Introduction

Ear disease and resultant hearing loss are significant public health issues in developing countries and among many Indigenous populations in developed countries [1-3]. Ear conditions are classified according to the part of the ear (the external, middle or inner ear) in which the disorder occurs. The ear is the organ of hearing and of balance. The outer ear is the part you can see - its shape helps to collect sound waves. The middle ear, a small air-filled cavity, is separated from the outer ear by the tympanic membrane (eardrum) and contains three tiny, inter-connected bones (hammer, anvil, and stirrup), which amplify sound waves. In the inner ear, sound waves are changed into electrical impulses and transmitted to the brain. The inner ear contains the semicircular canals and the utriculus and sacculus, the chief organs of balance and orientation.

(For more information about the structure of the ear visit the Australian hearing website - http://www.hearing.com.au/.)

Disorders of all parts of the ear - regardless of the site - have the potential to impair hearing. Conductive hearing loss results from the interruption of sound as it is conducted between the external environment and the inner ear. Sensorineural hearing loss results from cochlea or auditory nerve damage which interferes with transmission between the inner ear and the brain. Sensorineural hearing impairment affects the ability to hear speech at reduced loudness levels, and may also cause sound distortion and other problems affecting the processing of speech. When conductive and sensorineural hearing loss coexist, the hearing loss is referred to as ‘mixed’. Factors associated with hearing loss include heredity, the ageing process, exposure to loud noises, and trauma to the ear. Other common causes of hearing loss are diseases including bacterial and/or viral infections (rubella, mumps, measles or the...
common cold). In Australia the leading reported causes of hearing impairment are the work environment (29%), followed by disease, illness or hereditary condition (17%) [4].

Estimates of self-reported hearing disorder in Australia range from 2.6% in the Australian Bureau of Statistics’ 1993 Survey of Disability, Ageing and Carers to around 9-10% in the 1995 and 2001 National Health Surveys and 15% in the South Australian Health Omnibus Survey [4]. Males are found to have higher rates of hearing impairment generally than females (the extent to which this due to their greater work exposure is not known). The prevalence of hearing disorder increases with age particularly over the age of 50 years. Approximately 17% of people with a hearing impairment reported its onset at 4 years and younger, but there was no obvious age trend past the childhood years.

Otitis media

Infection in the middle ear can cause inflammation and lead to various forms of otitis media (OM). For babies and young children, ear infections are the most common type of illness with three out of four children experiencing some form of OM by the time they have reached 3 years of age [5]. OM is a common disorder in developed and developing countries [6], but its form, onset, and natural history vary from population to population [1]. In developed countries, OM with effusion is prevalent and considered a major problem, but acute and chronic suppurative forms of OM are much more common in developing countries [7, 2].

The main types of OM are:

- **Acute otitis media (AOM) without perforation**: acute inflammation of the middle ear and eardrum (tympanic membrane), usually with signs or symptoms of infection. AOM is characterised by the presence of fluid behind the eardrum, combined with one or more of the following: bulging eardrum, red eardrum, recent discharge of pus, fever, ear pain, and irritability.

- **Acute otitis media with perforation**: discharge of pus through a perforation (hole) in the eardrum within the previous 6 weeks.

- **Recurrent acute otitis media (rAOM)**: more than three attacks of AOM within six months, or more than four in 12 months.

- **Chronic otitis media**: a persistent inflammation of the middle ear – it can occur with or without perforation, either as chronic suppurative otitis media, or as otitis media with effusion (respectively).

- **Chronic suppurative otitis media (CSOM)**: recurrent or persistent bacterial infection of the middle ear, with discharge and perforation of the ear drum (CSOM is distinguished from acute perforation with discharge in that the discharge persists). Symptoms include hearing loss – pain is not a feature. CSOM has been identified on the basis of discharge persisting for 6 weeks or more, but an expert panel convened by the World Health Organization defined it recently as discharge for at least 2 weeks.

- **Otitis media with effusion (OME)**: an inflammation of the middle ear characterised by fluid behind the eardrum, without signs or symptoms of acute otitis media; also sometimes referred to as serous otitis media, secretory otitis media, or (more colloquially) ‘glue ear’.

- **Dry perforation**: perforation of the eardrum, without any signs of discharge or fluid behind the eardrum.

(For more information about otitis media visit the Medline Plus website - http://www.nlm.nih.gov/medlineplus/ency/article/001336.htm)

Internationally, three bacterial pathogens are recognised as the major causes of primary OM - **Streptococcus pneumoniae** (25-50%), **Haemophilus influenzae** (15-30%), and **Moraxella catarrhalis** (3-20%) [11]. Viruses most implicated with OM are the respiratory syncytial virus (RSV), adenovirus virus and influenza virus [12, 2, 13]. The most commonly isolated organism in chronic suppurative otitis media (CSOM) is **Pseudomonas spp**. [2, 14-16]. Once established in the middle ear or mastoid system, it exacerbates the disease process [17, 2]. Other pathogens include **Staphylococcal aureus** and gram-negative bacilli (such as **Proteus spp**. and some anaerobes [16, 2], but their role is believed to be limited [18, 2].

Hearing loss is not an inevitable consequence of OM, but nearly all people with CSOM will experience some degree of conductive hearing loss resulting from tympanic membrane perforation, ear discharge, granulation tissue or polyps, cholesteatoma (a benign growth of skin in the ear), ossicular discontinuity or fixation, or oedema of the ear canal [2, 17]. Perforation of the tympanic membrane does not always indicate hearing loss, but normal hearing is unlikely [19]. A decrease in hearing can occur if there is middle ear effusion and the eustachian tube becomes blocked, preventing air from getting into the middle ear and the accumulation of fluid behind the drum. Hearing impairment associated with OM is generally conductive in nature, mild to moderate in degree, and may be intermittent or persistent according to the middle ear condition present at the time [2, 20, 21]. If OM becomes chronic and is not adequately treated, there is an increasing risk of permanent hearing loss.
Treatment

Treatment for OM may include the use of antibiotics and analgesics for the pain. There is worldwide agreement that amoxycillin is the first drug of choice for OM [15, 2, 22, 23, 8]. However, bacterial resistance is a concern associated with the use of antibiotics. Viral infection, in addition to bacterial infection, in the middle ear effusion of patients with acute OM may reduce the response to antibiotics [24, 2]. Antibiotics may not be completely protective against mastoiditis [2], which is bacterial infection of the air cells in the skull behind the ear. For OME, antibiotics are considered appropriate as 50% of middle ear aspirates contain bacteria [25, 2]. However, due to lack of long-term clearance of effusion, antibiotics have a minimal role in the restoration of hearing to normal levels [2].

For CSOM, the priority is to heal the perforation, maintain an intact eardrum and minimise hearing loss [2]. As initial pathogens have usually been replaced by *Pseudomonas* spp., antimicrobial therapy recommended for acute OM is not likely to be effective for most cases of CSOM [26, 2]. Even if *Pseudomonas* is not present, those present may be antibiotic resistant. Ear toilets are often recommended – this involves cleansing the ear canal of discharge. Topical antibiotics are often more effective than oral or parenteral antibiotics (parenteral means intravenous, subcutaneous, intramuscular or mucosal).

When complications occur, diagnosis may necessitate bacteriology of ear swabs and radiological investigations [2]. Radiological examinations include computed tomography (CT scan) – for diagnosis of complications associated with conductive hearing loss, and assessment of boney erosion from cholesteatoma [17, 2, 26-29]. There may be a necessity for surgery. A surgical procedure – myringotomy – can be performed to assist in restoring hearing by releasing the fluid that builds up in the middle ear.

Testing for hearing loss

Conductive hearing loss is identified by means of audiometric testing. Audiometric tests such as pure tone audiometry, speech audiometry, impedance audiometry, and tympanometry determine the extent of loss in decibels. A decibel (dB) is a measure of sound intensity. The definitions vary, but a common categorisation of is:

- **Mild** (21-45dB) - soft sounds may be difficult to distinguish
- **Moderate** (46-60dB) - conversational speech is hard to hear, especially if there is background noise
- **Moderately severe** (61-75dB) - it is very difficult to hear ordinary speech
- **Severe** (76-90dB) - conversational speech can't be heard
- **Profound** (>90dB) - almost all sounds are inaudible

Conversational speech measures around 65dB. In children, a hearing loss of 31dB or more in the better ear is considered disabling, but even a loss of 20dB may have a significant impact during the critical period of language development [2].


For young babies, a distraction test is often used to test hearing [2]. This involves presenting a sound to a baby – the normal response is for the baby to turn his/her head to locate the source. Babies should respond to two out of three sound presentations. The process requires two testers, one to provide the sound (out of the baby’s field of vision), and the other to help focus the baby’s visual attention. Many experts agree that parental concern is often the single most important factor in the diagnosis of hearing loss. However, even though parents are usually the first to identify their child’s hearing impairment, the detection is usually late. Parent Held Records (a parental questionnaire) elicit the presence of parental concern in relation to a child’s hearing. These questionnaires accompany child health booklets which are distributed to parents throughout Australia.

For children over the age of 3 years old, pure tone audiometry is an appropriate method of testing [30, 2]. This method uses a machine called an audiometer which produces a range of beeps and whistles (pure tones) – the person being tested presses a button or otherwise indicates when a sound is heard. If the sound is heard through headphones, air conduction hearing can be tested (this includes the outer hearing pathway and the middle ear). If sounds are listened to through a bone conductor (a vibrator held against the mastoid bone, located behind the ear) the sounds of the inner hearing pathways can be measured. In rural settings, however, it is not always possible to achieve sufficiently low background noise levels for this procedure [19].

Pneumatic otoscopy and tympanometry are complementary ear tests – the strengths and weaknesses of one test are offset by the strengths and weaknesses of the other [2]. Otoscopy can be used to assess the colour, translucency and resting position (retracted, neutral) of the tympanic membrane. It is essential that the tympanic membrane can be observed with a good light source and that the view is unobstructed by cerumen (wax in the ear). A normal eardrum is translucent with a ground-glass, usually pearly-grey appearance (it can turn red when a patient cries) [25, 2]. Otoscopy can be used in the diagnostic process for OM, but cannot be relied on solely. Pneumatic otoscopy is a two-step procedure including visualisation of the ear canal and drum with a light source, and observation of the tympanic membrane when a slight positive and negative pressure is applied to the sealed ear canal [2]. The mobility
of the tympanic membrane is evaluated – crisp movement of the tympanic membrane with slight application of pressure is normal. Thickening of the tympanic membrane causes it to be less mobile: if there is absence of movement, OME is highly likely.

Tympanometry is a quantitative measure of tympanic membrane mobility and is used to assess the impedance of the middle ear to acoustic energy [2]. This is done by by placing a sealed sounding source and a microphone in the external auditory canal and measuring acoustical energy that is absorbed or reflected by the middle ear. A tympanogram is generated by delivering a single low-frequency tone (220 Hz) and plotting readings of air pressure versus ear canal compliance. There is a risk of a false positive if there is impacted cerumen, tympanic perforation, canal stenosis (narrowing), or improper placement of the instrument tip. Tympanometry and otoscopy together are a reliable indicator of middle-ear disease, but to determine if there is an associated hearing loss an audiogram must be obtained.

References
10. Menzies School of Health Research (2001) Recommendations for clinical care guidelines on the management of otitis media in Aboriginal and Torres Strait Islander populations. Canberra: Commonwealth Department of Health and Aged Care


The Australian Indigenous HealthInfoNet is an innovative Internet resource that contributes to ‘closing the gap’ in health between Indigenous and other Australians by informing practice and policy in Indigenous health.

Two concepts underpin the HealthInfoNet’s work. The first is evidence-informed decision-making, whereby practitioners and policy-makers have access to the best available research and other information. This concept is linked with that of translational research (TR), which involves making research and other information available in a form that has immediate, practical utility. Implementation of these two concepts involves synthesis, exchange and ethical application of knowledge through ongoing interaction with key stakeholders.

The HealthInfoNet’s work in TR at a population-health level, in which it is at the forefront internationally, addresses the knowledge needs of a wide range of potential users, including policy-makers, health service providers, program managers, clinicians, Indigenous health workers, and other health professionals. The HealthInfoNet also provides easy-to-read and summarised material for students and the general community.

The HealthInfoNet encourages and supports information-sharing among practitioners, policy-makers and others working to improve Indigenous health – its free on line yarning places enable people across the country to share information, knowledge and experience. The HealthInfoNet is funded mainly by the Australian Department of Health and Ageing. Its award-winning web resource (www.healthinfonet.ecu.edu.au) is free and available to everyone.