ABORIGINAL AND TORRES STRAIT ISLANDER EAR HEALTH MANUAL

Harvey Coates AO.FRACS
Kelvin Kong FRACS
Alastair Mackendrick FRACS
Francis Lannigan MD, FRACS
Shyan Vijayasekaran FRACS
Paul Bumbak FRACS

With

Lou Leidwinger MS
Sharon Weeks MA
Ann Jacobs B.App.Sci.
Peter Morris FRACP
Irene Nannup AHW
Jacinda Burgess Dip Aud

Introduction

The state of a nation's health can be measured by the prevalence of children with chronic suppurative otitis media (CSOM). Otitis media (OM) in all of its forms is a disease of poverty. When the World Health Organization (WHO) defines a 4% prevalence rate of CSOM as being a major public health problem, then the current rates of many times that in some Aboriginal communities is a serious indictment of the poor living conditions in these communities. The effect of up-to-32 months of conductive hearing loss in childhood has a life-long impact on the child's speech and language development and subsequent educational and vocational outcomes.

It is in light of these concerns that public health initiatives to improve the general health of Aboriginal communities by improving housing and access to water, nutrition and medical care have been advocated. In addition, publications such as the "Systemic review of existing evidence and primary care guidelines on the management of otitis media in Aboriginal and Torres Strait Islander populations" from the Office of Aboriginal and Torres Strait Islander Health have become standard reference protocols for management of otitis media. We also thank Australian Hearing for the use of some of their teaching materials. The purpose, then, of this manual is to supplement these guidelines with background teaching material and resources.

The authors are grateful to Kimberley Health and the Health Department of Western Australia for permission to base the manual on the excellent second edition of The Kimberley Ear Health Manual. We appreciate the updated 2010 Recommendations for Clinical Care Guidelines on the Management of Otitis Media in Aboriginal and Torres Strait Islander Populations. We also acknowledge the organizational skills of Ms Jan Zach.

The preparation of this Aboriginal Ear Health Manual was made possible by a seeding grant from the American Society of Paediatric Otolaryngology. The funding for the production for this ear health manual was made possible by a grant from the Telethon Foundation in Perth, Western Australia.

Authors

Clinical Professor Harvey Coates AO, MS, FRACS, Department of Otolaryngology Head and Neck Surgery, University of Western Australia. Senior ENT Surgeon, Princess Margaret Hospital for Children, Perth.

Associate Professor Kelvin Kong FRACS. Consultant ENT Surgeon to John Hunter Hospital Newcastle.

Mr. Alastair Mackendrick FRACS. Former Consultant ENT Surgeon to Kimberley Health Service.

Professor Francis Lannigan MD. FRACS. Department of Otolaryngology Head and Neck Surgery University of Western Australia. ENT Surgeon, Princess Margaret Hospital for Children, Perth.

Associate Professor Shyan Vijayasekaran FRACS. Department of Otolaryngology Head and Neck Surgery, University of Western Australia. ENT Surgeon Princess Margaret Hospital for Children, Perth.

Mr Paul Bumbak FRACS. Consultant Paediatric ENT Surgeon Princess Margaret Hospital for Children, Perth.

Louis Leidwinger MS. Audiologist Pilbara Health Network WA.

Sharon Weeks MA. Audiologist in Private Practice.

Ann Jacobs B.App.Sci. Speech Pathologist in Private Practice, Perth, WA.

Associate Professor Peter Morris FRACP. Paediatrician/Researcher Menzies School of Health, Darwin.

Irene Nannup Former Senior Health Worker, Derbarl Yerrigan Health Service, Perth, WA.

Jacinda Burgess, Doctoral Candidate. Audiologist, Sydney Cochlear Implant Centre, Newcastle NSW.

Foreword

The Hon Richard Court AC, Former Premier of Western Australia, Chairman, The Channel 7 Telethon Trust.

The Channel 7 Telethon Trust has a charter to financially support the medical and social welfare of children and young people, and fund the research into children's diseases.

Funding the production of the Aboriginal and Torres Strait Islander Ear Health Manual which is a practical guide to assist in tackling hearing issues, is a very worthwhile initiative for the Channel 7 Telethon Trust.

We would like to thank the authors and the Government agencies responsible for this publication and we are eager to support its widespread distribution.

Hon Richard Court AC
Chairman
Channel 7 Telethon Trust

FOREWORD TO THE FIRST EDITION

Hearing problems and ear infections are some of the most common problems managed at the primary health care level throughout Australia. How these problems affect the Aboriginal and Torres Strait Islander population has, for some reason, received scant attention in teaching programs. Almost everyone can benefit from teaching material written in plain language and that is the advantage of this Manual. It explains the basics and the essentials of ear health, has superb drawings and photographs, and its sections are compact and readable.

This Manual has been in the making for many years and is a credit to Professor Coates and the health professionals that have contributed to its development. Everyone involved in it has enormous expertise, a strong passion, and have been advocates for improved ear health within the Aboriginal and Torres Strait Islander population for a long time.

This Manual will certainly help address practice uncertainty, but the vital ingredient for effective programs and services will always be their development in partnership with Aboriginal peoples and their representative agencies. I encourage readers to join us in this journey.

Mr Henry Councillor
Chair,
National Aboriginal Community Controlled Health Organisation

Dedicated to Sarah

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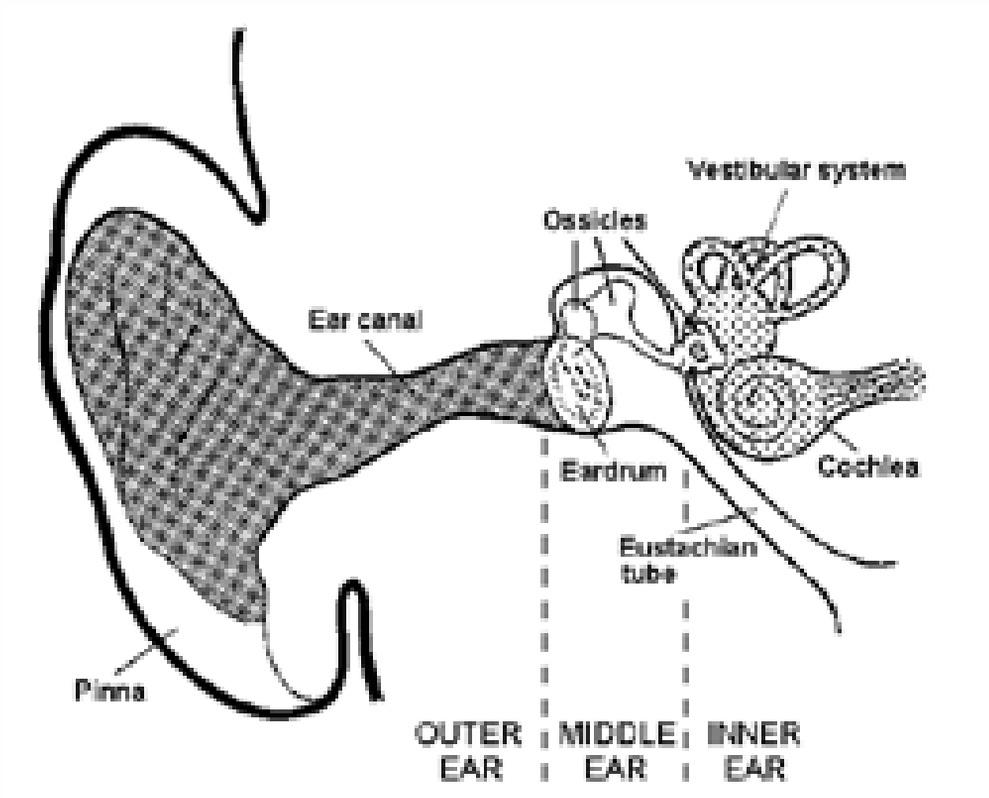
Anatomy and Function of the Ear

Study of the structure and function of various parts of the ear is needed to understand the different types of hearing loss and the methods used in preventing or treating hearing loss. The ear can be divided into three parts, which work together, they are the outer ear, the middle ear and the inner ear.

Basic Anatomy of the Ear



The Outer Ear

The outer ear consists of the pinna and the ear canal ending in but not including the eardrum. The outer ear works like a funnel. It directs sound down the ear and helps localize sound. The ear canal is about 24mm (1 inch) long. It has two bends and ends at the ear drum. The outer two thirds of the canal is formed of cartilage and the rest is bone.

The ear canal is lined with skin. The skin of the outer two thirds is the same as on the rest of the body. The skin contains sweat glands and special glands, which produce wax (cerumen). The wax is sticky and antibacterial and helps waterproof the canal. This prevents small particles from entering the canal and keeps a healthy ear free from infection. The skin is covered with hairs that help move dirt out of the canal. The ear canal ends at the ear drum.

The eardrum has three layers. The outer layer is skin; the middle layer is fibre which gives the ear drum its bounce; and the inner layer of mucous membrane which is part of the lining of the middle ear.

The Middle Ear

The middle ear is an air filled cavity, bridged by the ossicular chain. It passes sound from the eardrum to the inner ear. The ossicular chain is made up of three small bones, the hammer, (malleus) anvil (incus) and stirrup (stapes) .The hammer is attached to the eardrum. The stapes footplate rests on the membrane-covered oval window of the inner ear. When sound waves move the eardrum, they are transferred mechanically through the ossicular chain to the inner ear.

The middle ear is connected to the back of the nose by the Eustachian tube. This connection allows for pressure to be equalized during swallowing, yawning and sneezing. It also acts as a drain. The Eustachian tube is shorter in children and is more likely to get contaminated from the back from the nose. It is because of the difference in the shape and function that makes young children prone to ear disease.

The Inner Ear

The inner ear is a very delicate mechanism. For protection it is located deep in the skull behind the eyes. The inner ear is filled with fluid and contains two sensory systems, the balance and the hearing systems. The back section of the inner ear consists of three canals which give us our balance and help in the stabilisation of eye movement. These are the semi circular canals and are known as the vestibular system.

The hearing system is contained in the cochlea and the auditory nerve. The purpose of the cochlea is to change the signal from a sound message to an electrical message. These electrical messages are sent to the brain by the auditory nerve. The cochlea is a fluid filled snail shell like structure. In it there are about 30,000 tiny nerve endings called hair cells and all these connect to the fibres of the auditory nerve which transmits the sound message to the brain.

Otoscopic features of the eardrum showing the ossicular chain

Causes of Hearing Loss

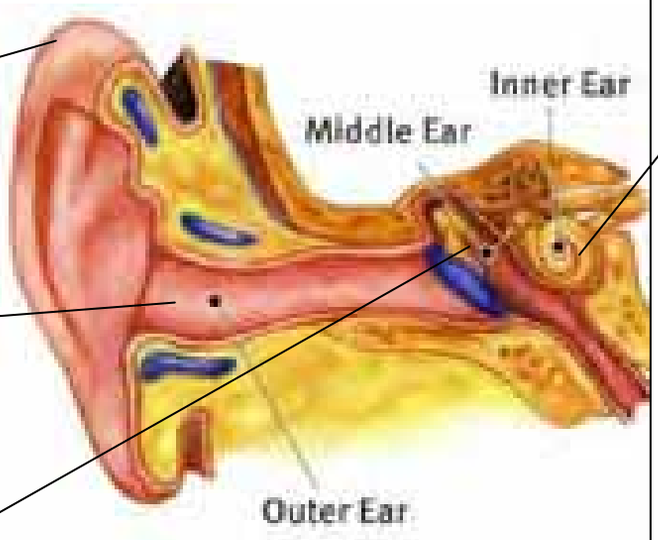
The main causes of hearing loss in Aboriginal and Torres Strait Islander children is otitis media or middle ear infections and its complications including otitis media with effusion (glue ear) and chronic suppurative otitis media.

CONDUCTIVE HEARING LOSS

Congenital Atresia

Wax obstructions
Foreign Bodies

Otitis media with effusion; chronic suppurative otitis media; ossicular problems



SENSORINEURAL HEARING LOSS

Congenital

Genetic
- Syndromic
- Non-syndromic

Non-Genetic

Acquired

Hearing loss – types and effects

There are three types of hearing loss. Below is a brief description of them.

Sensorineural
Sensorineural hearing losses are caused by damage to the hair cells of the inner ear, auditory nerve or brain. There are several causes of sensorineural hearing losses such as noise exposure, ageing, meningitis, genetic factors, certain drugs, certain pre-natal conditions, some viruses, etc. Most, but not all, sensorineural hearing losses are permanent and do not get better. A majority of people with sensorineural hearing losses can be helped with amplification (hearing aids and /or cochlear implant). Often people with sensorineural hearing loss will experience tinnitus, or ringing in the ear.

Conductive
Conductive hearing losses are caused by some physical blockage or mechanical problem, which interferes with sound transmission through the outer or middle ear. Causes of conductive hearing loss include wax blockage, perforated ear drum, the various forms of otitis media, otosclerosis, a break in one of the middle ear ossicles, etc. Most, but not all, conductive hearing losses can be medically and/or surgically treated, resulting in improved hearing, frequently to near normal levels. Some people with conductive hearing losses use amplification.

Mixed
A mixed hearing loss has both conductive and sensorineural components to the loss. As in pure conductive hearing losses, medical and/or surgical intervention with the conductive component can often improve the hearing.

The effect of hearing loss

To understand the effects of hearing loss it is important to understand the need for good hearing. Good hearing is essential for the development of normal language and communication. Even a *mild*, fluctuating conductive hearing loss, which can be associated with otitis media, can have a negative effect on language and learning in many children.

If a child has a hearing loss it will cause problems in the development of various skills. The amount of problems that happen will depend on two main aspects of the hearing loss:

- The age of onset - the earlier in the child's life, the greater these skills are impacted.
- The degree of hearing loss - the greater the hearing loss, the greater these skills are affected.

These are some of the effects of different degrees of hearing loss on learning and classroom performance:

Slight (16 - 25 dB)

Understand conversation at 3 m
Speech/language development may be affected because of hearing loss
Should understand most classroom discussion
A few children may require some degree of amplification

Mild (26 - 40 dB)

Understand conversation at 1 - 1.5 m
May have delayed speech/language development
Will miss up to 50% classroom discussion
Will need amplification, hearing aids or FM system
May need special education attention

Moderate (41 - 55 dB)

Understand conversation at 0.5m
Will have difficulty at school
Likely will have speech/language delay
Will require hearing aids and/or FM systems
Will need special education assistance and probably special training for listening
Uses vision for additional cues to understand spoken messages

Moderately Severe (56 – 70 dB)

May understand speech at ~25 cm
Will hear moderately loud environmental sounds
Will have delayed speech/language
Requires use of hearing aids and FM systems
Will need special education assistance and special training for listening

Severe (71 - 90 dB)
May understand some speech at <15 cm
Hears loud environmental sounds
Will have delayed speech / language
Requires use of hearing aids and FM systems
Requires auditory training
Uses vision for additional cues to understand spoken messages
Speech / language will not develop spontaneously if loss present before 1 year old
May be a candidate for cochlear implantation

Profound (> 91 dB)

May only be aware of very loud sounds
Speech and language will be defective
Visual and gestural cues essential for learning
Needs full time special education assistance
Requires use of a hearing aids and FM systems
May be a candidate for a cochlear implant

Hearing and the development of language

A normal human ear can hear a wide range of sounds ranging in frequencies between 20 and 20,0000 Hz. Human hearing is most sensitive to the frequencies between 500 to 4000 Hz, which are the most important for understanding speech.

A normal human ear is also capable of detecting very, very soft sounds around 0 dB (decibels) in intensity. It can also tolerate very loud sounds up to 120 dB. Above 120 dB sounds become painfully loud.

When babies are born, their most highly developed sense is hearing. For the first few months of life, babies without middle ear disease or a profound hearing loss will exhibit a stereotyped startle response to sudden loud sounds, the Moro reflex. A sudden loud sound will cause the baby to extend its arms and legs and throw its head back. This particular reflex normally will disappear by about 4 months of age. After 4 months of age, a baby will simply “jump” at sudden loud sounds, much as an adult will do.

From a very early age (days), babies can distinguish subtle cues in speech sounds, for example, the difference between a spoken “ba” and “pa”, or “ba” and “da. By one month of age, a baby will lay still in response to certain sounds, particularly the mother’s voice.

Between 4 and 6 months babies begin to locate sound by shifting their eyes or turning their heads towards the sound. This behaviour is a reflex at this stage.

From about 6 months of age, babies will turn their head towards a sound.

Also at around 6 months of age, babies will produce speech-like sounds. Within a short time, a couple of months, the baby will then only produce speech sounds of the language(s) spoken around it.

In addition, around 6 months of age, babies will smile at soothing sounds, and cry at harsh or angry sounds. They begin to recognize sounds like the rattle of the spoon in a plate. They will localize sounds more directly and can follow the conversation of familiar people by turning and watching as each person speaks.

By 12 to15 months, the child will start using single words with meaning, and is able to understand much of the conversation around it. The child should now be following simple instructions.

At 18 to 20 months of age, a child should start to put 2 words together in basic sentences.

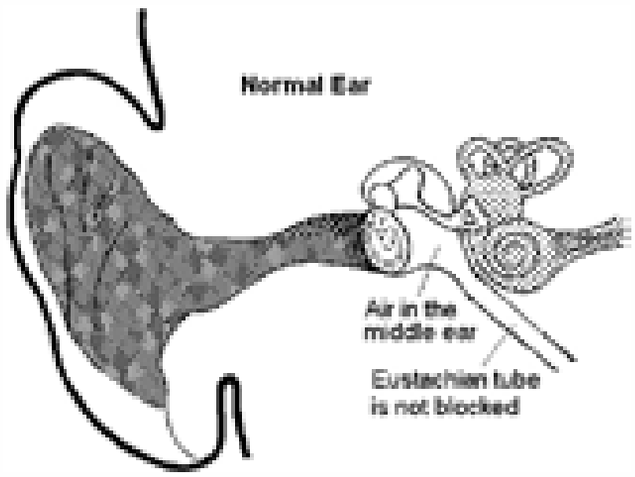
By 2 years of age a child has learned to interpret all sorts of sounds and the words and actions of people in their environment. The child may have 50 words and talk in 3 word sentences. From here language continues to rapidly expand so that by 3 years of age it is possible to have an intelligible conversation with the child. By 6 years of age, most children have developed language skills to a high level. They use these language skills in many ways:

1. To communicate and socialize with others
2. To think (cognitive skills)
3. To learn through reading, writing and listening

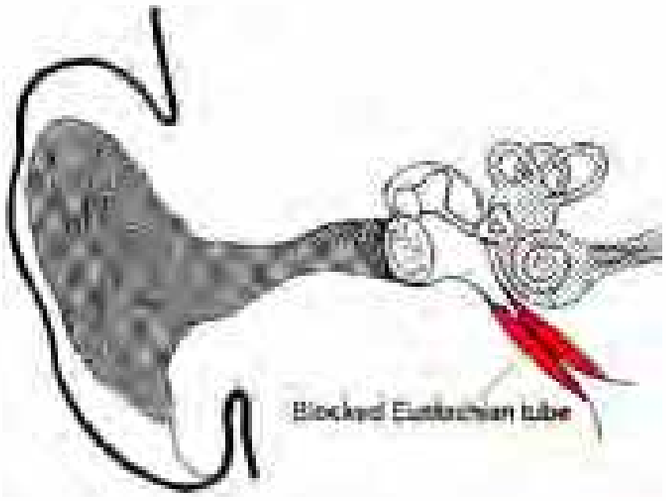
Questions about hearing

AGE	QUESTIONS TO ASK CAREGIVERS
Newborn to 4 months	• Do sudden, loud noises wake the baby? • Does the baby cry at very loud noises? • Does an awake baby jump at sudden, loud noises like a door slamming or a dog barking nearby?
3 to 4 months	• Does the baby sometimes turn its eyes or start to turn its head to see where a noise comes from? • Is the baby distracted from feeding by moderately loud noises close by?
4 to 7 months	• Does the baby frequently turn straight to sounds? • Does the baby make a variety of babbling sounds? • Does the baby enjoy playing with noisy toys or objects? • Can you soothe the baby with your voice?
7 to 9 months	• Does the baby turn to find things heard but not seen? • Does the baby gurgle, coo or babble to unseen sources of voices or other sounds?
9 to 24 months	• Does the baby show pleasure when hearing sounds like the bath running, food being prepared or kids coming home? • Does the baby copy words and sounds? • Does the baby by about 15 months use some single words spontaneously? • Does the baby respond when you call from another room?

The Development of Otitis Media

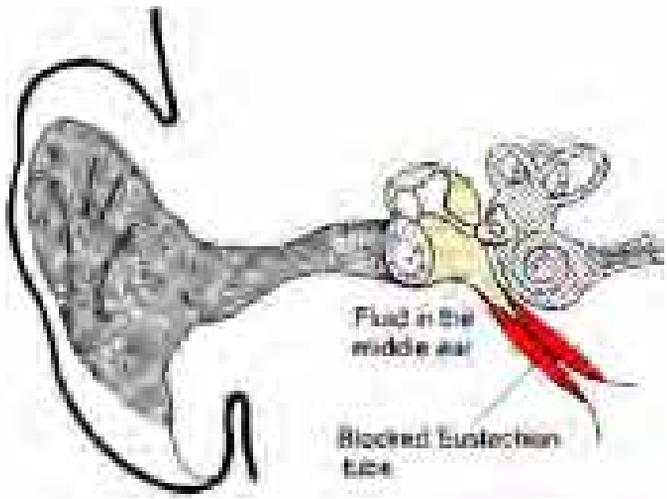


In a normal ear there is air in the middle ear. The Eustachian tube opens when yawning and swallowing to let air get into the middle ear.



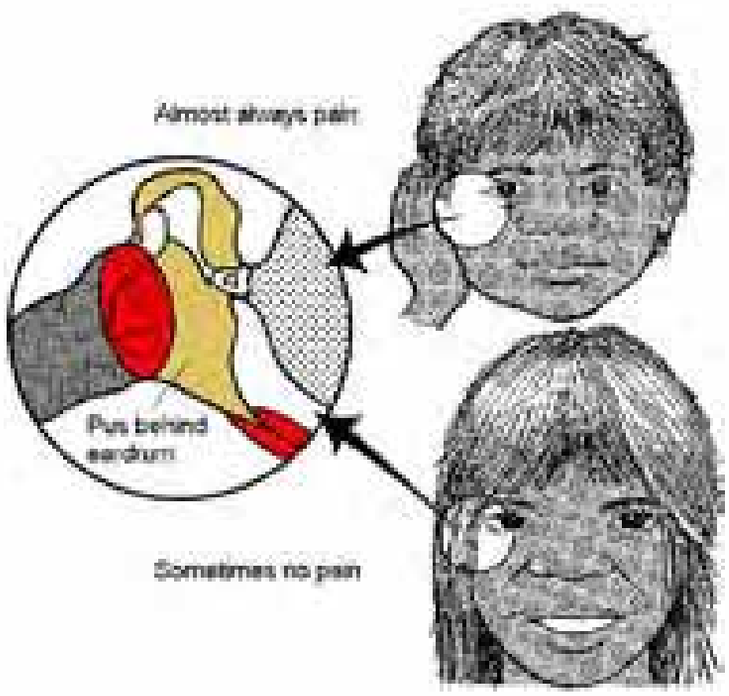
The Eustachian tube can swell and become blocked. Air cannot get into the middle ear and fluid cannot drain out of the middle ear.

Keeping the nose clean and doing the Breathing, Blowing and Coughing Program can help unblock the Eustachian tube.

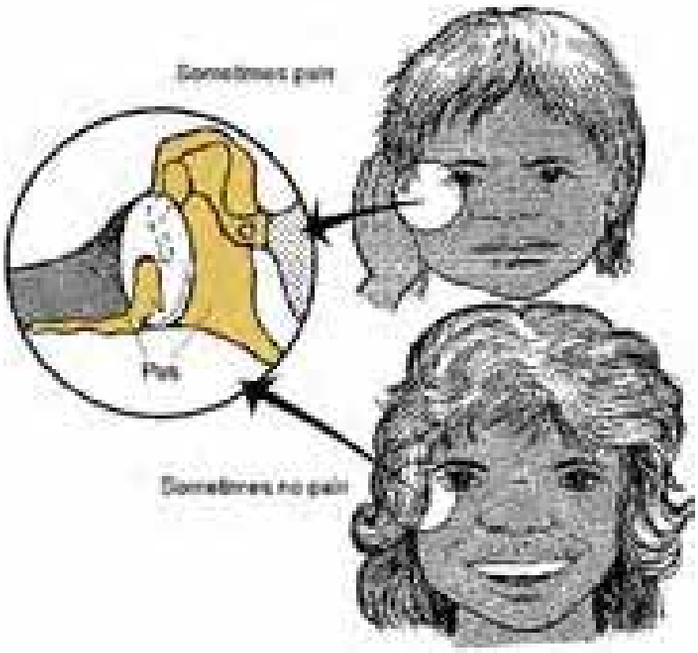


Fluid can build up behind the eardrum. At this point the ear is not infected. This is called otitis media with effusion. If the fluid is present for 3 months or more, it is called glue ear.

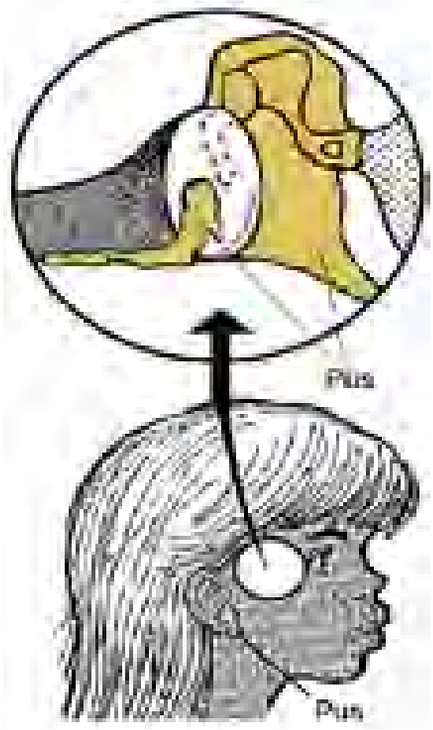
Keeping the nose clean and doing the Breathing, Blowing and Coughing Program can help the fluid go away.



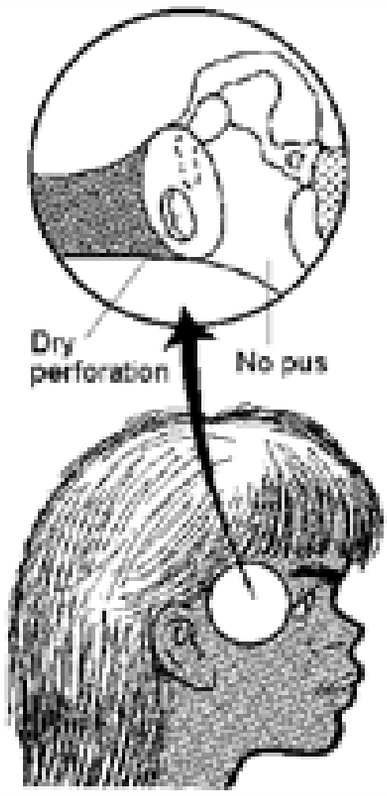
The ear can become infected and the fluid turns to pus. The eardrum becomes red and bulges out. There is almost always much pain. This condition is called acute otitis media.



The eardrum can burst and the pus drains out. After the eardrum bursts, the pain usually goes away. Sometimes the eardrum will heal up on its own, and sometimes it will not.



If the pus keeps draining from the ear for a long time, it is called chronic suppurative otitis media, or runny ear.



If the runny ear is syringed and treated with antibiotic ear drops, the pus can go away and the ear becomes dry. Sometimes the eardrum will heal up on its own. If it does not, and the hearing is bad, the ear surgeon can put a patch or graft on the eardrum.

If the pus does not go away with syringing and antibiotic ear drops, there may be a cholesteatoma or 'skin cyst" in the middle ear. The ear surgeon will need to examine the ear.

Preventative otology
Preventing ear disease and hearing loss

Preventative otology is the utilization of public health, medical or surgical management to prevent or reduce the manifestations of otological disease and hearing loss. Preventative otology uses strategies that aim to prevent the development of middle ear disease, or prevent or reduce some of the signs and symptoms of middle ear disease and hearing loss. Strategies and interventions include environmental, medical, surgical, audiological and educational initiatives.

It is important that prevention strategies should be culturally appropriate for Aboriginal and Torres Strait Islander communities, and that community consultation is essential before the introduction of prevention programs.

Amongst the indigenous communities of the world, there are higher rates of chronic suppurative otitis media and associated hearing loss. This is felt in part to be due to poor hygiene, diet and housing. It results in negative schooling, behavioural and health outcomes in an already disadvantaged group in the community. Improved public health measures play an important role in reducing the prevalence of hearing loss, ear infection rates, and improving quality of life and social outcomes. Early medical and surgical interventions are needed to treat the disease during the critical periods of development.

Environmental prevention strategies:

Improve nutrition
- Less “junk food”
- More fresh, healthy food

Improve the home environment
- Clean water for showering and washing
- Avoiding overcrowding – a bed for each child

- Keep flies away from ears, nose and throat

Increase breast feeding

- Protection against infection

Reduce passive smoking

- Don't smoke around babies or children

Regular health checkups
Nose blowing
Breathe Blow Cough (BBC) Program

Medical and surgical prevention strategies:

Vaccination:
Pneumococcal conjugate vaccination available to all Indigenous children particularly those under the age of two years and can help reduce the incidence of otitis media, pneumonia and meningitis caused by the pneumococcus bacteria. In children over two years of age and adults the pneumococcal polysaccharide vaccine is available and also helps reduce these infections but is not recommended for those under the age of two years.

Access to Specialist Healthcare:
Timely referral to otolaryngologists for assessment and surgical intervention can improve hearing outcomes

Audiological prevention strategies:

Regular hearing tests
Audiological rehabilitation is critical once hearing loss has been diagnosed:

- Ongoing education about effective communication strategies
- Appropriate use of devices to assist hearing -
    1. standard hearing aids and bone conductors
    2. classroom devices such as soundfield amplification systems (which provide uniform soundfield throughout the classroom and increase the speech-signal: noise ratio) and FM systems (a form of personal amplification whereby an FM signal from a microphone worn by the teacher is picked up by a receiver worn by a child with hearing loss)

Educational prevention strategies:

Encourage regular visits to healthcare providers
Provide information to parents and other caregivers about middle ear disease and hearing loss
Provide information on the effects of middle ear disease and hearing loss on school performance
Encourage parents and other caregivers to use strategies to develop speech and language skills
Inform teachers or carers when a child has a hearing problem

Otoscopy
Examination of the ear

This section indicates the steps in carefully and safely examining a child's ear, including the all important history from the parents or caregiver.

1. History

Ask the child or parents about the ear and/or the infection:

- Is the ear sore?
- How long has it been sore for?
- Has any pus been coming out of the ear?
- How long has it been coming out for?
- Has the child been swimming, and where?
- Can the child hear as well as before?

2. Ear examination

Sit on a chair when looking at the child's ear so that your eye is at about the same level as the child's ear. For very young children, have them sit on someone's lap.

a. Look at the ear from the outside noting any pus coming out etc

b. Show the child the otoscope and explain what you are going to do.

c. Using the otoscope

For children, gently pull the pinna (outer ear) up and back to straighten the ear canal. Hold the otoscope in such a way that you can brace your little finger against the child's head. In this way if the child moves suddenly, the otoscope will not be jammed into their ear.

For infants, gently pull down and back on the ear lobe to straighten the ear canal.

d. Looking in the ear

The following figure depicts normal right and left eardrums. The major landmarks are the long process of the malleus, the cone of light reflected from where the long process of the malleus connects to the ear drum (umbo), and the short process of the malleus. Some eardrums are so transparent that other features behind the eardrum can be seen.

However, a large number of children may have abnormal appearing eardrums due to a history of repeated bouts of otitis media. Consequently, when looking at eardrums it is important to report one of the following attributes and record them accordingly.

Is the eardrum:

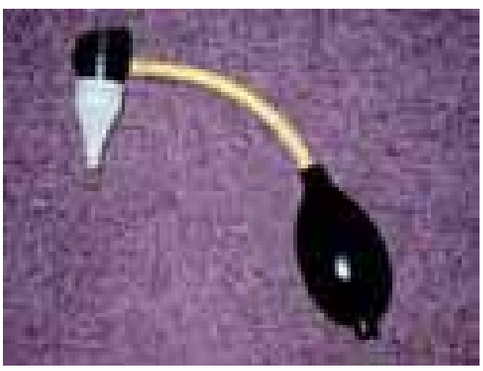
- Normal?
- Intact?
- Perforated?
    - dry, wet or with pus
    - small, medium or large perforation
- Foreign object?
- Healed perforation?
- Excessive wax?
- Unsure?
- Unsure

Normal Ear	Retraction pocket	AOM
		

CSOM	OME
	

Pneumatic Otoscopy

Pneumatic otoscopy is a subjective measure of tympanic membrane and middle ear status. Although there is a shortage of evidence based literature on its use it remains a common diagnostic procedure. It is used to diagnose possible eustachian tube dysfunction or otitis media.



The pneumatic otoscope is a hand held instrument similar to an otoscope but with the ability to seal the ear canal with the speculum. It has a light source with a pneumatic tube attached to the otoscope which allows a puff of air to be placed into the ear canal. By squeezing a bulb connected to the pneumatic tube the pressure can be changed in the ear canal. The puff or air allows for the observation of how the ear drum responds to changes in ear pressure. The pressure required to move a normal tympanic membrane ranges from 10-15mm of water pressure. However the pressure needed to move a tympanic membrane with a significant middle ear effusion may be from 40-116mm.

Pneumatic otoscopy requires that the pneumatic otoscope is correctly functioning, that is, the battery should be fully charged and there should be a strong light source to allow for optimal visualization. The pneumatic seals should also be checked to ensure they are functioning.

The use of the pneumatic otoscope requires some practise. Observation of the movement in the posterior superior part of the tympanic membrane is most indicative of the middle ear status. To perform the test the child should remain quite still. The pneumatic otoscope is inserted into the ear canal with appropriate sized speculum to obtain a seal. There is often reported pain and discomfort to patients during the test and as a result the test may not be used frequently. This discomfort is due to the pressure being introduced exceeding that which is required to move the tympanic membrane. The presence of cerumen partially or completely obstructing the ear canal may need to be removed and reviewed to obtain a clear view of the tympanic membrane.

If the tympanic membrane moves well then the eardrum is intact and there is no middle ear fluid. If the eardrum has restricted movement or no movement at all and the tympanic membrane is intact, then the child may have a middle ear effusion.

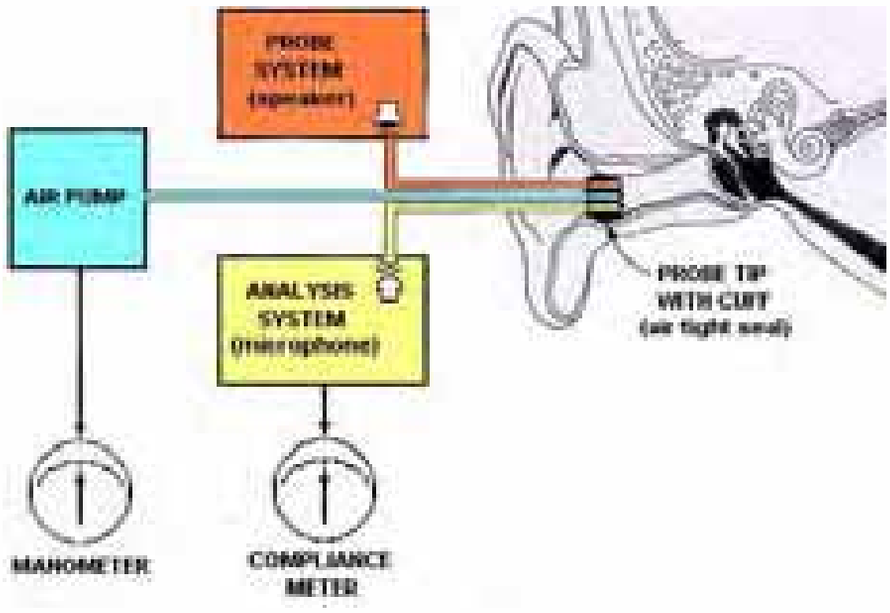
Tympanometry

What is tympanometry?

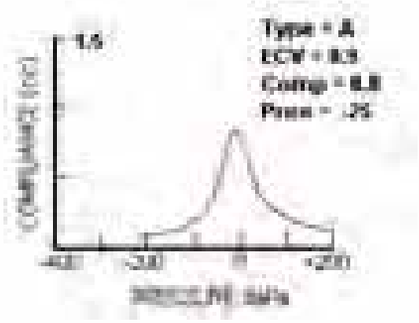
Tympanometry is a technique used to look at the function of the middle ear. It is NOT a hearing test. It is a test used together with otoscopy (looking into the ears) and audiometry (testing the hearing) and is useful in helping to determine how the middle ear is functioning.

How does a tympanometer work?

The procedure of tympanometry involves inserting a probe into the outer ear canal and creating an air-tight seal. The probe contains a tiny speaker, a microphone and an air pump. The air pump changes the air pressure range (typically +200 daPa to –400 daPa) in the ear canal. The speaker introduces a calibrated tone into the ear canal, which changes in frequency and loudness. Some of the sound produced by the speaker will be passed through the middle ear, while some of the sound will be reflected back off of the tympanic membrane. The microphone measures the amount of reflected sound in the ear canal. The "compliance" of the eardrum and middle ear (i.e. how well this system responds to sound) is then determined by the tympanometer as the air pressure changes.



What is a tympanogram?
A tympanogram is a chart which can tell us how well the middle ear is functioning.



What does a tympanogram tell us?

Tympanograms are classified into types according to the shape of the tympanometric trace ("peak"), which is dependent upon the middle ear pressure, and the middle ear compliance.

A tympanogram can provide three helpful pieces of information:

Middle ear pressure
This is the air pressure of the air contained within the middle ear. It is shown by where the "peak" of the tympanometric trace falls along the pressure axis.

Middle ear pressure values ranging from +50 daPa to –200 daPa for children, and +50 daPa to –50 daPa for adults is generally considered normal.

Compliance
The compliance of the middle ear system is a measure of how well the system responds to sound. This is shown by the height of the "peak".
Middle ear compliance values from 0.3 to 1.5 cc are usually considered normal.

Equivalent volume of the ear canal
Normative ear canal volumes vary as a function of age. Typically for children a volume range of 0.5 to 1.5 cc is typically considered normal, while for adults the range is 0.5 to 2.00 cc. This value is reported by the tympanometer, but not shown on the tympanogram graph.

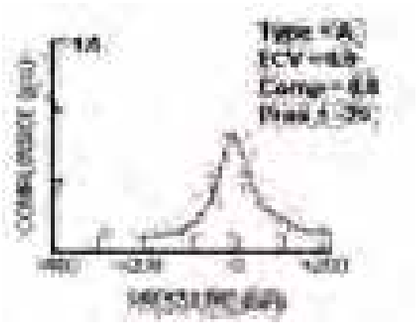
In general, classification of tympanograms is as follows:

Type A tympanograms	normal middle ear pressure Peak between +50 daPa to –200 daPa for children
Type C tympanograms	abnormally low middle ear pressure Peak less than –200daPa for children
Type B tympanograms	no pressure peak

Compliance values and equivalent ear volume allow classification into subtypes, and provide valuable information for diagnosis.

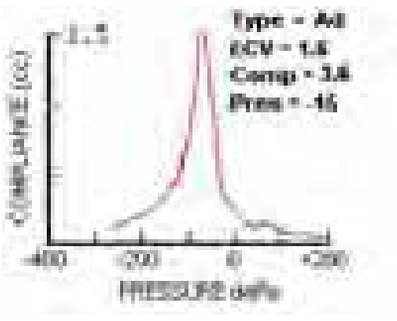
Type A:

There are three sub-types of Type A tympanograms, A, As and Ad. All Type A tympanograms have normal middle ear pressure peaks. Following are illustrations of the Type A sub-types:



A standard **Type A** tympanogram, with normal middle ear pressure (Pres = -25) and normal compliance (Comp = 0.8), is indicative of a properly functioning Eustachian tube. Generally this tympanogram would be described as representing normal middle ear function.

Type As tympanograms, with normal middle ear pressure (Pres = -20) but reduced compliance (Comp = 0.2) can represent normal middle ear function, or a stiff middle ear system suggestive of some form of ossicular fixation (otosclerosis or tympanosclerosis affecting the ossicles) with normal Eustachian tube function.

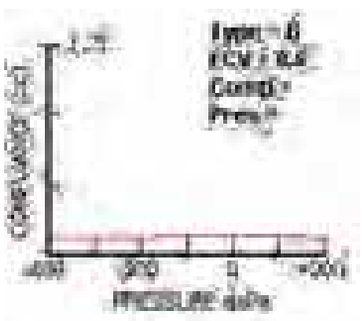


Type Ad tympanograms, with normal middle ear pressure (Pres = -15) but increased compliance (Comp = 3.6) indicate a flaccid, or hyper-mobile, middle ear system. This could represent an ossicular subluxation (a partial or full ossicular discontinuity), or a healed tympanic membrane perforation.

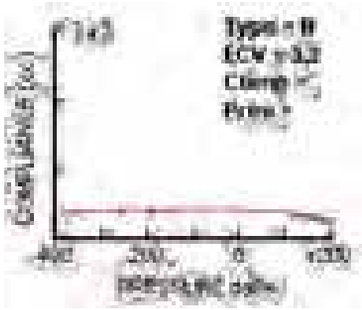
Type B:

Type B tympanograms exhibit no air pressure peaks and are generally described as “flat” tympanograms. There are several middle ear conditions, which can result in Type B tympanograms.
Type B subtypes are

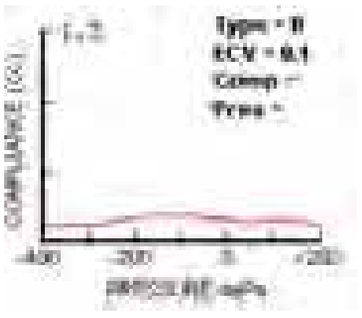
- those with normal equivalent ear canal volume
- those with high equivalent ear canal volume
- those with low equivalent ear canal volume.



A **Type B** tympanogram with normal ear canal volume (ECV = 0.5 cc) typically means a middle ear effusion. However, some people with very thickened tympanic membranes, or perforations may also exhibit a tympanogram of this type.



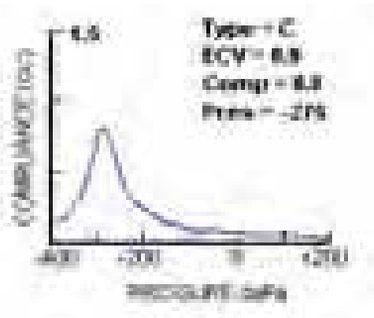
Type B tympanogram with a high ear canal volume (ECV = 3.2), consistent with a tympanic membrane perforation, a patent grommet or T tube.



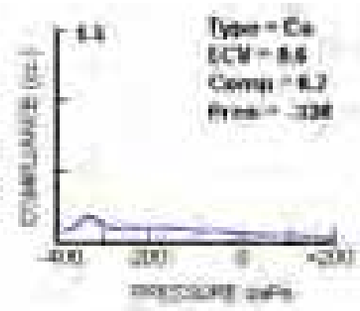
Type B tympanogram with a low ear canal volume (ECV = 0.1) indicating that the probe is blocked, either by wax in the ear canal, or the probe tip is against the side of the ear canal wall.

Type C:

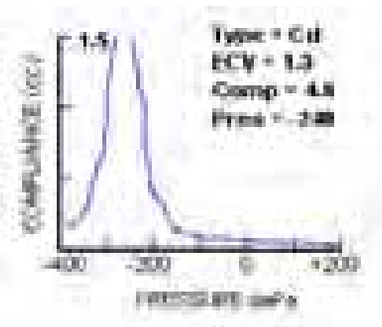
Type C tympanograms generally have similar compliance values and shapes as Type A tympanograms. What sets them aside from Type A tympanograms is that the middle ear pressure is abnormally low indicating Eustachian tube dysfunction.



This **Type C** tympanogram, with normal compliance (Comp = 0.8) but low middle ear pressure (Pres = -275) typically means a Eustachian tube dysfunction without the presence of middle ear effusion.



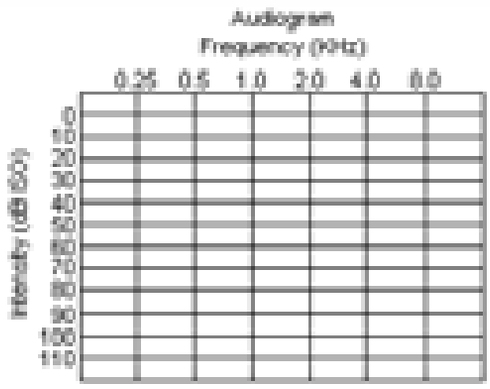
This **Type Cs** (shallow) tympanogram, with reduced compliance (Comp = 0.2) and low middle ear pressure (Pres = -330), in addition to indicating a Eustachian tube dysfunction, most likely also means there is some fluid in the middle ear as well as some air.



This **Type Cd** (deep) tympanogram, with increased compliance (Comp = 4.8) and low middle ear pressure (Pres = -240), also suggests either an ossicular subluxation, or healed tympanic membrane perforation (similar to Type Ad) with Eustachian tube dysfunction.

Audiology
The Measurement of Hearing

Hearing is measured by determining how well a person can hear a range of frequencies of sounds. There is a specific procedure used to gather this information, which then is generally plotted on a graph called an audiogram. Below is a sample audiogram form:



Across the top of the audiogram are numbers representing various frequencies of sounds that are typically tested. Low frequency sounds are represented on the left side of the audiogram, while high frequencies are on the right. Frequencies are measured in hertz (Hz), or kilohertz (KHz). This audiogram form depicts frequencies in KHz. The range of frequencies on the audiogram corresponds to the range of frequencies most needed for verbal communication purposes. Occasionally intermediate frequencies of 0.75, 1.5, 3 and 6 KHz may also be tested and plotted.

Going from the top to the bottom of the audiogram is the intensity scale in decibels (dB). "ISO" refers to the International Standards Organization which is a worldwide association that sets standards for a wide range of physical measurements. Softer sounds are represented at the top of the audiogram, while loud sounds are at the bottom. The actual values plotted on an audiogram at the different frequencies are called thresholds. A threshold is defined as the intensity at which a person can hear a specific sound 50% of the time. There is a standardized procedure to determine thresholds.

Generally an audiogram will show the hearing results for both the right and left ears. As such there are different symbols used to differentiate the hearing results for each ear. However, before proceeding with this topic, two other concepts need to be introduced.

Air and Bone Conduction Testing:

Air and bone conduction testing is used to establish the type of hearing loss present. A hearing loss can be sensorineural, conductive or mixed.

Air conduction testing is done using standard earphones, although sometimes an insert phone is used. Basically, air conductive testing assesses the outer, middle and inner ear as a unit. On the other hand, bone conduction testing uses a bone vibrator, which is placed on the mastoid prominence behind the pinna. The bone vibrator transmits sounds to the bones of the skull, which in turn stimulate the inner ear directly. Basically, bone conduction testing assesses inner ear function. Comparison of the air and bone conduction thresholds is used to determine the type of hearing loss.

Masking:

There are certain circumstances that arise during air and bone conduction testing where the non-test ear may hear the stimulus presented to the test ear. This situation can result in an erroneous interpretation of the test results. Masking of the non-test ear is a technique used to eliminate the possibility of the non-test ear hearing the stimulus. Masking is necessary if there is a 40 dB difference in the air conduction threshold of the test ear and the bone conduction threshold of the non-test ear. An unmasked signal of a high enough intensity presented to the test ear can "cross over" and be heard by the non-test ear. Masking is almost always necessary when testing bone conduction. Bone conducted sounds are transmitted equally by the bones of the skull to both ears. There are a few situations when masking for bone conduction does not need to be used, or cannot be used. It is beyond the scope of this manual to engage in a comprehensive discussion of masking. The masking concept is introduced in order for one to recognize masked audiometric signals plotted on an audiogram and to be able to interpret the audiogram accordingly.

Audiometric Symbols:

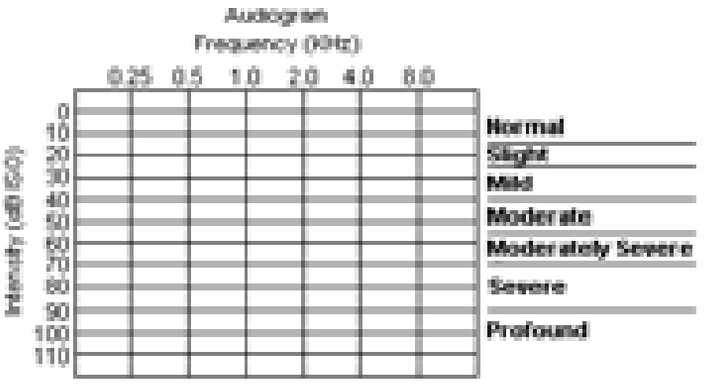
In order to differentiate test results from the right and left ears, and whether plotted thresholds have been masked or not, a series of standardised audiometric symbols have been developed. Occasionally the symbols will also be colour coded, with red representing the right ear, and blue the left.

	Air Conduction		Bone Conduction	
	unmasked	masked	unmasked	masked
Right	O	or	<	[
Left	X	or	>	]

Any of the above symbols with an arrow, down and to the left for the right ear, , or down and to the right for the left ear, , attached to it means that there was no response at that frequency. Most audiograms will contain a key to the audiometric symbols.

Audiogram Interpretation:

The information contained on an audiogram allows the determination of the degree and type of hearing loss. For verbally reporting the degree of hearing loss, there are standardized descriptive terms that are used. The following figure illustrates these terms and ranges of hearing loss associated with them:



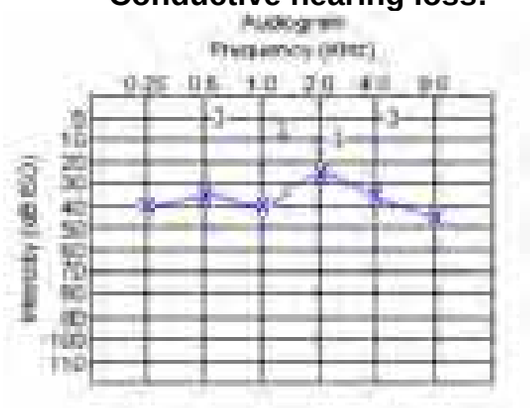
There are three types of hearing loss, sensorineural, conductive and mixed. By definition, a sensorineural hearing loss is present if there is less than a 15 dB difference between the air and bone conduction thresholds of a given ear, and the air and bone conduction thresholds are worse than 15 dB. A conductive hearing loss is defined by bone conduction thresholds being 15 dB or better than the air conduction thresholds, and the bone conduction thresholds are 15 dB or less. And a mixed loss will have both conductive and sensorineural components in the loss.

Following are sample audiograms illustrating sensorineural, conductive and mixed hearing losses.

Sensorineural hearing loss:

Moderate to severe sensorineural hearing loss

Conductive hearing loss:

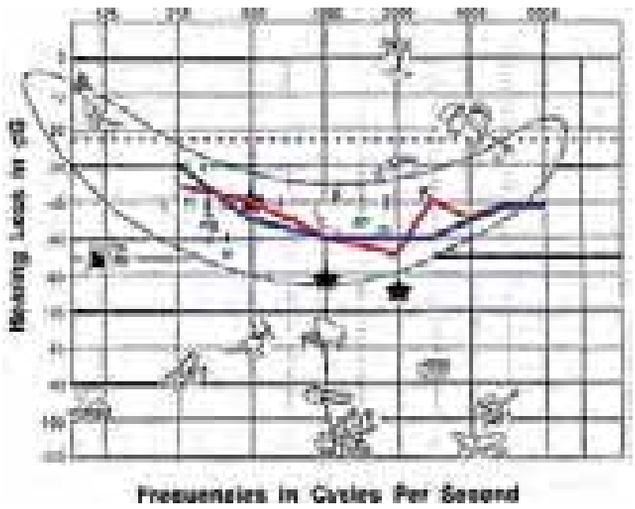


Mild to moderate conductive loss

Mixed hearing loss:

Moderately severe to profound mixed loss

Speech Banana



Ref: http://www.hearingaidforums.com/showthread.php?t=5668

Middle Ear Disease and School

All children who suffer from middle ear disease face difficulties with learning. In the case of Aboriginal children, learning may be further complicated by:

- English being a second language
- English being the language used for instruction in the classroom

Otitis media in the early childhood years may mean that young Aboriginal children may have a poor grasp of their own first language by the time they enter school. Children who do not hear properly will find it difficult to pick up the sounds of their own language, and even harder to then learn a second language. In addition, there are a number of sound differences between English and Aboriginal languages.

A hearing loss, even a mild fluctuating loss caused by otitis media, will affect learning. Some difficulties that may occur include:

- Telling the difference between sounds
- Putting sounds in words together
- Sequencing and remembering sounds
- Listening for sounds in noisy conditions
- Developing word usage due to poor vocabularies
- Remembering and explaining words
- Understanding questions properly
- Replying to questions properly

When children go to school, they have to rely on their hearing a lot more. At home when they don't hear something properly, they can always figure out what is going on by looking, or asking or waiting till someone tells them what is going on. At school, teachers often only give instructions once and they do not like the children to be looking around or asking someone else what they should be doing. This is very frustrating for the child and he/she can find him/herself always in trouble for not concentrating and disturbing others.

The other problem that children with a conductive hearing loss will find is that their auditory processing system is not developed enough for them to learn to read and write easily. The combination of hearing problems in the classroom and a history of poor hearing, means that school can be very hard, even for bright children.

Central Auditory Processing Disorder (CAPD)

"Central Auditory Processing Disorder (CAPD), also known as Auditory Processing Disorder (APD), is an umbrella term for a variety of disorders that result in a breakdown in the hearing process. In short, our brain cannot make sense of what our ears hear because the auditory signal is distorted in some way" *(Australian Hearing).*

As a result, one of the biggest problems experienced by individuals with CAPD is difficulty listening in background noise. It cannot be explained on the basis of a normal peripheral hearing loss. Children that have central auditory processing problems may have one or more of the following symptoms; be distractible, constantly asking for repeats, have difficulty understanding speech in background noise, be sensitive to loud sounds, have difficulty following complex instructions, or have poor memory for chains of digits or words. The child may also have reading spelling and other academic difficulties or display behaviour problems. The most common cause for CAPD is long standing conductive hearing loss such as glue ear or chronic suppurative otitis media that later causes inefficiency in the brain processing of the electrical output from the ear.

The condition can be assessed with specialized testing particularly in children over the age of 6 years. If the diagnosis is confirmed there are several classroom strategies that the audiologist may recommend and in some cases further treatment may also be suggested such as speech therapy, occupational therapy or computer based learning using one of the several programs available.

Sometimes children do not understand that their problems are caused by a hearing loss - they think that they are stupid. It is extremely important that all children are educated about middle ear disease so they can tell the Health Worker or Teacher and adjustments can be made to the program.

Social Emotional Aspects of Hearing Loss

For anyone suffering long-term hearing loss in early life and childhood (and this is not exclusive to Indigenous people), it can have life long negative consequences in the following areas;

- Language development
- Socialization
- Education - hence literacy and numeracy
- Social/emotional wellbeing and self esteem
- Training and employment opportunities
- Mental health and self harm
- Domestic violence
- And as a consequence of the above factors, can be a reason for the over representation of Indigenous people in the criminal justice system

The effects of auditory sensory deprivation from hearing loss especially in the first 5 years of life can lead to abnormal brain development that is manifested as central auditory processing disorders, or more simply termed, learning problems or listening problems. Even if a person's hearing becomes normal at a later age, these listening problems remain. Consequently they can have significant impacts on adult education, training, and employment. Hence, the need to address hearing loss as early as possible.

Children with a Hearing Loss
General strategies that teachers can use in classrooms

- Be aware of the factors in the environment which affect listening:
  - noise from people talking and moving
  - general background noise e.g. traffic, air conditioners
- Write the key vocabulary on the board
- Use pictures or objects to illustrate a point and maintain interest
- Ask a peer to adopt a child and give prompts
- Inform parents or clinic staff about children who have sore ears
- Remind children and parents of the importance of healthy ears to learning
- Make sure the role model is speaking clearly at all times
- When the students want to talk to the teacher, make sure they are quiet and facing you

- Keep the students close to the teacher
- Keep plenty of light on your face when talking
- Make sure that you keep your hand away from your face when you are talking
- Use non-verbal gestures to help give meaning
- Use language that is accessible and explaining difficult terms if they are used
- Implement a blow, breathe and cough (BBC) program daily in the classroom
- Provide the students with tissues on a needs basis to frequently clear noses

Suggestions for teachers for children with Central Auditory Processing Disorder (CAPD). Some children will appear to be helped by most suggestions but some will be difficult to help no matter what is tried.

1. Reduce distractions – this involves getting the child's attention before giving instructions.
2. Preferential seating – seat the child away from known distractions such as open windows, pencil sharpeners, doors, air conditioners.
3. Delivery style – avoid multiple commands, give instructions in the most simple form possible.
4. Speak at a slower rate than normal and clearly as research has shown that background noise is often equal to or louder than the teacher's voice.
5. Instructional transitions – utilizing review of the previous material before beginning new lessons to give the student a feeling of success.
6. Utilization of words such as "Listen" "Ready" and "Remember" seem to be effective for signaling an important message.
7. Visual aids include overheads, opaque projectors and computers can be utilized to supplement the teachers oral presentations as well as to provide an alternative mode to the auditory channel. Combining the visual and auditory modes of learning may benefit all students in the classroom.
8. Some children may benefit from the child having an FM system and the teacher wearing a microphone during class.

Common Conditions

Features, Diagnosis, Audiogram, Tympanogram, Management, Complications for;

Acute Otitis Media (AOM)

Acute otitis media without perforation (AOM) - Presence of middle ear fluid with symptoms or signs of suppurative infection, which may include, otalgia, fever, irritability, vomiting or diarrhoea.

Acute otitis media with perforation - Acute suppurative infection with recent discharge from the middle ear (within the last 7 days).

Chronic suppurative Otitis Media (CSOM)

Persistent discharge from the middle ear through a tympanic membrane perforation for more than 6 weeks.

Otitis Media with Effusion (OME or Glue Ear)

Presence of middle ear fluid without symptoms or signs of suppurative infection.

Otitis Externa (Swimmer's Ear)

Infection in the ear canal.

ACUTE OTITIS MEDIA (AOM)

FEATURES

MOST COMMON SYMPTOMS

- Otalgia (ear pain) or pulling of the ear
- Irritability
- Fever

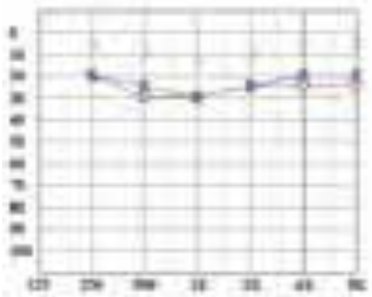
OTHER SYMPTOMS

- Anorexia
- Vomiting
- Diarrhoea
- Otorrhoea (runny ears)
- May be relatively “silent”

Bulging eardrum of AOM

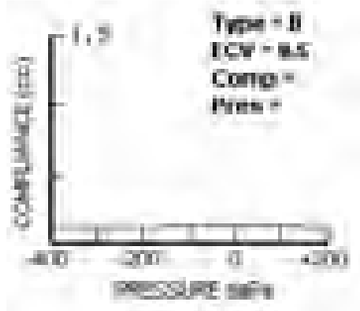
AUDIOLOGY

Mild Conductive hearing loss



TYMPANOMETRY

Usually Type B Tympanogram



DIAGNOSIS

- Bulging red ear drum
- Decreased mobility with pneumatic otoscopy
- Ear drum may rupture ➜ discharge in ear canal

AGGRAVATING FACTORS

- Upper respiratory tract infection (cold)
- Stopping breast feeding early
- Reflux
- Passive cigarette smoke exposure
- Overcrowding
- Poor hygiene
- Poor nutrition

PREVENTATIVE MEASURES

- Continue breast feeding until 12 months
- Avoiding smoking around babies and children
- Avoid dummies after 12 months
- Avoid prop-feeding, with the baby lying flat and the bottle “propped up”
- Vaccination including Prevnar
- Early treatment of ear infection to avoid

ACUTE OTITIS MEDIA (AOM)

TREATMENT

- Antibiotics e.g. Amoxicillin 90mg/kg/day for 10 days
- If allergic to Penicillin – Rulide D/Septrin
- Analgesia e.g. paracetamol
- Local anaesthetic ear drops (if no perforation)
- If no improvement in 48 hours, Augmentin/Cefaclor
- Treatment of otorrhoea
  - Non-ototoxic topical antibiotic ear drops e.g. Ciproxin HC/Ciloxan ear drops

COMPLICATIONS

- Otorrhoea (if perforated ear drum)
- Chronic otitis media
- Otitis media with effusion
- Perforation
- Acute mastoiditis
- Facial nerve palsy
- Cholesteatoma
- Meningitis
- Sensorineural hearing loss

INDICATIONS FOR REFERRAL

- Persistent otitis media
- If complications are suspected
- Persistent otorrhoea after one week of treatment
- Recurrent otitis media
  - 3 attacks in 6 months
  - 4-6 attacks in 12 months
  - presence of middle ear effusion for 3 months or longer
  - balance problems, speech/language delay
- Suspected cholesteatoma

Acute perforated eardrum.

CHRONIC SUPPURATIVE OTITIS MEDIA (CSOM)

FEATURES

MOST COMMON SYMPTOMS

- Otorrhoea (discharge from ear)
- Itchy ear
- Hearing loss

DIAGNOSIS

- Otorrhoea (discharge from ear) with perforation of tympanic membrane
- Perforated tympanic membrane
- Ear drum may rupture ➜ discharge in ear canal

OTHER AGGRAVATING FACTORS

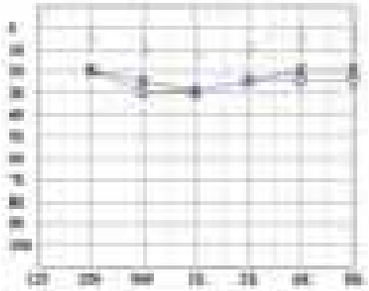
- Contaminated water entering the ear
- Upper respiratory tract infection (cold)
- Stopping breast feeding early
- Reflux
- Passive cigarette smoke exposure
- Overcrowding
- Poor hygiene
- Poor nutrition

Moist moderate Tympanic membrane perforation

Small perforation will produce discharge

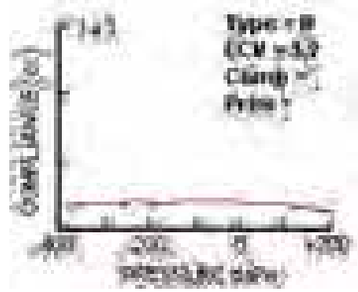
AUDIOLOGY

Mild Conductive hearing loss



TYMPANOMETRY

Usually Type B Tympanogram



PREVENTATIVE MEASURES

- Continue breast feeding until 12 weeks
- Avoiding smoking around babies and children
- Avoid prop-feeding, with the baby lying flat and the bottle “propped up”
- Vaccination including Prevnar
- Early treatment of ear infection to avoid chronic discharge.
- Avoid contaminated water entering ear

CHRONIC SUPPURATIVE OTITIS MEDIA

TREATMENT

- Betadine ear toilets
- Antibiotics – topical fluoroquinolones eg. Ciloxan eardrops
- Culture of middle ear fluid
- Myringoplasty to close perforation (once ear is dry)

COMPLICATIONS

- Hearing loss
- Granulation tissue and polyps
- Cholesteatoma
- Chronic mastoiditis
- Meningitis
- Intracranial abscess

INDICATIONS FOR REFERRAL

- Hearing loss
- Discharge that fails to resolve despite adequate medical treatment
- Non-healing perforation
- Any of the listed complications

Cholesteatoma

OTITIS EXTERNA (SWIMMER'S EAR)

FEATURES

- Pain and tenderness of the ear canal (may spread to the outer ear)
- Discharge
- Itching
- Swollen ear and ear canal
- Occasionally reduced hearing
- Sometimes noises in the ear (tinnitus)

DIAGNOSIS

- Otoscopy – appearance of skin of outer ear canal
  - o red scaled and peeling
  - o "soggy" cardboard like appearance
- Ear canal may be inflamed and swollen and painful to touch
- Swab

OTHER AGGRAVATING FACTORS

- Swimming
- Hot and humid climates
- Eczema
- Cotton bud use

TREATMENT

- Dry ear toilet
- Antibiotic drops (Ciproxin HC as ear drops)
- Use of otowicks for swollen ear canal
- Swab for microscopy

Classical Otitis Externa showing infected debris and slight swelling of ear canal

Severe otitis externa and swelling

COMPLICATIONS

- Narrowing of the ear canals
- Facial cellulitis
- Malignant otitis externa leading to osteomyelitis of the temporal bone
- Fungal infection

INDICATIONS FOR REFERRAL

- Failure to resolve after 1 –2 weeks of treatment

PREVENTATIVE MEASURES

- Avoid water entering ear
- Ear protection when swimming and bathing
- Avoid use of cotton buds or inserting other objects into the ear

OTITIS MEDIA WITH EFFUSION (OME OR GLUE EAR)

FEATURES

SYMPTOMS IN YOUNG CHILDREN (0-3)

- Balance problems
- Delayed speech development
- Hearing loss (fluid in the middle ear blocks the conduction of sound)
- Irritability and pulling at ear

SYMPTOMS IN OLDER CHILDREN (3-7)

- Hearing loss
- Difficulty at school
- Behaviour problems
- Delayed speech and language (may affect reading development)

DIAGNOSIS

- Retracted ear drum
- May show fluid levels or bubbles
- Decreased mobility on pneumatic otoscopy
- Different colours – from red to white to yellow

OTHER AGGRAVATING FACTORS

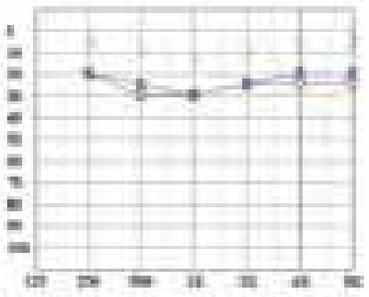
- Upper respiratory tract infection (cold)
- Reflux
- May follow acute otitis media (AOM)
- Blocked Eustachian tube
- Prematurity/low birth weight

Diffusely retracted ear with OME

OME with attic retraction pocket

AUDIOLOGY

Mild Conductive hearing loss



TYMPANOMETRY

Type B or Type C Tympanogram

PREVENTATIVE MEASURES

- Treatment of colds and upper respiratory tract infections
- Avoid smoking around babies and children
- Early treatment of acute otitis media
- Regular ear health checks

OTITIS MEDIA WITH EFFUSION (OME OR GLUE EAR)

TREATMENT

- Antibiotics
- BBC program
- Steroid nasal spray if allergic child
- Hearing aids
- Grommets (ventilation tubes)

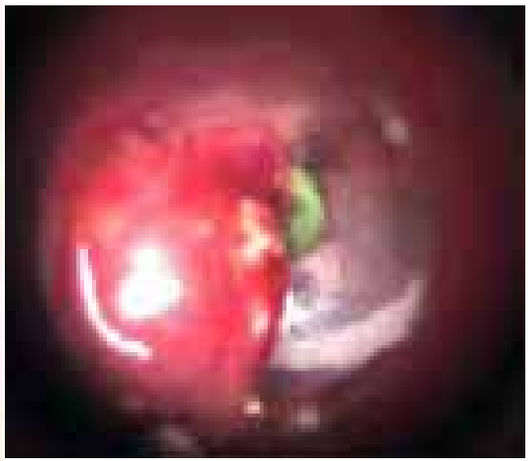
See below: various types of grommet tubes in the tympanic membrane

COMPLICATIONS

- Acute otitis media
- Cholesteatoma
- Ossicular problems
- Language problems/reading difficulties
- Central auditory processing disorder
- Hearing loss in background noise as adult

INDICATIONS FOR GROMMETS

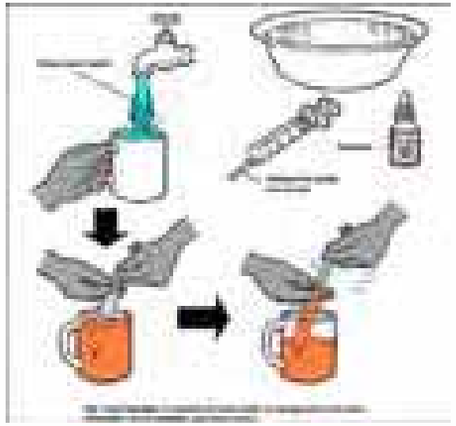
- 3 attacks of otitis media in 6 months
- 4 attacks of otitis media in 12 months
- handicapping hearing loss for 3 months



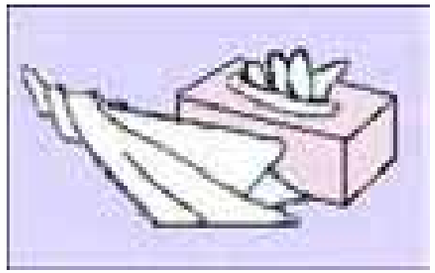
Different types of grommet tubes in tympanic membrane
First image of granulation polyp obscuring grommet.

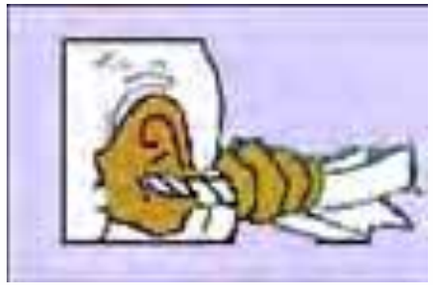
MEDICAL TREATMENT CHRONIC SUPPURATIVE OTITIS MEDIA (CSOM)

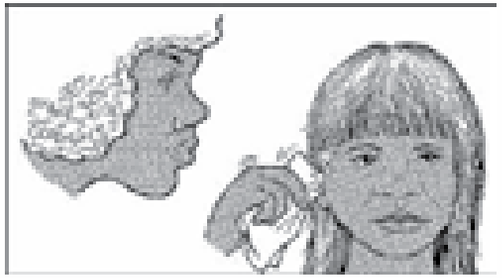
Ear toilets using Betadine 0.5%



Dry the ear canal using tissue spears

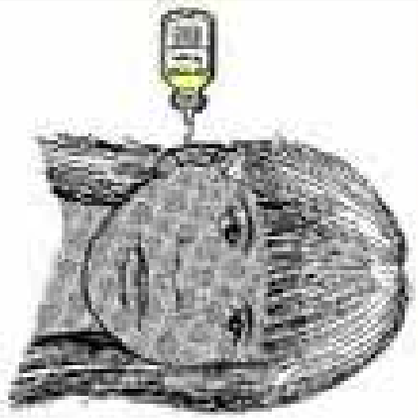




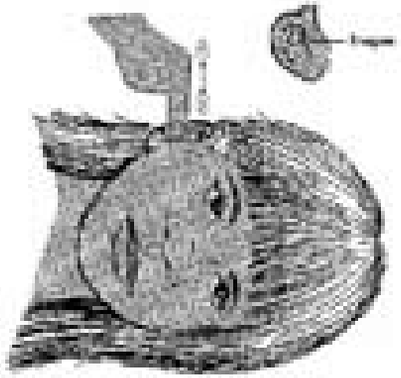


Ear drops

With the person lying on their side, the recommended number of ear drops are put into the ear



With the finger on the tragus, the tragus is “pumped” to force the medicine through the perforation into the middle ear where it is needed. Sometimes the person will report tasting the medicine



MEDICAL TREATMENT CHRONIC SUPPURATIVE OTITIS MEDIA (CSOM)

Ear toilets using Betadine 0.5%

- Ear syringing is done to wash pus due to suppurative otitis media out of the ear canal and middle ear.
- Getting rid of the pus then allows the instillation of antibiotic ear drops to treat the infection.
- Syringing: The senior author does not believe this is as effective for clearing discharge as Betadine ear toilets. But it is included because it is current practise in some areas in Australia

PROCEDURE

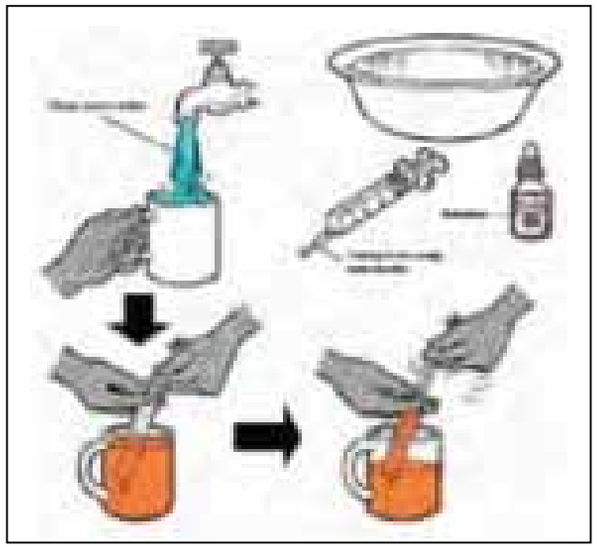
Dilute 5ml (one teaspoon) of 10% solution of Betadine with 100ml of clean warm water

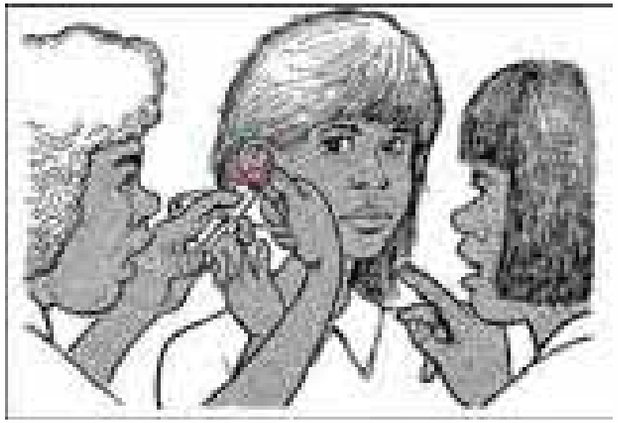
Use a 10 or 20ml disposable plastic syringe. To syringe an ear, a short piece of tubing from a scalp vein needle is attached to the end of the syringe. Whenever refilling the syringe, remove the tubing to keep it from contaminating the solution or container. Attach the cut off end of a scalp vein needle firmly. This will provide a soft tip.

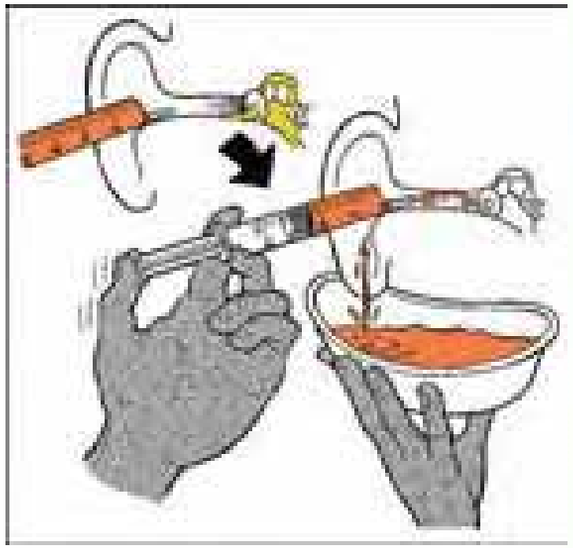
With infants or children with small ear canals, the solution can be dropped into the ear with a pipette, with the infant or child lying on their side. The pipette is then used to suck the solution out of the ear canal.

With older children, with one hand the pinna is grasped and pulled up and back. The syringe is aimed toward the top part of the eardrum and gentle syringing begins.

Hold the syringe up to the ear and point the tip so that the solution does not directly hit the ear drum
The person having their ear syringed, or care giver, should hold a kidney dish or bowl under the ear to catch the solution that comes out of the ear. A towel should be placed over the shoulder
Syringing is continued until no more pus comes out. The ear is then dried with tissue spears.







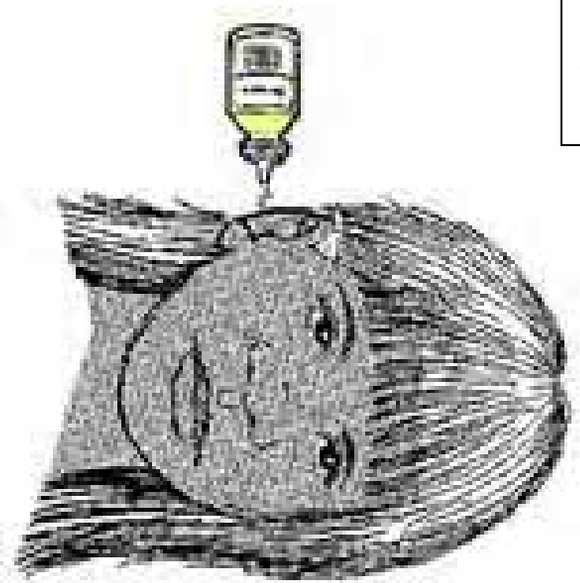
MEDICAL TREATMENT of CHRONIC SUPPURATIVE OTITIS MEDIA (CSOM)

Ear drops

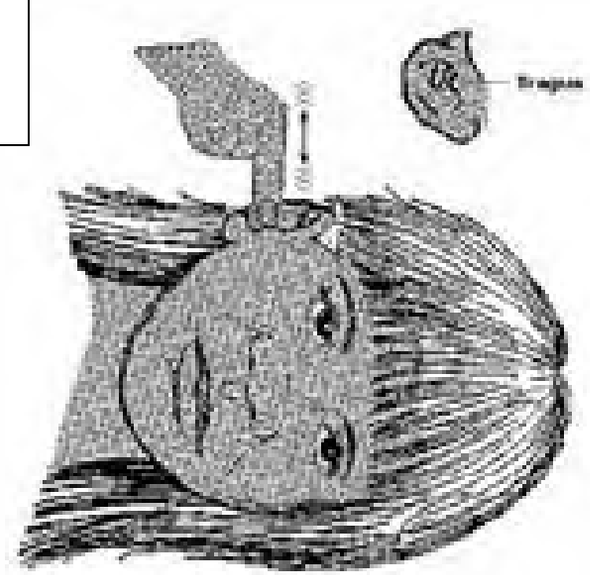
- Use of topical antibiotic corticosteroid combination ear drops helps with otorrhoea and reduces the risk of developing secondary otitis externa.
- The use of non-ototoxic ear drops e.g. Ciproxin HC or Ciloxan ear drops, has become the treatment of choice.
- With a perforation in the ear drum there is the risk that potentially ototoxic ear drops, e.g. Sofradex, may enter the middle ear and inner ear and cause permanent hearing loss.

PROCEDURE

Clean out the discharge using irrigation with Betadine
Use a tissue spear to dry the ear
Instill the drops as shown
Treatment is three drops twice a day for three to five days



With the person lying on their side, the recommended number of ear drops are put into the ear



With the finger on the tragus, the tragus is “pumped” to force the medicine through the perforation into the middle ear where it is needed. Sometimes the person will report tasting the medicine

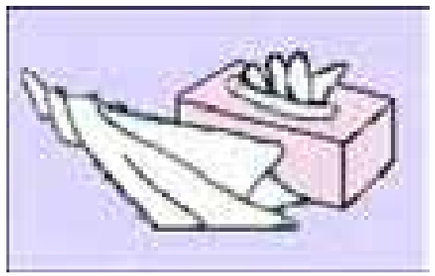
MEDICAL TREATMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA (CSOM)

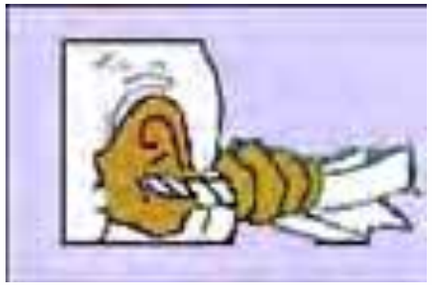
Drying the ear canal using tissue spears

- Tissue spearing is a technique used to either remove pus from the ear canal, or to dry the ear canal following ear syringing.

PROCEDURE

A tissue spear is made by twisting a square of toilet tissue or facial tissue into a "rat's tail".
The tissue spear is then inserted into ear by rotating it.
The tissue spear is inserted to about 2.5 cm, or until the child blinks.
The tissue spear is left in place 1-2 minutes.
Remove and repeat until the tissue is dry.





Telemedicine

Telemedicine and specifically teleotology, allow the transmission either “live “ or of stored images of the ear drum to specialists for diagnostic and treatment recommendation. A video otoscope (the Welch–Allyn macro view is a commonly used hand held video otoscope) with a built in digital camera which allows the image of the eardrum (tympanic membrane) to be shown on a computer to the patients/carers. In addition the live images can be transferred to a central telemedicine unit often with a whole room view allowing patients/carers to talk to the ENT specialist and discuss their treatment options. On occasion the computer image can be stored and later sent to the ear surgeon for comment (store and send) along with history, audiometry and tympanometry. This whole process of telemedicine allows the Aboriginal Health Worker, nurse or doctor in rural and remote regions to obtain specialist opinion via email or live telemedicine conference.

How to use a video otoscope

Using the video otoscope is surprisingly easy to those who have otoscopic skills with conventional otoscopes--- the main problem for the viewer is usually the presence of wax/debris, infection in the ear canal obscuring their view of the eardrum. It is crucial to remove the wax/infection either by syringing or by direct removal with a wax hook and headlight by those trained in that technique. It is important to dry the ear canal with a tissue spear if it is wet – otherwise the video otoscope lens may fog up.

The video otoscope is held upright and a finger propped against the patient’s head to steady the instrument and prevent hurting the patient’s ear canal if they move suddenly. The viewer’s other hand gently pulls the outer ear upward and backwards to straighten the ear canal to allow the introduction of the video otoscope in the ear canal. If the viewer needs to “store and send” the image, then it can be captured by pressing either a camera button or in some cases a foot pedal. On occasions the video otoscope is used to capture a video of the eardrum’s movement when the patient holds their nose and “pops” (valsalvas) their ear or the examiner blows air into the sealed ear canal (pneumatic otoscopy) to see if the eardrum is mobile. There is a

learning curve with the use of the video otoscope but with patience and practice will be rewarded with every improving images of the eardrum.

Videoconferencing

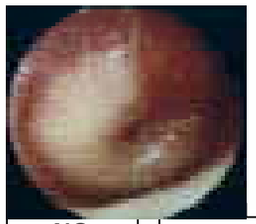
"Live view" telemedicine allows the Aboriginal Health Worker, nurse, doctor and patient/carer to directly discuss with the Ear Specialist history and treatment options for their ear condition. The viewer screen at each end of the teleconference can have multiple images of the patient's eardrum, of the audiogram and of the patient/carer and medical attendants. This enables the patient/carer to be fully assessed by the ear Specialist and for medical and surgical treatments to be discussed and arranged, saving much time for the patient/carer who might otherwise have months to wait to see the visiting specialist.

Algorithms for Treatment

- Does this child have a middle ear infection?
- Management of OME.
- Management of AOM with perforation.
- Management of AOM without perforation.
- Management of CSOM.
- Management of dry perforation.
- Hearing loss due to otitis media.

DOES THIS CHILD HAVE A MIDDLE EAR INFECTION (OTITIS MEDIA)?

Is there a bulging eardrum or pain?



NO

NO

YES

Can you see discharge in the ear canal or next to the eardrum?

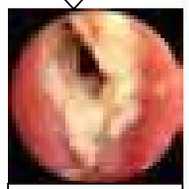
Is there a perforation (hole in the ear drum)?

YES

NO

Is the ear canal swollen and sore?

YES



OTITIS EXTERNA

NO

Has there been discharge through a perforation (hole in the eardrum) present for >6 weeks despite treatment for AOM?

NO

YES

AOM WITHOUT PERFORATION

AOM WITH PERFORATION

CSOM

Is there a perforation (hole in the ear drum)?

NO

YES

Is at least one eardrum translucent (see through) with no signs of a fluid level?

YES

NORMAL EARDRUM AND PROBABLY NORMAL HEARING CONTINUE TO REVIEW REGULARLY

NO

OME

DRY PERFORATION

MANAGEMENT OF BILATERAL OTITIS MEDIA WITH EFFUSION (OME)

REFER FOR A HEARING TEST (AUDIOMETRY)

HOW LONG HAS BILATERAL OME BEEN PRESENT?

> 3 MONTHS

< 3 MONTHS

REVIEW AGAIN IN 3 MONTHS

HEARING LOSS < 20dB

BILATERAL OME WITH NORMAL HEARING

- Continue to review regularly
- Refer for ENT assessment ONLY if severe retraction pocket

HEARING LOSS > 20 dB

Usually antibiotics not given however AMOXYCILLIN 25-50 mg/kg 1-2 times daily for 3 months, option for infants at high risk of developing CSOM

REASSESS AFTER COMPLETION OF ANTIBIOTICS

OME RESOLVED

NORMAL EARDRUM(S) AND PROBABLY NORMAL HEARING

- Continue to review regularly

OME PERSISTS HEARING LOSS 20-35 dB

BILATERAL OME WITH MILD HEARING LOSS

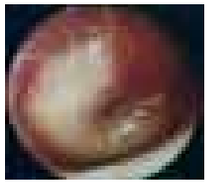
- Recommend strategies for communication and amplification
- Ensure ongoing audiological and educational support
- Consider ENT referral

OME PERSISTS HEARING LOSS > 35 dB

BILATERAL OME WITH MODERATE HEARING LOSS

- Recommend strategies for communication
- ENT referral for grommet surgery
- Refer for hearing aids if surgery unavailable or unsuccessful
- Ensure ongoing audiological and educational support

MANAGEMENT OF ACUTE OTITIS MEDIA WITHOUT PERFORATION

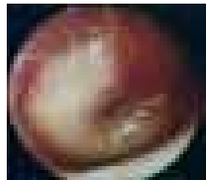


AOM WITHOUT PERFORATION

TREAT WITH AMOXYCILLIN 50 mg/kg 2-3 times a day FOR AT LEAST 1 WEEK especially children less than 2 years of age
ANALGESICS IF PAIN PRESENT

REVIEW AT 4 – 7 DAYS

DISCHARGE AND BULGING EAR DRUM RESOLVED



BULGING EAR DRUM PERSISTS

BURST EARDRUM

TREAT WITH AMOXYCILLIN 90 mg/kg/day FOR AT LEAST 1 MORE WEEK, FOLLOWED BY REVIEW

BULGING EAR DRUM PERSISTS

HAVE THERE BEEN 3 OR MORE EPISODES OF AOM IN THE LAST 6 MONTHS?

NO

AOM RESOLVED

- Continue to review regularly

YES

RECURRENT AOM (rAOM)

- Discuss option of prophylactic antibiotics (amoxycillin 25 mg/kg/day once daily) with family

PERSISTENT AOM

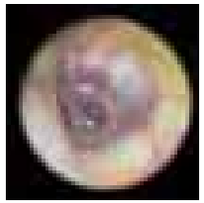
- Continue Amoxycillin 90 mg/kg/day until bulging eardrum resolved
- Consider Azithromycin 30mg/kg stat in children over 6 months
- Continue to review weekly

AOM WITH PERFORATION

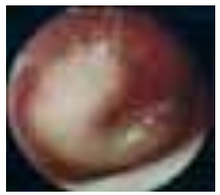
- See Management of Acute Otitis Media with Perforation

MANAGEMENT OF ACUTE OTITIS MEDIA WITH PERFORATION

AOM WITH PERFORATION



TREAT WITH AMOXYCILLIN 50-90 mg/kg/day FOR AT LEAST 2 WEEKS REVIEW WEEKLY



DISCHARGE AND BULGING EAR DRUM PERSISTS

TREAT WITH AMOXYCILLIN 90 mg/kg/day PLUS TOPICAL ANTIBIOTICS eg. CILOXAN EARDROPS CONTINUE TO REVIEW WEEKLY

DISCHARGE AND BULGING EAR DRUM PERSISTS

PERSISTENT AOM WITH PERFORATION

- Continue Amoxycillin 90 mg/kg/day or combination therapy (e.g. Amoxycillin 50 mg/kg/day plus Amoxycillin-Clavulanate 50 mg/kg/day) plus topical antibiotics until discharge and bulging drum resolved
- Continue to review weekly

CSOM

- Discharge through a perforation present > 6 weeks despite appropriate treatment for AOM

DISCHARGE AND BULGING EAR DRUM RESOLVED

HAVE THERE BEEN 3 OR MORE EPISODES OF AOM IN THE LAST 6 MONTHS?

NO

AOM RESOLVED

- Continue to review regularly

YES

RECURRENT AOM (rAOM)

- Discuss option of prophylactic antibiotics (amoxycillin 25 mg/kg/day once daily) with family

MANAGEMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA (CSOM)

DISCUSS TREATMENT OPTIONS FOR CHRONIC MIDDLE EAR DISCHARGE WITH FAMILY
EMPHASISE THE NEED FOR LONG TERM REGULAR DRY MOPPING FOLLOWED BY ANTIBIOTIC DROPS

REGULAR TREATMENT NOT POSSIBLE

CONSIDER SUPERVISED DOSING OR USE OF A SCHOOL BASED PROGRAM

REGULAR TREATMENT NOT POSSIBLE

CONTINUE TO REVIEW REGULARLY
ADVISE TO KEEP EAR AS DRY AS POSSIBLE

REGULAR TREATMENT POSSIBLE

REGULAR TREATMENT POSSIBLE

CSOM TREATMENT
CILOXAN EARDROPS 2-4 DROPS 2-4 TIMES A DAY AFTER DRY MOPPING
CONTINUE UNTIL EAR DRY FOR AT LEAST 3 DAYS OR FOR UP TO 14 DAYS MAX
CONTINUE TO REVIEW WEEKLY

MIDDLE EAR WET

MIDDLE EAR DRY

DRY PERFORATION

PERSISTENT CSOM
CONSIDER TOPICAL CIPROFLOXACIN DROPS
OR HOSPITAL ADMISSION FOR IV OR IM CEFTAZIDIME
(DISCUSS WITH LOCAL MEDICAL OFFICER)

MEDICAL OFFICER ASSESSMENT TO EXCLUDE CHOLESTEATOMA
REFER FOR A HEARING TEST (AUDIOMETRY)

HEARING LOSS < 20 dB

HEARING LOSS 20-35 dB

HEARING LOSS > 35 dB

CSOM WITH NORMAL HEARING

- Continue to review regularly
- Consider ENT referral

CSOM WITH MILD HEARING LOSS

- Recommend strategies for communication and amplification
- Ensure ongoing audiological and educational support
- Consider ENT referral

CSOM WITH MODERATE HEARING LOSS

- Recommend strategies for communication
- ENT referral for ear drum repair (myringoplasty)
- Refer for hearing aids
- Ensure ongoing audiological and educational support

MANAGEMENT OF DRY PERFORATION

HOW LONG HAS THE DRY PERFORATION (HOLE IN THE EAR DRUM) BEEN PRESENT?

> 3 MONTHS

< 3 MONTHS → **REVIEW AGAIN IN 3 MONTHS**

REFER FOR A HEARING TEST (AUDIOMETRY)

HEARING LOSS < 20 dB

DRY PERFORATION WITH NORMAL HEARING

- Continue to review regularly
- Consider ENT referral if recurrent infections a problem

HEARING LOSS 20-35 dB

DRY PERFORATION WITH MILD HEARING LOSS

- Recommend strategies for communication and amplification
- Ensure ongoing audiological and educational support
- Consider ENT referral

HEARING LOSS > 35 dB

DRY PERFORATION WITH MODERATE HEARING LOSS

- Recommend strategies for communication
- ENT referral for ear drum repair (myringoplasty)
- Refer for hearing aids
- Ensure ongoing audiological and educational support

HEARING LOSS DUE TO MIDDLE EAR INFECTION

BILATERAL OME > 3 MONTHS

CSOM > 3 MONTHS

DRY PERFORATION > 3 MONTHS

SPEECH AND LANGUAGE DEVELOPMENTAL DELAY

FAMILY CONCERN

CONTINUE MEDICAL TREATMENT SEE MANAGEMENT FOR OME AND CSOM

REFER FOR A HEARING TEST (AUDIOMETRY)

HEARING LOSS < 20 dB

HEARING LOSS 20-35 dB

HEARING LOSS > 35 dB

NORMAL HEARING

- Continue to review regularly

MILD HEARING LOSS

- Recommend strategies for communication and amplification
- Ensure ongoing audiological and educational support
- Consider ENT referral

MODERATE HEARING LOSS

- Recommend strategies for communication
- ENT referral for ENT assessment
- Refer for hearing aids
- Ensure ongoing audiological and educational support

Surgical Procedures
Ventilation Tubes (grommets)

Why is the operation needed?
Grommets (ventilation tubes) are usually inserted for treatment of otitis media with effusion (glue ear), or recurrent middle ear infection. Grommets may be needed in these cases:

- Four to six separate attacks of otitis media in 12 months
- Three separate attacks of otitis media in 6 months
- A handicapping hearing loss, which affects the child for 3 months
- A mild hearing loss for 12 months or greater
- Speech and language delay
- Balance problems

How is the operation performed?
The procedure can be done either by itself or with another procedure. If it is done by itself, sometimes the child can go home the same day (same day care unit). If done with another procedure then the child may spend a night in hospital.

How long do grommets stay in?
Grommets usually remain in place for between 3 and 9 months, at which time they come out of the eardrum by themselves into the ear canal. A second set of grommets is required in approximately 20%of children.

What will I notice after the operation?
There should be no significant pain for more than twenty four hours and usually there should be little in the way of discharge or bleeding from the ear. Often there will be antibiotic drops given post operatively to help keep the grommet from blocking or getting infected.

What should I do after the operation?
Do not let water go into the ear. To stop water getting into the ear, use:

- silicon ear putty
- "blue tac"
- ear plugs

Children should not do "bombies" or dive or swim underwater, as water may enter the ear despite the ear protection. Children are reviewed every 6 - 9 months while the tubes are in place, to make sure that no discharge or problems have occurred, and to check the child's hearing after the operation. Children are reviewed once the tubes have come out as well, to check on the healing of the eardrum and to make sure that no fluid is behind the eardrum.

What if water gets into the ear?
If water does get into the ear, or the patient has a cold, there may be some drainage from the ear This can be easily treated with antibiotic eardrops. The treatment for discharging grommets is the application of 5 drops of Ciloxan ear drops 2 times a day for 5 days. Occasionally ear washouts are necessary using Betadine 0.5% solution and a plastic syringe followed by the use of the drops as described.

What complications may happen after the operation?
Complications may include discharge (as mentioned above), polyps and bleeding, or development of retraction pockets or cholesteatoma at the site of the operation. In rare cases, where there is infection that does not respond to eardrops and oral antibiotics, admission to hospital for IV antibiotics and removal of the tube may be needed. In 1.6%-10% of cases, a hole (or perforation) may remain once the grommet has come out. A further operation to repair the hole in the eardrum (myringoplasty) may be needed.

Photograph of Ventilation Tube (grommet) in situ

Surgical Procedures
Myringoplasty

(repair of holes in the eardrum using a special graft)

How do holes in the eardrum occur?
A hole in the eardrum, or perforation, may come from a previous ear infection or if the eardrum does not heal after grommets (ventilation tubes) have come out.

Why is the operation needed?
Repair of the eardrum (myringoplasty) is an operation that is performed to reconstruct the eardrum if there is a perforation. Material is grafted over the hole in the eardrum allowing the eardrum to heal. This improves the hearing, allows the child to swim and prevents skin at the edges of the perforation growing into the middle ear (cholesteatoma).

What is used to repair the hole?
The graft material varies, but is always taken from the patient. The graft material used is either subcutaneous tissue/fat/fascia, or a tragal cartilage graft. Graft material is sometimes taken from behind the ear or from the front of the ear (tragus). This requires a small cut and occasionally a larger cut behind the ear.

What will I notice after the operation?
There will be blood stained discharge draining from the ear for up to four weeks. If the discharge becomes smelly, please see a doctor. There may be some "popping" sounds. Long-lasting pain is not usual, and you should see a doctor. If you become very dizzy after leaving hospital, also see a doctor.

What should I do after the operation?
Water should be kept off the small cut to remove the graft material for one week. Do not let water go into the ear. To stop water getting into the ear, use:

- silicon ear putty
- "blue tac"
- ear plugs
- Vaseline and cotton wool

How successful is the operation?
The success of the operation varies according to the size of the hole, and the presence or absence of infection both before and after the operation. Success rate varies between 50-80%.

What complications may happen after the operation?
Complications include infection and rejection of the graft, hearing loss (uncommon), ringing in the ears (tinnitus) and dizziness and loss of balance (vertigo), and very rarely (1 in 10,000) facial nerve palsy.

Photo of myringoplasty.

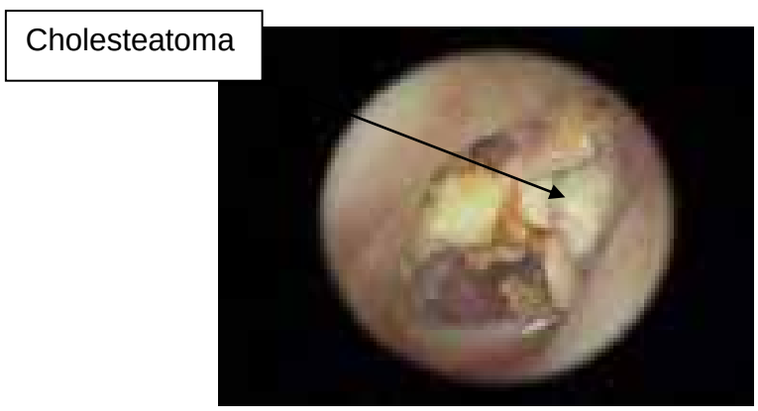
Tissue Engineered Regeneration of Ear Drum
Exciting recent developments in Japan by Professor Kanemaru have shown a method of regenerating the eardrum in people with chronic ear drum perforations by a short procedure under local anaesthetic in adults and under general anaesthetic in children. This uses a tissue growth factor which stimulates the growth of the three components of the tympanic membrane or ear drum, to grow along a gelatine foam scaffold to successfully repair the perforations in a significant number of patients in pilot studies in Japan. This technique has been performed in Perth for the first time in Australia with success. It is hoped in the future that this procedure will be available throughout Australia if Australian pilot programs show success rates equivalent to conventional myringoplasty.

Complications of Otitis Media

Which patients to refer for urgent treatment?
Despite the common use of antibiotics, there is still the risk of complications of otitis media and chronic suppurative otitis media of infection involving the middle ear, mastoid, inner ear and intracranial cavity.

Mastoiditis
Acute mastoiditis involves the development of an abscess within the mastoid bone behind the external ear, often accompanied by systemic symptoms and a tender lump between the external ear and the mastoid region, which may cause the outer ear to stick out. In acute mastoiditis the crease behind the ear is usually blunted or absent.

Suspected cholesteatoma
Cholesteatoma occurs when the normal lining skin of the eardrum accumulates in the middle ear or other parts of the temporal bone. Usually it develops from a retraction pocket in the eardrum or migration of skin through a defect of the eardrum such as a perforation. Clinically, the diagnosis is made by the visualisation of a white mass in the tympanic membrane or middle ear. Usually surgical management is necessary for this condition.



Intracranial complications (associated meningitis or brain abscess)
Acute otitis media and chronic suppurative otitis media may lead to meningitis or inflammation of the lining of the brain or an abscess in the brain or thrombosis of one of the great blood vessels in the region (lateral sinus thrombosis).

Facial paralysis
Facial nerve paralysis can be caused by otitis media, either in its acute or chronic form as well as with cholesteatoma. The child will have an inability to move one side of the face, and this condition requires acute intervention by the otolaryngologist.

Labyrinthitis
Labyrinthitis occurs when there is spread of infection from the middle ear or mastoid into the vestibular and cochlear organs. This may cause a permanent hearing loss and dizziness and, in the presence of fever and an acute infection, is a medical emergency.

Resources

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Prepared by The Darwin Otitis Guideline Group in collaboration with the Office for Aboriginal and Torres Strait Islander Health Medical Technical Advisory Group for the Office for Aboriginal and Torres Strait Islander Health, Australian Government Department of Health and Ageing. Canberra ACT.

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Special thanks go to:
Artwork created by Darryl Bellotti, an Indigenous artist of both Yamatji and Nyoongar descent.
Abbott & Co Printers, for typesetting and printing
PFL Print Finishing Line for binding the book.

Aboriginal Ear Health Manual