections and systemic viral infections, rubella, mumps, influenza, etc. is well known. Shambaugh (1959) concludes, on the basis of histopathological changes in the middle ear, that viruses are important factors in acute middle ear infections.

A few unsuccessful attempts to isolate a virus from middle ear effusions were made by Forschner, 1925; Robison and Nicholas, 1951; Siirala, 1957; Harcourt and Brown, 1953; Fishman et al., 1960; Laxdal et al., 1966, and Grönroos et al., 1964.

Some of these studies were concerned with acute otitis media, in some the methodology was open to criticism. After a sound study, Fishman et al. (1960) stated "Failure in this small series of patients to incriminate a viral agent does not unequivocally rule out a viral etiology. A larger group of patients and different host systems should be included in further studies."

In view of the above, it was felt that this aspect of the disease should be further investigated as other agents, such as mycoplasmas might be involved. It is known that mycoplasma is involved in respiratory infection in children and mucous secretion is a feature. Mycoplasma pneumoniae seems to be the causative organism of bullous myringitis (Merrifield et al. 1966).

Materials and Methods.

The patients studied (50) were part of a clinical series of 100 seen at the Groote Schuur Hospital between January, 1967, and September, 1968.

Under general anaesthesia the external auditory meatus was mechanically cleaned with normal saline and suction. Myringotomy was performed with the aid of a

Zeiss operating microscope and the middle ear effusion aspirated and trapped in the specially designed suction apparatus. Normal saline was used instead of antiseptics, such as zephiran or hibitane, as traces of the antiseptic might be sucked up with the specimen and interfere with the culture of bacteria or viruses.

The trapped specimen was sealed with a sterile screw cap in its sterile receptacle. At the same time an examination of the post nasal space was performed and adenoids, if present, curetted and placed in a sterile bottle. If adenoids were not present a swab was taken of the secretions of the nasopharynx. 10 cc. of blood was withdrawn from the antecubital vein and placed in a sterile test tube.

All three specimens were delivered to the Dept. of Bacteriology, Medical School, University of Cape Town within two hours of being obtained for processing.

The suction apparatus.

The features required of a sucker for this study are:-

a) The suction tip must be small enough to operate through a myringotomy incision destined to lodge a grommet ventilation tube. The Zöllner sucker has the correct diameter.

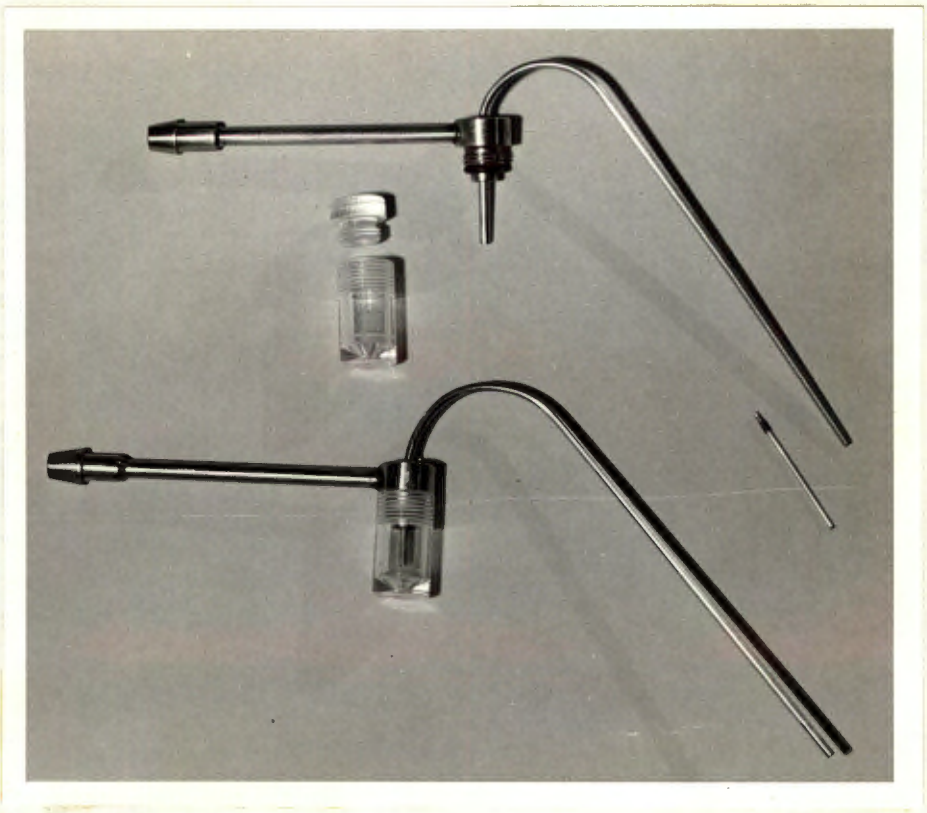

FIG. XIV. Suction apparatus.

Exploded view above with detached suction cup and its screw cap. Microbiological examination of middle ear effusions can now be properly carried out with negligible incidence of contaminants.

b) Very powerful suction is required to aspirate the highly viscous almost rubbery effusions.

c) In spite of this very high suction pressure the aspirate must be effectively trapped.

d) This trap must be able to be sterilized.

e) It is highly desirable that the aspirate be sent to the microbiologist without intermediate handling to avoid contamination. After many preliminary experiments and many adjustments, the apparatus eventually evolved proved admirably suitable. This apparatus should, in future, always be used to obtain specimens for microbiological investigation after myringotomy. Swabbing of the exudate is notoriously unreliable due to contaminants being picked up from the external canal (Lahikainen, 1953; van Dishoeck et al. 1959). The aspiration technique will probably result in a higher incidence of 'non-bacterial' otitis being reported and a lower incidence of Staphylooccus aureus as an etiologic factor in otitis media. (Grönroos et al. 1964).

Results.

The Virus Research Unit of the University of Cape Town undertook the investigations. Dr. W.B. Becker reports "Thirty-three middle ear aspirates, 10 pharyngeal swabs and

9 specimens of adenoidal tissue were cultured for mycoplasmas. Thirty-one of the aspirates, 8 of the swabs and 4 of the adenoids were also cultured for viruses. Standard media were used for culturing mycoplasmas (Difco PPLO broth and agar) at 35°C. Virus isolation was attempted in standard cell cultures of monkey kidney and Hela cells and in suckling mice.

The only positive result was the isolation of an Adenovirus type 8 from one of the specimens of adenoids.

It must be commented that the middle ear aspirates were not optimal specimens. They consisted of minimal amounts of blood-stained fluid remaining after samples had been taken for cytological and histological examination".

Specimens gathered towards the end of the experiment showed that the volume of aspirate was much larger due to the improved function of the trapping mechanism.

Comment.

The first virus ever to be cultured from an ear discharge was by Yoshie (1955). During an influenza epidemic, influenza A virus was isolated from the middle ear discharge in 4 patients. Berglund et al. (1966, 1967)

isolated the Respiratory syncytial (RS) virus from the middle ear exudates and throat washings of patients during a RS virus epidemic. Many of the positive cultures were obtained in patients having the clinical features of secretory otitis media. Tilles et al (1967) cultured 2 viruses, a Coxsackie B4 and an Adenovirus type III but no mycoplasmas from 90 children with bulging drums.

Grönroos et al. (1964) found no PPLO nor virus in 326 specimens obtained in acute otitis media.

Thus it is evident that the vast majority of workers, including ourselves, have failed to isolate viruses directly from the middle ear fluid. It is possible that local inhibitors interfere with isolation of viruses. Siirala et al. (1961) demonstrated the presence of specific viral antibody in exudates of patients with sterile otitis media, suggesting that this or other inhibitors may be interfering with viral isolations.

Also, viable virus may only be present in the middle ear fluid for a very short period at the outset of the disease. Berglund (1966, 1967) stresses that the earlier after the onset (days rather than weeks) of the

disease, the better are the chances of a positive culture. His cases developed their effusions while in hospital for observation during a RS virus epidemic. I do not know the date of onset of the disease in my patients. Many have had it for months or even years, making the isolation of a specific virus or mycoplasma very unlikely.

CHAPTER V.

CONVENTIONAL RADIOGRAPHY. PNEUMATIZATION OF THE TEMPORAL BONE.

There is no adequate definitive description of the radiographic appearance of the temporal bone in chronic middle ear effusions.

It is generally accepted that the mastoid is well pneumatized and without bone destruction (Thorburn, 1965; Shambaugh, 1967; Feuerstein, 1966). All these authors mention clouding of cell outlines as a feature in the absence of bony septal breakdown. Thorburn adds that the mastoid is well pneumatized but haziness may be caused by simple mucosal swelling or advanced cholesterol granuloma. We will endeavor to show that these views completely misrepresent the true picture.

Pneumatization.

The problem of pneumatization gradually assumed its position among the most important questions of otology. Bezold (1882, 1893) was the first to stress the clinical importance of the air-cell system. Witmaack (1918), in his epoch-making theory on pneumatization, opened up the

heart of the problem.

During the first year of life the pneumatization of the tympanum and the antrum is completed. In the second and third years the air cells begin to develop from the antrum, both peripherally and centrally, and this is accompanied by a pneumatizing process from the epi- and hypotympanum. At the end of the fourth, or at least within the fifth year of life, the mastoid process is generally fully pneumatized if development has been undisturbed. Mouret and Portmann (1940) consider that pneumatization continues as long as the skeleton grows. According to Wittmaack it goes on throughout life.

There are three main groups of theories concerning the development after birth.

A. Pneumatization - a mucosal function. Wittmaack is the father of this theory. A pathological mucous membrane resulting in arrest of pneumatization is solely due to otitis media neonatorum, described by Aschoff in 1897. He demonstrated that the middle ear of a newborn infant may be filled with a non-bacterial mucopurulent secretion containing amniotic fluid, vernix caseosa and meconium, causing irritation and infiltration. This is very common. Aschoff found that it occurred in 50 - 90% of all autopsies of infants.

Thickened subepithelial connective tissue forms an obstacle through which the epithelium cannot pass and the preformed cavities are therefore not pneumatized. They gradually narrow because of continued new bone formation and the result is that - depending upon the time when the mucosal changes occur - a more or less dense sclerotic mastoid develops.

The decisive importance attributed to otitis in infancy by Wittmaack has been opposed by Lundgren (1944) and RÜckensteiner and Prietzel (1947).

Schwarz (1936) and Albrecht (1937) consider pneumatization to be determined by the genotypic structure of the mucous membrane which may be but little affected by exogenous factors. Diamant (1940) is of the same opinion.

B. Pneumatization - a bone function.

Eckert-Moebius (1938) and Bast and Forrester (1939) consider pneumatization closely bound up with the growth of the temporal bone. The parts of the bone subjected to the least static and dynamic stress have a weak trophic stimulus and they atrophy as a result of deficient nutrition.

Ruedi (1937, 1939) concluded that pneumatization is a genotype-determined mesenchymal process, the direction and type of which depend upon the bone tissue. Opheim (1944) concurs with this view.

C. Pneumatisation due to mechanical factors.

Krainz (1924) was the best exponent of this view. The atmospheric pressure, causing stasis in the veins in the subepithelial connective tissue, gives rise to oedema which extends to the adjoing narrow spaces causing pressure and disappearance of free marrow cells. Only an oedematous marrow reticulum remains. The atmospheric pressure pushes the epithelial sac into the marrow spaces. The epithelium plays no part, merely lining the resulting air spaces. This physiological process of pressure atrophy continues as long as spongy bone is available.

This theory is, to say the least, highly improbable. Nowhere else in the human body does atmospheric pressure occlude or cause stasis. The whole exposed body in its entirety is subject to the same atmospheric pressure, and blood not being compressible, will flow freely even if the pressure is increased to many atmospheres, e.g. in skindivers, as long as the pressure is generalised.

Mastoid Sclerosis.

One school considers a dense sclerotic mastoid developing as a result of inflammatory new bone formation. Ruedi (1939) and others are inclined to return to this original theory.

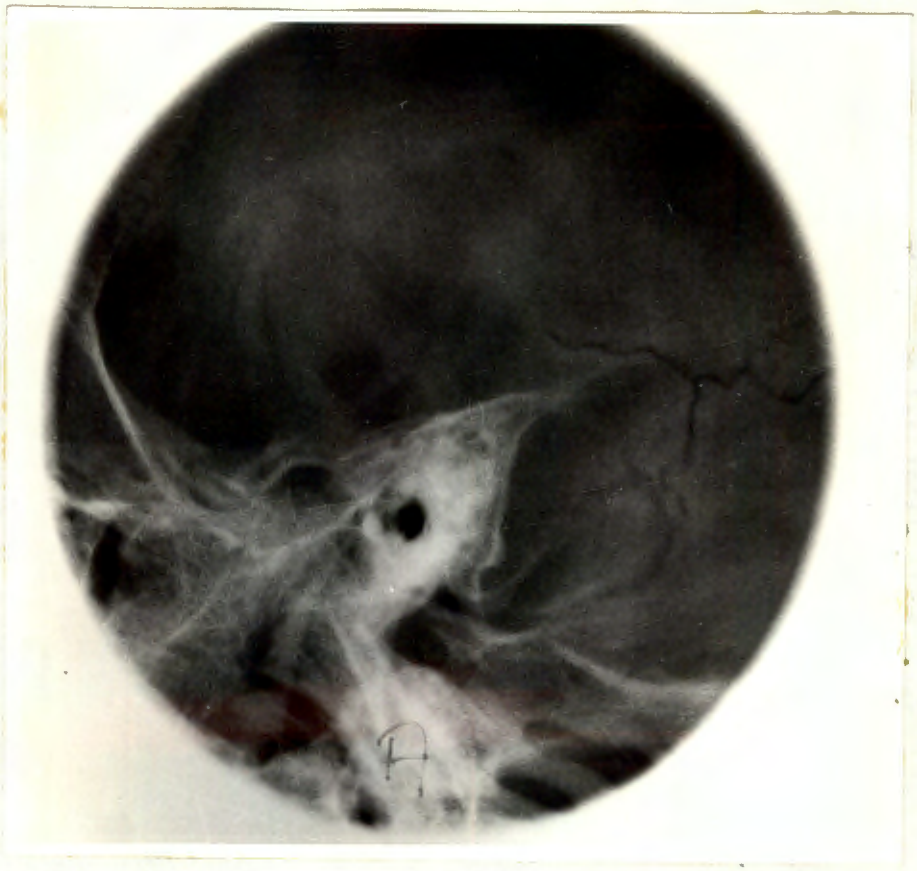

FIG. XV. Schüller's view of temporal bone. Typical appearance in secretory otitis media. Small contracted mastoid with poorly developed air cell system contrasting highly with sigmoid sinus. Note sharply delineated sinus plate and tegmen.

The other school regards a dense mastoid as the cause of chronic otitis rather than the result. This forms an essential part of Wittmaack's theory.

Author's investigations.

With the co-operation of the Department of Radiology, 68 patients with proven secretory otitis media were investigated. The following standard views were taken:- Townes view, basal view, Stenvers view of each ear and a Schüllers view of each ear.

The degree of development of the pneumatic cell system was simply graded into 3 categories thus:

a) Normally pneumatized when there was evidence of an extensive air cell system invading the whole mastoid bone and possibly the petrous.

b) At the other end of the scale was the so-called infantile or diploeic mastoid with none or very little development of cells. In the Schüllers view the mastoid would appear white and very opaque with a very clearly defined tegmen and sinus plate. (Fig. XV).

c) The intermediate variety, called the mixed type. Here there was some evidence of air cell development, usually centrally around the antrum but not reaching the periphery. Some cells might show thickened walls being evidence of sclerosis.

One hundred and thirty-six ears were evaluated with the following results:-

115 infantile or diploeic	-	84.6%
13 mixed type	-	9.5%
8 normally developed	-	5.9%

The 8 normally pneumatized ears require closer analysis. They belonged to 6 patients. Four patients had unilateral secretory otitis media, the unaffected ears accounting for 4 of the normally developed mastoids. The remaining 4 ears belonging to 2 patients were, therefore, the only cases having fluid bilaterally in normally developed air cell systems.

The corrected incidence of secretory otitis media in radiologically well-developed mastoids in this series should be 4 in 132, or 3.3%.

This is in sharp contrast with the published views of authorities mentioned earlier.

Shambaugh (1967), when discussing the origin of cholesteatoma in his standard textbook, page 218, states that attic retraction ensues from long-standing secretory otitis media ..."Radiography in such patients will show a well pneumatized mastoid process ...."

Our studies showed overwhelmingly that the roentgenographic picture of secretory otitis media is that of the small contracted poorly pneumatized mastoid. Furthermore, the 4 normally pneumatized ears, as well as the 13 of the mixed type, responded to simple myringotomy, (6 had, in addition, teflon buttons inserted). None relapsed and appeared completely reversed with full mobility of the tympanic membrane and normal hearing, on follow up.

The radiological picture is thus of prognostic significance, the chronic relapsing cases only being found in the infantile type of mastoid.

Comment.

Broadly, the radiographic appearance of 3 conditions are similar:

Secretory otitis media,
Cholesteatoma,
Benign chronic suppurative otitis media.

The growth of the air space in the middle ear cavities is obstructed, retarded or made impossible by an otitic process or a chronic catarrh of the tube during the period of air cell formation. "If the middle ear

cavities are cut off from the outer air because of mucosal proliferation, the progress of pneumatization becomes wholly or partially impossible". (Ojala, 1950). The degree varies according to how completely and how constantly the tube has been occluded.

This underdeveloped middle ear cleft is an otitic cripple, so to speak, susceptible to the onslaught of bacteria and poorly equipped to equalize pressure and discharge exudate.

An upper respiratory infection leads to inflammation and exudation of the middle ear cleft which is retained as secretory otitis media. Atrophy and breakdown of the tympanic membrane leads to benign chronic suppurative otitis media. With less marked infection and long continued tubal obstruction with negative middle ear pressure, attic retraction results eventually in cholesteatoma. The association of secretory otitis media and cholesteatoma in the same ear, or secretory otitis media in one ear of a patient and cholesteatoma in the other, is well known clinically.

CHAPTER VI.

TUBAL FUNCTION. CONTRAST STUDIES. TYMPANOGRAPHY.

Tubal dysfunction, or even tubal obstruction, has been widely incriminated as the cause celebre initiating the chain of events leading to middle ear effusions.

Henderson and Henderson (1932) and Tumarkin (1962) have described well what happens to gas in any enclosed body space. If, for example, the eustachian tube becomes blocked at a moment when the intra-tympanic air contains 80% nitrogen and 20% oxygen, O_2 is absorbed by a process comparable to O_2 absorption in the lung alveoli due to a pressure gradient. This causes the intra-tympanic pressure to drop, and the tympanic membrane tends to be sucked inwards. The mucosa swells and exudes so that the cavity becomes progressively smaller. At first there is N_2 equilibrium, i.e. 80% atmosphere on both sides. (circulating blood carries N_2 at 80% of atmospheric pressure).

With the smaller cavity and pressure again at 100% atmosphere, the relative N_2 pressure rises and will be absorbed by the circulating blood. Unless air can

enter somehow, the system is doomed and it will completely fill with fluid ex vacuo.

Absolute tubal obstruction is an infrequent occurrence. Every clinician knows that it is always possible to inflate the tube retrogradely after paracentesis for secretory catarrh.

Zöllner (1942) found that the tube was normally patent in middle ear catarrh, for which reason he regarded the condition as an exudate due to an inflammatory process.

Senturia (1963) cauterized the nasopharyngeal orifices of the eustachian tubes in dogs to produce experimental effusions. He was impressed to find that the eustachian tube returned to normal and was patent in spite of a persistent middle ear inflammatory process. The lumen was unobstructed in all cases after the third day. It confirms the clinical observation in humans that in long-standing cases of middle ear effusions, the eustachian tube is patent and may be inflated without difficulty. Also that the eustachian tube has a remarkable ability to recover from trauma or infection.

Numerous methods have been advocated to test for eustachian tube patency and function. Valsalva's manoeuvre

was the first described and remains one of the simplest and most effective.

Rich (1925) demonstrated,by several well executed experiments, that the tube opens only through contraction of the tensor palati. He further showed that the tube is only effectively opened by the act of swallowing.

Buckingham and Ferrer (1966) demonstrated that retracted ear drums usually expand with a middle ear vent. Therefore, one can assume that one of the causes of the collapse is a failure of eustachian tube function and not necessarily eustachian tube occlusion. Such a failure of function could be a lack of ability of the nasopharyngeal orifice to open regularly with swallowing.

Shambaugh (1963) noted that the cause of this malfunction of the eustachian tube remains one of otology's unsolved problems.

Flisberg (1963) and Flisberg et al. (1963) simulated the condition of relative negative pressure in the middle ear by sealing a tube in the external canal in cases with perforated ear drums, or in myringotomized ear

drums. A tube was led to a manometer and air removed from this sealed system to create a vacuum equal to 30 mmHg. (408 mm H_2O). When normal controls, with myringotomized ears, swallow several times, the negative pressure is reduced and equilibrium quickly established between the middle ear external canal complex and the nasopharynx. In the case of chronic otitis media with perforation, the patient is unable to equalize the negative middle ear pressure.

This work was refined and expanded upon by Miller (1965) and Buckingham and Ferrer (1966).

These manometric studies do not demonstrate the existence of a negative middle ear gas tension, but they show a rather marked defect in eustachian tube function - the inability to equalize a negative middle ear pressure with a positive nasopharyngeal pressure. The eustachian tubes of these patients are thus incapable of re-supplying the middle ear with air when the air in the middle ear is absorbed. A negative middle ear pressure then occurs and the tympanic membrane collapses medially, especially if it is atrophic, to compensate for the inequality of pressures.

In the presence of a negative middle ear pressure, the tube in these patients cannot open, though it can be forced open by Valsalva's manoeuvre or politzerisation.

It appears certain that the air in the middle ear and mastoid is constantly absorbed and must be constantly resupplied by periodic opening of the eustachian tube in the normal state.

These foregoing and numerous other tests, either alone or together, are not entirely satisfactory. They depend upon the flow of air from nasopharynx to tympanic cavity.

Sades' well documented work (1966) showed that there is a physiological escalator system in the middle ear cleft similar to the nose, bronchi and sinuses, comprising a mucous blanket carried by cilia. Foreign material is evacuated from the middle ear within minutes. The eustachian tube issues superiorly from the tympanic cavity, thus an active propelling mechanism is required.

A physiologic method of testing for eustachian tube patency and function would be to deposit a foreign material in the tympanic cavity and measure its rate of clearance.

The first attempt to demonstrate the auditory tube by the use of a radiopaque medium was by Reverchon and Worms (1925). Lipiodal was introduced into the eustachian tube through the nasopharynx.

Welin (1947), using a water soluble contrast medium, injected the material through perforated tympanic membranes with a special pressure syringe.

William House is cited by Compere (1958) as first conceiving the idea of filling the tympanic cavity with radiopaque material and noting the emptying time in an effort to evaluate eustachian tube function in secretory otitis media. The series was too small for profound conclusions but he hoped to stimulate interest in a new technique. This method is difficult and not suitable for children, who comprise the vast majority of secretory otitis media cases.

This appeared to be a promising research method and worthy of elaboration.

With the co-operation of the Department of Radiodiagnosis, a system called tympanography was eventually evolved. It comprises:-

a) Instillation of a contrast medium iophendylate (myodil). On the day prior to radiography, under general anaesthesia, myringotomy and aspiration of the middle ear cavity is performed and a teflon grommet vent is inserted.
The following day the tube is inspected for patency and the external auditory meatus is filled with iophendylate. With a pneumatic speculum, or by utilizing the tragus as a piston, the contrast medium is gently forced into the middle ear cleft.

b) Films are then taken

i. immediately
ii. after 1 hour
iii. after 24 hours
iv. after 96 hours (4 days)
v. weeks or months later.

c) Compere recommended Stenvers' views, but it was soon discovered that the best unimpeded views were the submento-vertical.

This is a very simple method of obtaining tympanograms and eminently suitable for use in children, there being practically no discomfort involved. The

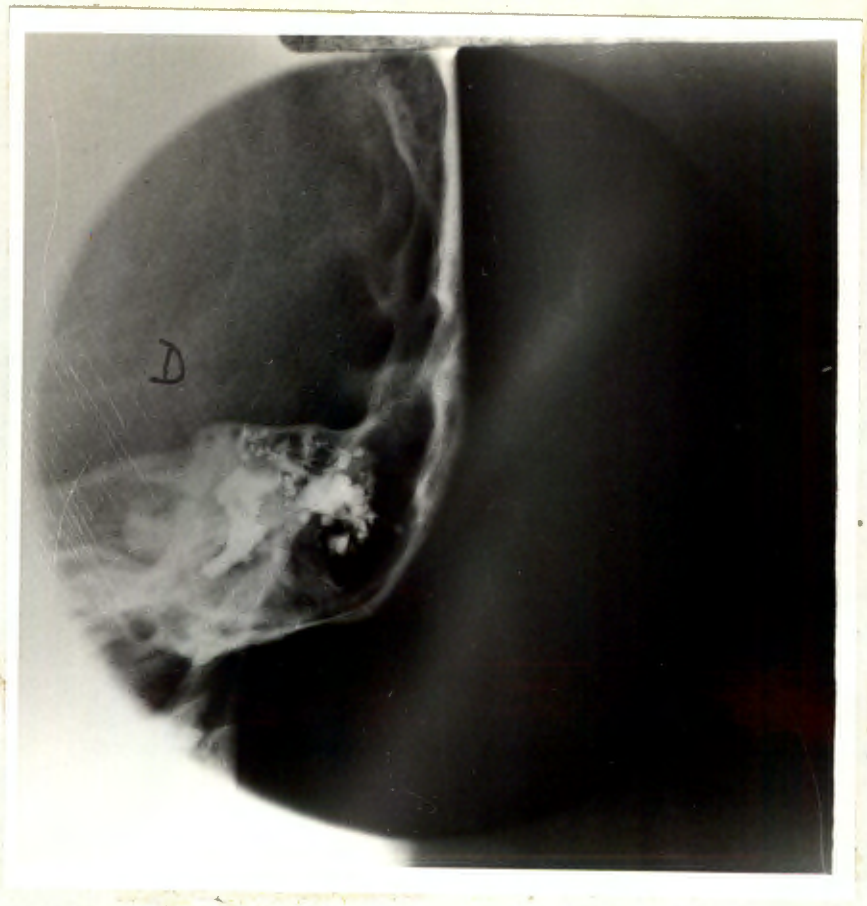

FIG. XVI. Tympanography.

Two hour Stenvers' view. Good filling of mastoid and middle ear.

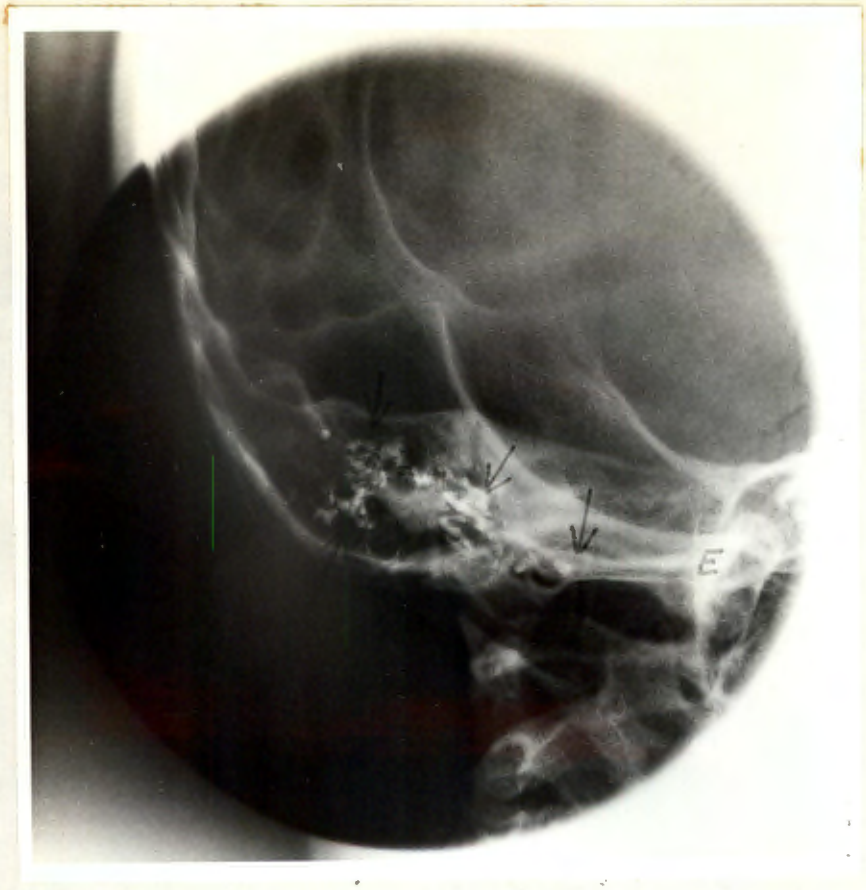

FIG.XVII. Tympanography.

Stenvers' view after 48 hours showing marked dispersion of medium.

FIG.XVIII.

Same patient one month later showing negligible clearance.

FIG. IXX. Tympanography.

Immediate film, basal. Both tubes well outlined. Patency emphasized by blobs of contrast medium in pharynx.

FIG. XX. Tympanography.

One hour well exposed left Stenvers' view of same patient. Compare with previous film. This does not give the same unobstructed view and is inferior for diagnostic purposes.

presence of the otologist is not essential as the radiographer can perform the filling of the middle ear after some instruction.

Results and Conclusions.

Good views were soon obtained showing the contrast medium and outlining the eustachian tube. In no case was there total obstruction of the tube. By Compere's criterion of normal clearance within 10 minutes, all our cases showed very severe impairment of middle ear clearance. There is hardly any difference between the immediate and the 1 hour film. The immediate film can often be recognised by dye entering the nasopharynx. In all cases, the 24 hour film still shows good concentration of contrast medium. Approximately 70% still had iophendylate in the middle ear cleft after 4 days. In some it persisted for weeks, gradually disappearing for 3 - 4 months.

A tympanogram was performed on a patient who had no fluid and normal hearing for 12 months due to a teflon tube remaining in situ and patent. His clearance was no faster than the average.

Only 2 adults with normal middle ears were obtained

as controls. Their clearance was no faster than the secretory otitis media cases.

Obviously more controls are required to standardize the investigation. Preferably the controls should be children as they are the main sufferers of this disease. It is hoped to solve this problem by utilizing the few and far between unilateral cases. Their normal ears will serve as controls.

This method is ideally suited to investigate the tube in cases of suspected congenital abnormality. It can very easily be used to visualise the tube in chronic suppurative otitis media.

To conclude, we found that this investigation is useful in establishing the patency and gross anatomic outline of the tube, but not reliable to determine the clearance rate of the middle ear (in other words, the physiologic 'patency' of the tube). Inconsistent clearance rates were obtained. Clinically, poor relapsing cases with poor response to treatment at times showed faster and more complete clearance than milder cases which responded well.

Judging from the 4 normal adult ears subjected to this investigation, I suspect that the normal middle ear clearance of radiopaque dye is very much slower than reported elsewhere.

CHAPTER VII.

BIOCHEMISTRY OF EFFUSIONS.

A great deal of painstaking, laborious and intricate work has been done in various parts of the world regarding the biochemical composition of the fluid. It is hoped in this manner to contribute to the understanding of the nature and formation of these fluids.

The most obvious point to prove is whether the effusion is an exudate or a transudate or a secretion, or a combination of these. The most widely held belief is that the fluid is a 'hydrops (transudate) ex vacuo'.

Exudate and Transudate.

In general, an exudate as opposed to a transudate would tend to have a higher specific gravity, a higher protein content, (as high or higher than the serum proteins), and a higher cellular content, or the breakdown products of these cells, e.g. D.N.A.

A survey of the literature appears to reveal a confusing picture, but after careful scrutiny a few basically important facts do emerge.

Tremble (1951) believes that a thin serous fluid is due to the negative pressure in the middle ear

and to be a transudate with a high protein content, whereas a thick mucous secretion is an exudate with a low protein content.

Suehs (1952) on the other hand is completely contradictory. He is of the opinion that the serous fluid is a transudate with a low protein content and the thick mucous fluid an exudate with high protein content. He himself, however, found no definite relationship between the type of secretion and the protein content in 8 cases of secretory catarrh.

Ivstam (1954) investigated the total protein content of the fluid in secretory otitis media and found it varied between 8.5% and 6.9%. In all of his cases it was higher than that of the serum of the same patients. He divided the middle ear effusions into serous and mucous types on the basis of their hexosamine and fucose content. (i.e. mucopolysaccharides). It is classed as serous when its hexosamine and fucose content is not greater than that in the serum of the same patient, and as mucous when it is of a higher value. A higher mucopolysaccharide level indicates active secretion of mucous from glands lining the cavity.

Ivstam argues that if the serous fluid in secretory catarrh had, from the beginning, been a transudate "ex vacuo" with a protein content of at most 2-3%, considerable water absorption must be assumed. If this absorption can produce a negative pressure of the order of 150 c.m. water, further transudation ex vacuo can occur. This is highly unlikely. It is more reasonable to assume an increased permeability in the vessels because of an inflammatory irritation with oedema and a tendency to exudation. The high protein content of effusions of even only a few days duration argues for the assumption of exudation. Although the fluid is as a rule sterile, an infectious origin cannot be excluded. The longer the history the more likely is the admixture of mucous likely. Often in secretory otitis media the middle ear is again filled with effusion a few days after paracentesis. This rapid recurrence may be due to lymphatic stasis. Ivstam goes on to argue that the effusion may thus develop as an inflammatory exudate or as a transudate which, with water absorption, has a high, dry content. Often both mechanisms are involved. The mucous secretion presupposes a previous inflammation.

Carlson and Lökk (1955) found that the middle ear fluids always contained more protein than the corresponding sera, averaging 11.4% (variation 7.0 - 16.3%). This higher protein content cannot be explained only by water absorption from the middle ear cavity. (Footnote). They base this on the electrophoretic pattern. They also observed that in cases of long duration the fluid aspirated contained relatively more gamma globulins than the serum of the same patient, and they assumed that a local synthesis of the gamma globulin would possibly occur in the middle ear cavity. This has been corroborated by Vuori (1960) who adds that in addition to the reticulo endothelial system, free lymphocytes, plasma cells and probably also macrophages possess the ability of producing gamma globulins in one way or another.

Gessert et al. (1959) and Senturia et al. (1958, 1961) find that no clear-cut distinction can be made between the various types of effusions on the basis of their protein content alone. The greater viscosity of the muco-purulent specimens, as compared with serous effusions, is not due to the presence of less water or more total protein.

Footnote: It has been suggested, (Jarvis, 1968) that the osmotic tension of the middle ear fluid should be measured, as water absorption would only take place if the osmotic tension of the fluid is less than that of blood plus capillary pressure.

There is a very good correlation between the number of cells found cytologically and the amount of D.N.A. found chemically. Even the serous specimens contained enough D.N.A. to indicate that they were not purely transudates of blood plasma such as one might expect in a hydrops ex vacuo.

The concentration of protein bound carbohydrate correlates very well with the cytological findings regarding mucous strands.

Summary.

The middle ear fluids have been extensively investigated by biochemical tests and electrophoresis and microscopy. These tests have shown the fluid to be an exudate and the protein fractions to be more or less identical with those in normal serum. The exudate has escaped from the capillary blood vessels of the swollen middle ear mucosa and has a high cell content. The fluid is characteristically mucoid and sticky and shows a positive reaction to mucicarmine, P.A.S. or alcian blue, and has a high mucopolysaccharide content indicating the presence of mucous. The exudate then mixes with the mucous secreted by the glandular structures, thus forming sero-mucous fluid. (Harrison, 1967).

The fluid then consists of exudate plus secretion

None of all the titles suggested in the introduction fit this concept. A clumsy name, such as secretory exudatory otitis media, would be correct but is too long for general usage.

The term, chronic middle ear effusion, is suggested as simple, correct and descriptive.

CHAPTER VIII.

DISCUSSION AND CONCLUSIONS.

The fluid in chronic middle ear effusions is of an inflammatory nature and neither bacteria nor viruses can be cultured from it.

A suppressed bacterial infection due to incorrect application of antibiotics is rejected as the etiological factor from findings in this clinical survey (Chapter II).

An allergic etiology is likewise rejected due to the negative history and clinical findings in this survey. Also, the pathological evidence in histologic material or fluid does not substantiate an allergic etiology (Chapter III).

The Hydrops ex Vacuo Theory.

This most generally accepted theory rests upon the existence of tubal occlusion.

Tubal catarrh leads to obstruction of and gas absorption from the middle ear cleft. Air absorption

from the middle ear, with its rigid walls, leads to collapse of the tympanic membrane and formation of a transudate through the thin capillaries into the relative vacuum.

This argument cannot be upheld because:

(a) Biochemical analyses and cytological examination have shown the fluid to be an exudate and not a transudate.

(b) Clinically, a completely blocked eustachian tube is very rare and experimentally difficult to produce. Senturia (1963) cauterized the nasopharyngeal orifices of the eustachian tubes in dogs to produce experimental tubal blockage and effusions. He was impressed to find that the eustachian tube returned to normal and was patent in spite of a persistent middle ear inflammatory process. The lumen was unobstructed in all cases after the third day confirming the clinical observation in humans that in long-standing cases of middle ear effusions the eustachian tube is patent and may be inflated without difficulty. The eustachian tube has, indeed, a very remarkable ability to recover from trauma or infection. Other attempts have been made to prove hydrops ex vacuo by producing tubal occlusion in dogs. Beck (1914) inserted wooden plugs into the

pharyngeal ostium, and Claus (1930) injected paraffin submucosally. A purulent otitis invariably resulted. Holmgren (1914) hermetically sealed off the tube by ligation. No negative pressures were recorded in animals which died after one day. After several days 6 out of 9 animals showed negative pressures ranging from minus 5 to minus 7 cm.H_2O with a sero-mucous effusion. Van Dishoeck (1941) calculated that in aerotitis media a requirement for the purely mechanical transudation ex vacuo is a negative pressure of at least -150 cm.H_2O in the middle ear. He believes other factors such as anoxia come into play in aerotitis.

(c) Sloan (1968) believes that a transudate is very unlikely because small pressure differentials can cause fluid shifts between solutions with only a membrane between them, e.g. ascites, pulmonary oedema. However, for fluid to transude from the vascular compartment to the air space of the middle ear would require a great force of $\pm$ 5 atmospheres to overcome the total osmotic effect (colloid and crystalloid) of the body fluids. The highest negative pressure ever recorded by Van Dishoeck was -50 cm.H_2O.

(d) Clinically, one frequently observes a bulging drum

and at myringotomy the fluid escapes as though under pressure.

An acceptable conception of the pathogenesis of chronic middle ear effusions must explain:

i) What is the actual nature of the inflammatory process?

ii) Why it is chronic and why does the effusion tend to recur repeatedly after aspiration?

iii) If one does not accept the hydrops ex vacuo theory, why does the insertion of middle ear vents have a markedly favourable effect on the course of the disease?

I propose the following conception:-

Although the pathologic picture is that of inflammation no organisms can be isolated. An upper respiratory infection, bacterial or viral, results in an ascending infection via the tube to involve the middle ear cleft. This results in vasodilatation, chemotaxis of the usual inflammatory cells, increased capillary permeability with diapedesis of cells and exudation of fluid. (See Fig.XIII)

Usually the inflammatory process is neutralized at this stage by the body's immunologic responses, and the exuded fluid is absorbed and evacuated via the eustachian tube. Alternatively, the infecting agent may

be more virulent, or the immunologic defence reaction may not be prompt, allowing the inflammation to proceed to increased tension within the tympanic cavity with pressure necrosis of the drum. Rupture of the drum leads to discharge of the purulent material. The inflammation usually subsides, the discharge becomes more mucoid in character and finally stops and the tympanic membrane heals or a perforation persists.

There is still a third alternative outcome possible, midway between the former two, and this alternative leads to a chronically retained middle ear effusion, thus: The local antigenic response described by Siirala and Vuori (1954) and Siirala (1957), and Siirala et al. (1961) appears to be vitally important in the understanding of this otherwise perplexing condition. They demonstrated that the middle ear fluid has in vitro bacteriocidal and bacteriostatic properties and an inhibitory effect on viruses. Siirala says, "it seems that the antibacterial and antiviral effect is a prominent factor in the defensive mechanism of the middle ear, and that it plays a part in sterilizing this fluid in cases in which the accumulation of fluid in the tympanum is

due to an inflammation of infectious origin and in keeping it sterile".

Thus it can be argued that in a bacterial or viral otitis media the infecting agent may have been destroyed or rendered hypovirulent, accounting for the consistently negative bacterial and viral cultures. The inflammatory process is halted in a pre-suppurative phase. This answers the first of the 3 questions posed earlier.

The problems raised by the second and third questions, namely, why is the effusion chronic or recurrent and what is the role of negative pressure, can be conveniently discussed together. I believe they are intimately interwoven.

It was conclusively shown in Chapter V that virtually all cases, certainly the typical chronic relapsing cases, show radiologically small, contracted, infantile mastoids. Thus, with Wittmaack I accept that something prevented the proper development of the air cell system - probably Aschoff's sterile otitis media neonatorum. Much later, with a peak at around the 7th year, the individual presents with deafness and effusion. The sub-normally

developed air-cell system will react more rapidly and in a more marked fashion to tubal obstruction because of the absence of the compliant buffering effect of a well-developed air-cell system.

The eustachian tube is a relatively long tube (35 - 40 mm.), lined with respiratory epithelium. It narrows down to an isthmus of approx. 2 mm. inner diameter and in the medial half there are longitudinal mucosal folds allowing expansion similar to the oesophagus. Poisseuille's law states that halving the diameter of a given tube will increase the resistance to flow 16 times. (In this case the flow of exudate towards the pharynx and the flow of air towards the middle ear).

Slight degrees of inflammatory swelling will reduce the diameter of the tube and retard drainage.

Let us, in the context of flow and drainage, look at the physical characteristics of the effusion. The glands of the middle ear mucosa are stimulated by the inflammatory process to secrete mucous (Politzer, 1886; Hoople, 1950; Sade, 1966). Excessive amounts of thick mucous imparts such a high viscosity to the effusion that drainage becomes virtually impossible.

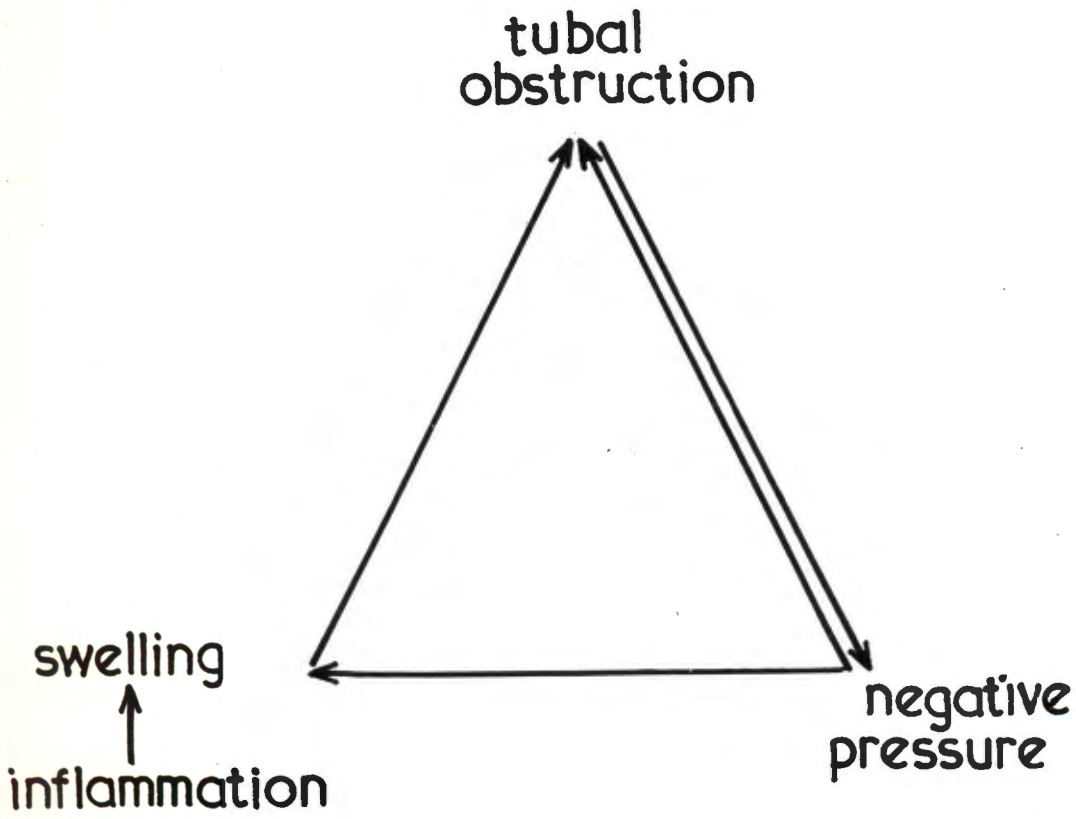
tubal
obstruction
swelling
inflammation
negative
pressure

FIG. XXI.

Even brief obstruction produced by a viscous effusion and a swollen mucosa, will, in the contracted mastoid,lead to a precipitous fall in middle ear pressure. The negative pressure will enhance the obstruction by occluding the eustachian tube like a flutter valve. Now a self-perpetuating cycle is established of tubal occlusion leading to relative vacuum in the middle ear which in turn leads to further obstruction. This dynamic concept is characterized in the accompanying diagram (Fig.XXI).

The negative pressure is probably not of a very high order, certainly less than -50 cm.H_2O. It is far below the level needed to produce a hydrops ex vacuo, but unless relieved by myringotomy and middle ear vent, the effusion is bound to be chronic and recurring.

The analogy of the oesophago gastric junction is evident. The intraluminal pressure of the oesophagus is negative and the intragastric pressure is positive, yet reflux does not take place. With respiration the pharyngeal pressure is positive and with a negative middle ear pressure equally effective tubal obstruction is produced.

This conception explains why retrograde tubal

inflation is possible in all cases and radiologically patent tubes are demonstrated (Chapter VI) in chronic middle ear effusions. The trapped, exuded and secreted products retained in the middle ear, in themselves may act as irritants and incite an inflammatory process leading to further exudation. This effect may be exerted by the high protein content or a local allergic reaction by means of the allergens released following disruption of the infecting organisms (Adlington and Davies, 1969).

This concept explains the beneficial effect of a grommet tube. One knows that it does not act as a drain as the highly viscous fluid could never drain outwards through its narrow lumen. It acts merely as an air vent, allowing equalisation of pressure. By re-establishing atmospheric pressure in the tympanum for a prolonged period - many weeks or months - the swollen, chronically inflamed mucosa may gradually regress and regain its clearance function.

Myringotomy alone, as a therapeutic measure, is futile, as the drum rapidly heals and closes, intratympanic negative pressure is re-established and the cycle of viscous effusion, obstruction and negative pressure continues.

With regard to nomenclature, the commonest terms in the current literature are serous or secretory otitis media. They are misnomers in that the fluid consists of both a secretion and an exudate. Although initially of inflammatory origin, neither viable bacteria or viruses can be obtained from the fluid in the chronically established phase. Therefore, the term otitis media is not strictly correct. The term chronic middle ear effusion is suggested.

Conclusion.

The individual with a small, poorly developed mastoid air cell system is at a disadvantage should he suffer an upper respiratory tract infection spreading to the middle ear cleft. This middle ear is an otitic cripple, poorly equipped to deal with an effusion, negative pressure developing rapidly due to reduced compliance. This leads, together with mucosal swelling and a viscous effusion, to chronic retention of the fluid.

The fluid is kept sterile by the bacteriostatic, bacteriocidal and viral inhibiting effect of the fluid.

CHAPTER IX.

SUMMARY.

A clinical series of 100 cases of chronic middle ear effusion personally investigated and treated by the author is described.

Allergy and misuse of antibiotics were unimportant factors in the etiology. The symptomatology and clinical features are described. The surgical treatment recommended is myringotomy and insertion of a middle ear vent.

Pathological specimens of the middle ear mucosa are difficult to obtain. Twelve tissue samples were studied revealing various stages of inflammation. Focal granulomas were unexpectedly common, being present in a third of the specimens. The fluid of 58 cases was examined cytologically. This revealed that inflammatory cells were predominant. No eosinophiles were seen.

A suction and trapping apparatus was evolved which enabled specimens to be sent to the pathologist without intermediate handling of the material.

Thirty-three middle ear aspirates, 10 pharyngeal swabs and 9 specimens of adenoidal tissue were cultured for mycoplasmas. Thirty-one aspirates, 8 swabs and 4 adenoidal specimens were also cultured for viruses. Only once was Adeno-virus type 8 isolated from one of the specimens of adenoids. These negative findings confirm the findings of other workers, but do not exclude a viral etiology, as viable virus may only be present at the onset of the disease.

A definitive description of the radiographic appearance of the temporal bone in chronic middle ear effusion is given. Sixty-eight patiehts were radiologically investigated.

Contrast tympanography was evolved to study middle ear clearance. Good outlines were obtained of the middle ear, cell system and eustachian tube, but the clearance rates found were inconclusive.

Finally, all the foregoing is synthesized in a dynamic concept of the etio-pathogenesis of this perplexing, albeit common, disease.

The international literature emanating mainly from Scandinavia, Germany, France, England and the U.S.A.

is reviewed appropriately under the various headings.

This study has cleared the air in some respects; some questions remain to be answered and numerous aspects need further elaboration.

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