PREVALENCE OF OTITIS MEDIA WITH EFFUSION AMONG PRIMARY SCHOOL CHILDREN IN KINTA VALLEY, PERAK

by

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State of Perak, Malaysia

Malaysia lies in the equatorial zone. Being in the tropics the average temperature throughout the year is constantly high (26^0C). The humidity is high (around 80%) due to the high temperature and high rate of evaporation. The rainfall is also heavy (more than 2500mm).The ethnic compositions of the country, as of 1988 census, are as in table 1.

Table 1: Ethnic composition of Malaysia.

Malay	10,480,000
Chinese	5,499,000
Bumiputeras	2,233,000
Indians	1,577,000
Others	677,000
TOTAL	20,466,000

Perak is bounded to the north by Penang Island, south by Selangor, to the east by Kelantan and Pahang and has a coastline facing the Straits of Melaka to the west.

In terms of GDP (Gross Domestic Product) per capita, the growth for Perak increased by 11.6% per year between 1996 and 1997. In 1998, the state achieved per capita GDP of 0.6% as compared to the national average of 1.2%.

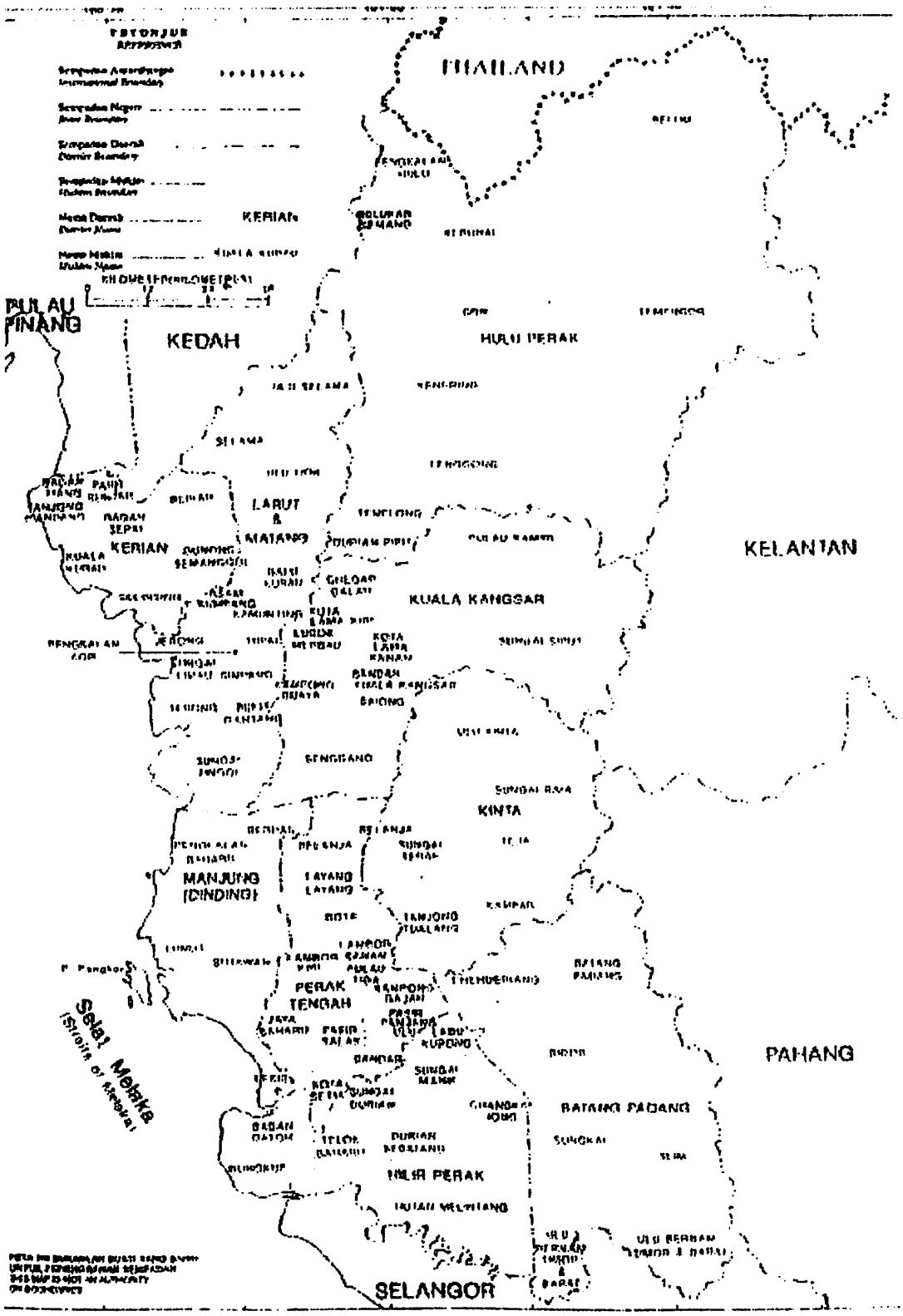

Figure 1: Map of Perak state.

ABSTRACT

IN BAHASA MALAYSIA

Objektif

Matlamat kajian ini dibuat adalah untuk menentukan prevalens penyakit otitis media dengan effusi di kalangan murid sekolah rendah yang berumur di antara 7 hingga 12 tahun di Lembah Kinta, Perak. Kajian ini merupakan kajian pertama yang dibuat di daerah ini.

Metodologi

Kajian ini dijalankan di antara Oktober 1999 sehingga November 2000. Sejumlah 1056 pelajar di antara umur 7 sehingga 12 tahun telah diperiksa. Lima sekolah kebangsaan di Lembah Kinta telah di pilih. Kesemua bangsa di negara ini telah dikaji, iaitu, banga Melayu. Cina dan India. Kebenaran daripada Jabatan Pendidikan, pengetua sekolah yang berkenaan dan ibubapa telah diperolehi. Kesemua penuntut telah diperiksa dengan mengunakan otoscop dan 'portable tympanometer'. Kanak-kanak yang mempunyai penemuan otoscopi yang tidak normal dan/atau 'tympanogram' yang tidak normal telah diperiksa lagi di Hospital Ipoh yang merupakan hospital rujukan. Di Hospital Ipoh, kanak-kanak ini menjalani pemerikaan lanjut dan menjalani pemeriksaan audiometri. Ini dibuat untuk mengetahui kadar kekurangan pendengaran di kalangan kanak-kanak ini.

Keputusan

Daripada 1056 pelajar yang dikaji, terdapat seramai 610 orang lelaki dan 448 orang perempuan. Terdapat bilangan pelajar yang sama rata di dalam semua golongan umur. Pelajar Melayu membentuk kumpulan terbesar yang dikaji, sejajar dengan census negara di mana banga Melayu membentuk kumpulan majoriti. Daripada jumlah 1056 pelajar yang dikaji, prevalens otitis media dengan effusi di kalangan ini hanya 1.8% dan ini hanya terdapat di golongan bangsa Melayu. Ianya juga sama rata di dalam kedua-dua jantina. Kelihatan juga bahawa ianya tinggi di kalangan pelajar muda dan semakin menurun apabila umur pelajar meningkat. Kadar kekurangan pendengaran konduksi di antara mereka yang di diagnosa dengan otitis media dengan effusi hampir minima, dengan hanya 0.2% mempunyai kehilangan ambang kondiksi lebih daripada 30dB.

Kesimpulan

Prevalens otitis media dengan effusi di antara para pelajar di antara umur 7 dan 12 tahun di Lembah Kinta adalah rendah dengan hanya 1.8% yang mempunyai penyakit ini.

ABSTRACT

Objective

The ascertain prevalence of otitis media with effusion among primary school children between the ages of 7 to 12 years in Kinta Valley in the state of Perak in Malaysia. This was a pilot study done in this state.

Methods

This was a cross sectional study done between October 1999 to November 2000. A total of 1056 students between the ages of 7 to 12 years were screened. Five national schools in the Kinta Valley were chosen. All the three major ethnic groups in Malaysia were screened, that is, the Malays, Chinese and Indians . Consent from Ministry of Education, the respective school headmasters and parents were obtained. The students were screened using otoscopy and portable tympanometry. Children who had exhibited abnormal otoscopy findings and /or abnormal tympanogram were given referral letters for further evaluation in Hospital Ipoh which is a tertiary hospital. At Hospital Ipoh, these children were further evaluated and pure tone audiogram was done. This was done to see the degree of hearing deficiency among these children.

Results

Of the 1056 students screened, there were 610 males and 448 females. There were equal number of student distribution among all the age groups. Malays formed the major group screened, which is in keeping with the national census,

where Malays form the majority group. Of the total 1056 students screened, the prevalence of otitis media with effusion was only 1.8% and this was prevalent only in the Malays ethnic group. There was also equal distribution of the prevalence of otitis media with effusion among the gender group. It was also seen to be higher in the younger age group and decreases as the age increases. The hearing deficiency among those diagnosed with otitis media with effusion was almost minimal with only 0.2% having conductive hearing loss more than 30dB.

Conclusion

The prevalence of otitis media with effusion among the school children between the ages of 7 and 12 years old in the Kinta Valley was low with only 1.8% having this disease.

CHAPTER 1

INTRODUCTION

INTRODUCTION

Otitis media with effusion in children has remained an interesting entity since the time of Hypocrites. Time and again studies have been conducted in different parts of the world with conflicting results.

Two such studies have been taken previously in Malaysia by Elango *et al* in 1991 and Saim *et al* in 1997 covering a population of east coast and west coast of Malaysia respectively.

Current study was planned in the state of Perak for the first time to compare with the other two previous studies.

1.1 Definition

Otitis media with effusion (chronic otitis media with effusion, secretory otitis media, nonsuppurative otitis media, catarrh, serous otitis media, serotympanum, mucoid otitis media, mucotympanum) refers to the presence of middle ear effusion (MEE) behind an intact tympanic membrane without acute signs and symptoms. This broad term includes nonsuppurative or clinically noninfectious forms of otitis media (Klein *et al,* 1989)

1.2 Literature Review

Many studies done worldwide showed vast range of prevalence and incidence of the disease. Many of the studies were population based, with subjects selected from the community-at-large. Others were clinic-based, reflecting the experience of children being examined and treated for middle ear disease. Still other studies were conducted in the school or day care setting. Those with cross-sectional designs have provided otitis media prevalence estimates, whereas prospective studies have provided estimates of incidence, prevalence, and description of the natural history of otitis media.

It is estimated, the annual incidence ranges between 14% and 62%, whereas prevalence estimates are between 2% and 52%. Many of the studies that have investigated the relationship between OME and age have reported that the incidence and prevalence peak in the preschool years and decrease as age increases (Daly, 1991). In the literature, there has been some debate regarding the age at which prevalence rates for OME are highest. A review on 23 studies showed a bimodal distribution of prevalence in childhood. The prevalence rises from birth onwards and reaches its maximum at about 2 years of age. After the age of two years, there is a steady decline in prevalence followed by a second peak at around 5 years of age. This review is limited to children between the age ranges of 6 months to 10 years (Zielhuis, 1990).

However, many of the studies have been done in the western world with little information from the developing countries, especially the Asian countries.

These studies are also limited to the ages from neonates to 8 years old with very few data on children in the later age group.

The prevalence of OME in Malaysia amongst schoolchildren aged between 7 and 12 years was estimated to be 2.9% (Elango *et al*, 1991). This study was done to see the prevalence of hearing loss and ear disorders in Kelantan using otoscopy and audiometer. However, 46% of cases with middle ear disorders were not detected using the pure tone audiometry. In another study done in Malaysia, (Saim *et al*, 1997) a cross-sectional screening test was performed to determine the prevalence of OME amongst preschool children between 5 and 6 years old in two districts, namely Kuala Lumpur, an urban district and Kuala Selangor, a rural district. The overall prevalence was 13.76%. The urban district had a prevalence rate of 17.89% and in the rural area it was 9.5%. Several factors were found to be significantly associated with the higher prevalence of OME, i.e., the higher socioeconomic status of the parents and bottle-feeding during infancy. Other factors in this study, such as race, premature delivery, passive smoking, allergy, asthma and family size, had no influence on the prevalence of otitis media with effusion.

In another study done in Hong Kong, 5898 Chinese children between the ages of 6 to 7 years were screened for prevalence of OME. These children had an initial otoscopic examination and 226-Hz tympanometry in the school premises. All children who had type B or type C tympanogram with no stapedial reflex was seen in the specialist clinic. A diagnosis of persistent OME was pronounced for those children who exhibited effusion on microscopy or an abnormal

tympanometry with an average air-bone gap of 10dB.(Tong *et al*,2000). An overall OME prevalence rate of 5.3% was found by screening tympanometry and otoscopy in the initial screening and a confirmed diagnosis rate of 2.2%. 32% of the cases resolved spontaneously within 6 months.

In Riyadh, 4214 children between the ages of 12 months to 8 years were examined and the prevalence of type B tympanogram, which was taken to indicate the prevalence of otitis media with effusion, was 13.8%, with 8.1% having bilateral disease and 5.7% having unilateral otitis media with effusion. (El-Sayed & Zakzouk,1995).

In Jamaica, screening was done on 2202 children between the ages of 5 and 7 years. Otitis media with effusion was found in 42(1.9%) of the 2202 children and there was no difference between boys and girls. The prevalence rate of hearing loss and OME was similar in the children attending government-owned and those attending private schools suggesting there is no correlation between socioeconomic status and this condition in Jamaican children. It is likely that the difference in interracial prevalence rates in the studies conducted in developed nations reflect true racial difference rather than the effect of socioeconomic class. The low prevalence rate in this study group is striking and is significantly lower than that found in the same age group in developed countries (Lyn et.al, 1998)

These figures are in contrast to the higher figures reported in western studies. In the Netherlands, 1439 children between the ages of 2 to 4 years old were

screened and it showed an initial high prevalence of 95% but these children were followed-up and during the course of the study 15-20% of the children had bilateral otitis media with effusion. This study had a high number of dropouts with only 43 children completing the trial because of loss to follow-up and logistical reasons (Zielhuis, 1989)

1.3 Historical background

Hippocrates, the father of medicine was probably the first to inspect the tympanic membrane, "a dry thin-spun web," and to recognize it as part of the organ of hearing. Among his statements were "children suffer from ear disease, adults from deafness."

B.H.Senturia and others first published the term 'glue ear' in 1960 in an article on middle ear effusion. There is evidence of similar description of middle ear filled with mucus that was relieved by incising the eardrum back to the Hippocratic School in 400 B.C.

The use of myringotomy as a treatment for deafness was popularized by Sir Astley Paston Cooper (1768- 1841). He insisted on performing bone conduction and that the nerve of hearing should be healthy before performing myringotomy. He also recognized that eustachian tube obstruction could arise from common cold, obstruction of tonsils and fibrosis from venereal disease. (Weir, 1990)

1.4 Anatomy

1.4.1 Nasopharynx

The nasopharynx lies behind the nasal cavity and above the soft palate. On the lateral wall is the torus tubarius, which protrudes into the nasopharynx. This is formed by abundant soft tissue overlying the cartilagenous part of the eustachian tube. Anterior to this is the triangular nasopharyngeal orifice of the eustachian tube. From the torus, a raised ridge of mucous membrane, the salphingopharyngeal fold, descends vertically.

1.4.2 Eutachian tube

In adults it lies at an angle of 45^0 in relation to the horizontal plane, whereas in infants this inclination is only 10^0 . The tube is longer in the adult than in the infant and in young children and its length varies with race. The posterior third of the adult tube is osseous and lies completely within the petrous part of the temporal bone and is directly continuous with the anterior wall of the superior portion of the middle ear cavity. The healthy osseous portion is open at all times unlike the fibrocartilagenous portion of the tube which is closed at rest and opens during swallowing or forced open such as during the Valsalva maneuver. The osseous and the cartilaginous portion meet at an irregular bony surface and form an angle of about 160^0.

The cartilagenous portion which forms the anterior two thirds, courses anteromedially and inferiorly and is firmly attached in its posterior end to the osseous orifice by fibrous band and usually extends some distance into the osseous portion of the tube. Tubal cartilage increases in mass from birth to puberty. The narrowest point in the lumen is called 'isthmus' and its position is usually at or near the juncture of the osseous and cartilagenous portion of the tube. From the isthmus, the lumen expands to 8 to 10 mm in height and 1 to 2 mm in diameter at the pharyngeal orifice. The lumen has a constant height, and there are only small differences between the height of the isthmus in the child and adult. The lumen is lined by respiratory epithelium, same as that of the nasopharynx and middle ear cavity. However, mucous glands predominate at the nasopharyngeal orifice and there is a graded change to mixture of goblet, columnar and ciliated cells near the tympanum. The mucociliary defense system within the tube starts in fetal life and is well established soon after birth.

1.4.3 Tympanic membrane

The tympanic membrane is a thin, semitransparent membrane, which separates the middle ear from the external auditory canal (Figure 2). It measures 8 to 10 mm in diameter and is obliquely placed forming an angle of about 55^0 with the floor of the external auditory meatus. The outer margin is thickened and forms a fibro cartilaginous ring known as the tympanic annulus, which is fitted into the bony tympanic sulcus. Superiorly, where the ring is deficient, the tympanic membrane is lax and thin due to absence of middle fibrous layer and this triangular area is known as pars flaccida or the

Sharpnell's membrane. The remaining portion is known as pars tensa. The most depressed portion of pars tensa is known as umbo.

The tympanic membrane has three layers: an outer (cuticular), a middle (fibrous) and an inner (mucous) layer. The outer layer is derived from the skin of the external auditory canal and consists of stratified epithelium. The middle layer consist of two layers: a superficial layer with fibers diverging out from the manubrium of malleus and a deep layer of circular fibers with abundant fibers near the circumference and few fibers near the center. The inner layer is derived from the mucous membrane of the middle ear cavity.

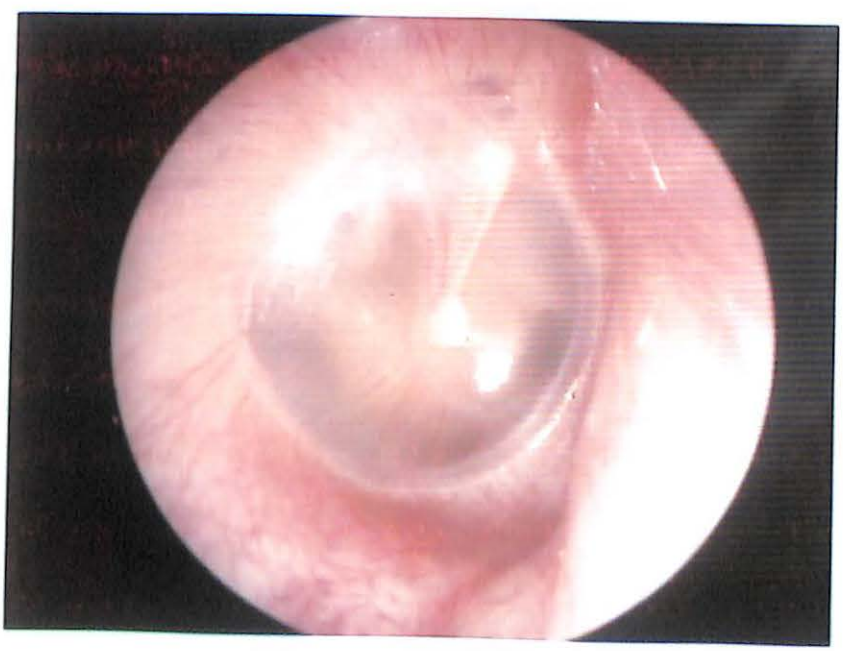

Figure 2: Normal tympanic membrane

1.5 Structure of tympanic membrane in otitis media with effusion.

Many studies have been done to look at the tympanic membrane changes during the course of otitis media with effusion but little is known regarding the pathogenesis of these lesions. The disease can present in many forms due to the large variation in the nature of effusions, from serous, mucoid to purulent fluid. The tympanic membrane can be affected in many ways due to the sequelae of the disease like atrophy, tympanosclerosis, adhesive otitis and perforations.

In otitis media with effusion, the distinct change is seen in the submucosal layer. The submucosal layer shows edema, fibrosis and decreased thickness of the circular and radial fibers of the tympanic membrane during histopathological examination (Sano *et al, 1994).*

In another study done in animals, it demonstrated the effect of the various types of effusion on the tympanic membrane structure (Wielinga *et al*, 2001). In serous effusions, the medial side of lamina propria showed edema, macrophages and increased fibroblastic activity. The circular and radial fibrous layer showed marked calcification. It also resulted in tympanosclerotic lesions mainly composed of fibrous tissue showing varying degree of hyalinization and calcification. In infected serous effusions, there is nearly total replacement of the lamina propria by a layer of homogenous connective tissue with normal cellularity. However, hyalinization and calcification do not develop in infected serous effusion. These observations show that the tympanosclerotic lesions

only develop in non-infected serous effusions. In sterile effusions, the lamina propria is disintegrated and is highly susceptible to calcification. In contrast, in infected effusions, the fibrous tissue disappears completely and is replaced by the new lamina propria, which is associated with increased vascularization.

1.6 Pathogenesis of otitis media with effusion

Otitis media is caused by multiple factors. Understanding the pathogenesis helps us in deciding the better methods of treatment. Important factors that contribute to the development of otitis media include infection (bacterial or viral), eustachian tube dysfunction, immunological status, allergy, environmental factors like day-care attendance, smoking in household, or a combination of factors.

1.6.1 Role of eustachian tube function in otitis media with effusion

The eustachian tube has three physiologic function (Bluestone, 1985) with respect to the middle ear: equilibration of air pressure in the middle ear with the atmospheric pressure, protection from nasopharyngeal secretions, and clearance into the nasopharynx of secretions produced within the middle ear.

A great bulk of evidence support the concept that eustachian tube dysfunction, or blockage, is a prerequisite in the development of negative pressure in the middle ear and for the subsequent development of effusion in the middle ear space. (Figure 3). The eustachian dysfunction can be due to obstruction and

abnormal patency of the eustachian tube. Obstruction may be either functional or mechanical. Functional obstruction is due to either persistent collapse of the eustachian tube because of increased tubal compliance or an inadequate tubal opening mechanism, or both. This results in persistent high negative middle ear pressure

Mechanical obstruction can be either extrinsic or intrinsic (Chopra, 2000). Intrinsic origin can be due to direct anatomical factors such as cleft palate, submucosal defect, short bony eustachian tube and horizontal eustachian tube. Extrinsic causes can be due to nasopharyngeal disproportion, like craniofacial abnormalities, hypertrophied adenoids and other nasopharygeal lesions, and impaired mucociliary clearance due to infection, primary ciliary disease, immunological disorders and allergic conditions.

There can also be an inherent functional defect of the eustachian tube in which the pressure equalization within the middle ear cavity is ineffective. The abnormally patent eustachian tube permits nasopharyngeal secretions into the middle ear and results in 'reflux' effusion. For example, sniffling can produce negative pressure in the middle ear resulting in ET dysfunction and OME.

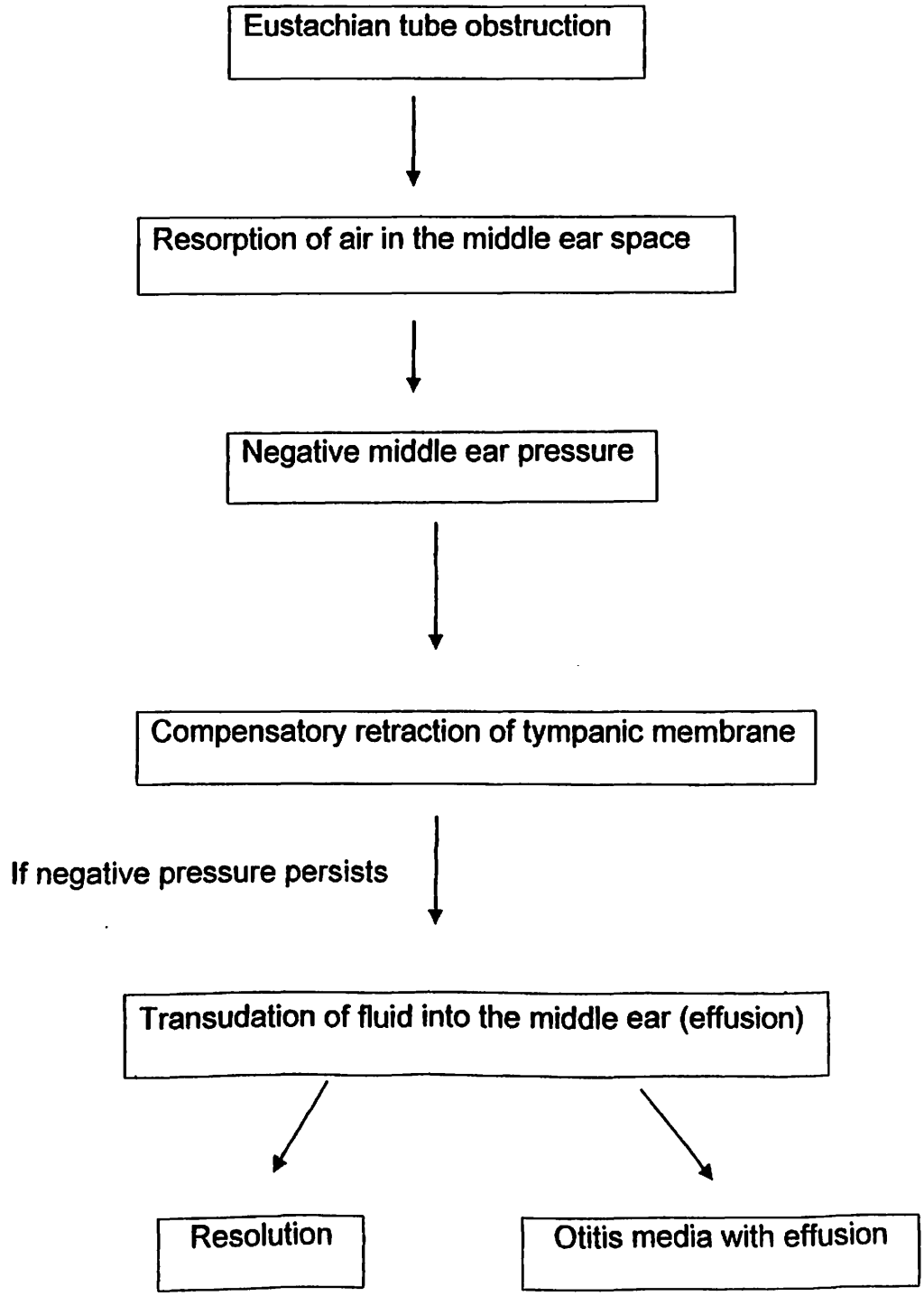

Figure 3: The sequence depicting evolution of otitis media with effusion

1.6.2 Infection

The role of infection, be it viral or bacterial in the pathogenesis of OME has been greatly investigated. Although viruses are not identified in the middle ear effusion, there is evidence to suggest that upper respiratory infection predisposes the ear to infection. Adenoviruses and respiratory syncytial virus antibodies were detected in 50% and parainfluenza 3 antibodies in about 20% of the acute otitis media patients. The possible mechanism for the development of OME is paralysis of the mucociliary system and mucosal swelling, causing tubal dysfunction or immunosuppression resulting from viral infection in the middle ear cleft. (Lim,1982)

Viral upper respiratory infection facilitates extension of pathogenic bacterial infection into the eustachian tube and middle ear cleft from the nasopharynx. Many studies done show that, there is presence of bacteria in the effusions obtained from children who had OME. The most common organism cultured is *Haemophilus influenzae* and the second most common pathogen was *Moraxella catarrhalis.* (*Bluestone et al, 1992*)

1.6.3 Immunologic reactivity in otitis media with effusion

The normal middle ear mucosa, is devoid of immunologic elements like lymphocytes, plasma cells and macrophages. Furthermore, it is devoid of neutrophils. However, in otitis media with effusion, the effusion results in an increased number of goblet cells and glands. Therefore, bacteriologic factors are necessary for the influx of immunocompetent cells. There are three possible

sources of the immunocompetent cells to reach the middle ear. They are 1) the gastrointestinal-associated lymphoid tissue (GALT), 2) the bronchus-associated lymphoid tissue (BALT), and 3) the tonsils and adenoids. However, there is no direct evidence of the immunocompetent cell from the GALT and BALT reaching the middle ear mucosa.

In contrast, tonsils may be a major source of producing IgA for the middle ear mucosa and this is an important immunoglobulin in the immunoregulation of the bacterial and viral diseases of middle ear infection. In addition, a decrease in the IgG immunoglobulin may be related to the development of recurrent otitis media. There is accumulating evidence that one of the possible factors in the development of otitis proneness is the genetic inability of these children to produce humoral antibodies against bacteria in levels that are sufficient either to protect the child against bacterial infections in the middle ear or to eradicate the bacteria once they arrive at the level of middle ear mucosa. (Bernstein, 1988)

There is also increased incidence of OME with allergic rhinitis. Allergic rhinitis develops due to interaction of the antigen and IgE antibody-bearing mast cells in the nasal mucosa. This interaction, experimented in monkeys, stimulates the release and synthesis of inflammatory chemicals. These mediators increase vascular permeability, mucosal blood flow, and mucous production. Intrinsic venous engorgement and extrinsic mucous plugs effectively obstruct the eustachian tube. The presence of inflammatory mediators in the nasal mucosa increases mucosal blood flow in the middle ear. This causes significant middle

ear under pressures that disrupt tight junctions and allow for the transudation of fluid into the middle ear cleft. Release of inflammatory mediators in response to the transudative event contributes to the middle ear inflammation and stimulates mucosal metaplasia and glandular activity, which is the hallmark feature of OME. (Bernstein & Doyle, 1994)

1.7 Diagnosis of otitis media

1.7.1 History

Most cases of OME are asymtomatic. Conductive hearing loss is the most common presenting symptom (Jung, 1991). Attentive parents may bring their children to a physician because of suspected hearing loss or delayed speech. Children with cleft palate, a history of allergy, symptoms of adenoid hypertrophy or immune deficiency have a higher incidence of OME than normal children. (Maw,1998).

1.7.2 Physical examination

A careful otoscopic examination of the tympanic membrane is the most important method to diagnose OME accurately. At the time of otoscopic examination, color, translucency, and contour of the TM should be evaluated carefully for signs of OME.

Typically pearly grey, the normal TM is replaced by an opaque creamy or yellow and bulging drumhead. In serous otitis media, the TM appears amber or straw-colored with normal contour. The TM in mucoid otitis media is characterized by an amber, thick, opaque appearance, with mild to moderate retraction and increased capillary vascularity on the surface. The TM may appear dark blue (idiopathic blue drum), which is associated with long standing OME with thick, mucoid fluid and cholesterol granuloma. Retraction of the TM becomes evident when handle of the malleus appears shortened and to lie in a

more horizontal position. The lateral process of malleus thus appears more prominent. The retraction may progress to touch the promontory and the incudostapedial joint or to skeletonize the ossicles and the medial wall of the middle ear. (Pelton,1998, Bluestone & Klein,2001)

Air bubbles or air-fluid level may be seen through the TM (Figure 4). This is seen in older children or in adults who have OME that is about to resolve. This is an indication of favorable prognosis.

Figure 4: Air bubbles seen behind the tympanic membrane.

Impaired mobility of the TM detected by pneumatic otoscopy is a valuable positive sign of OME. Examination of the ears with an operating microscope helps to diagnose OME accurately and should be used whenever the diagnosis is not apparent. In older children or in adults, a tuning fork test can be used to confirm conductive hearing loss.

1.8 Audiological evaluation

1.8.1 Tympanometry

Tympanometry is the most accurate diagnostic tool for the detection of OME when it is used in conjunction with otoscopic examination. In typical OME cases, the tympanogram shows a flat B curve. The stapedial reflex usually does not yield a response. Air and bone pure tone audiometry shows a mild to moderate conductive hearing losses having a mean hearing threshold ranging from 17dB to 34dB.(Maw, 1998)

Tympanometry is a technique for indirectly characterizing tympanic membrane compliance and estimating middle ear pressure by means of electroacoustic and manometric measurements. The main role of tympanogram in audiology is to detect OME because it gives a reflection of the middle ear pressure.

The most commonly used classification is the one initially proposed by Jerger *et al.* (1974).

Type A - peak between +200 and - 99mmH_2O.

Type C1 - peak between -100 and -199 mmH_2O.

Type C2 - peak between -200 and -399 mmH_2O.

Type C3 -peak between -400 and -600 mmH_2O.

Type B - no observable peak between +200 and -600 mmH_2O.

It is also important to state the pressure range over which the ear was tested. This is to overcome the problem of some machines that can check only to a small negative pressure. In certain instances, a flat tympanogram down to -200 mmH_2O could well peak at -300 mmH_2O, thus reclassifying a type B as a type C tympanogram.

Immitance instrumentation as depicted in figure 5, consist of (Brookhouser, 1998):

1. An external ear canal probe, with three openings, which can achieve an air-tight seal against the canal wall;

2. A sound stimulus generator capable of transmitting at least one frequency stimulus, the 'probe tone', and, in some devises, multiple frequencies that are transmitted through one of the ports;

3. A microphone to detect sound in the external canal via the second port; and

4. A vacuum pump capable of altering the pressure (+ and -) in the external ear canal via the third port.

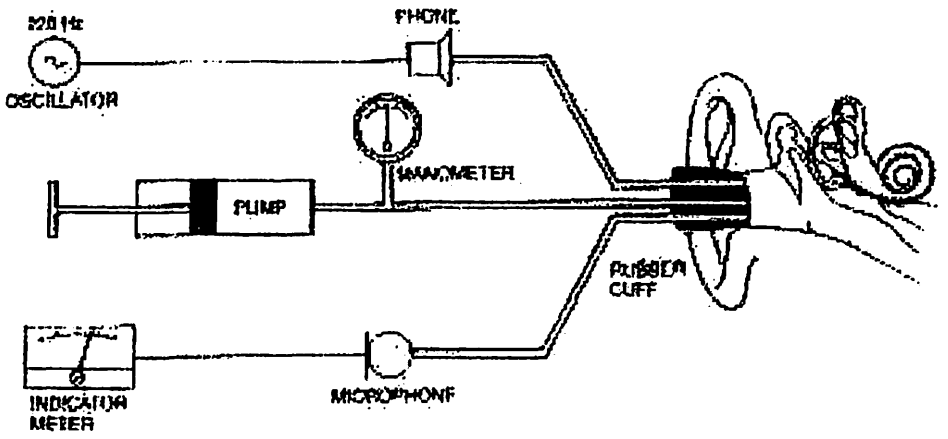

Figure 5. Schematic diagram of tympanometer.

When a probe tone is introduced into the ear canal, some portion of the acoustic energy is transmitted through the tympanic membrane to the middle and inner ear while the remainder is reflected back into the canal. Variation in the admittance characteristics of the tympanic membrane-middle ear complex, produced by either ear disorders or mechanical alterations introduced during the course of immittance testing, can be measured at the probe tip in the ear canal.

Tympanometry involves measurement of admittance (previously labeled compliance) at the probe tip as pressure is varied, generally from positive to negative, in the ear canal. The resultant tympanogram graphically displays air pressure in the x-axis and admittance value on the y-axis. Because factors such as probe tone frequency pump speed and direction of pressure change can affect results, these variables are controlled automatically in all the new devices.

1.7.1.a Static admittance

The difference in millimhos between the peak and tail of the tympanogram in the positive pressure region of the curve is labeled as the static admittance. This is most useful for detecting ossicular chain disorders, including fixation and disarticulation, usually associated with significant conductive hearing loss.

1.7.1.b Tympanometric peak pressure

The highest point in the tympanometric curve is labeled as the tympanometric peak pressure. It is the point of maximum admittance, which occurs when the air pressure is equal on both sides of an intact tympanic membrane. The presence and location of the peak along the x-axis provides an indirect measure of middle ear pressure behind the intact tympanic membrane. It can be positive in the early stages of acute otitis media but typically becomes negative as middle ear effusion develops. (Brookhouser,1998)

1.7.1.c Tympanometric width

The tympanometric width is defined by the sides of the tympanic curve at 50% of the peak static admittance. The tympanometric width has proved useful in determining the probability of middle ear effusion in uncertain cases.

A variety of conditions can alter the shape of tympanogram. Paradise *et al* in 1976 has correlated the different types of tympanogram and their varients with the clinical findings, which has been adapted by many.(Bluestone & Klein, 2001, Kenna, 1999). A normal tympanogram is shown in figure 6.

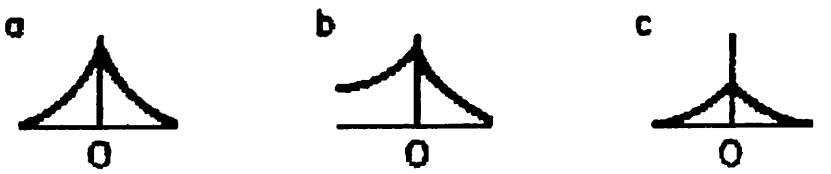

Figure 6: Normal tympanogram with its variants

A flattened tympanogram, with low peak and gradual gradient (Figure 7) suggest that the tympanic membrane compliance is reduced and that its response to changes in external canal air pressure is dampened. This is usually seen when fluid had replaced all or most of the middle ear cavity, or when the tympanic membrane or ossicular chain has been stiffened due to scarring or other pathological changes.

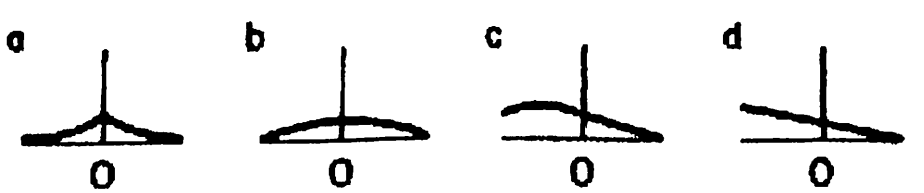

Figure 7: Low compliance tympanogram