

Review of ear health and hearing among Indigenous Australians

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Preface

This review of ear health and hearing among Indigenous Australians has been prepared by the Australian Indigenous HealthInfoNet as a part of our contributions to 'closing the gap' in health between Indigenous people¹ and other Australians. The aim is to make relevant, high quality knowledge and information easily accessible to policy makers, health service providers, program managers, clinicians, researchers and the general community. The review is an example of the HealthInfoNet's translational research [1], defined as 'comprehensive applied research that strives to translate the available knowledge and render it operational' ([2], p.1794).

The main purpose of the review, which follows the model of narrative reviews/syntheses [3], is to provide an authoritative, up-to-date review of ear health and hearing of Indigenous people that (1) is a valuable overview for people working in the area; and (2) assists in the development/refinement of policies, strategies and programs.

Research for the review involves the collection, collation, and analysis of a wide range of information, including both published and unpublished material. Sources include the full range of relevant literature, including journal articles and other publications, the vast majority of which are accessible via the HealthInfoNet's Australian

1 The term Indigenous is used in this review to refer generally to the two Indigenous populations of Australia - Australian Aboriginal people and Torres Strait Islander people.

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Indigenous Health *Bibliography*. This bibliography, with more than more 20,000 entries includes journal articles, books, book chapters and reports (including 'grey' literature).

As well as the relevant journal literature, the HealthInfoNet's reviews draw on important government reports, particularly those produced by the Australian Bureau of Statistics (ABS), the Australian Institute of Health and Welfare (AIHW) and the Steering Committee for the Review of Government Service Provision (SCRGSP), and reports in the *Aboriginal and Torres Strait Islander health performance framework* series. These reports, prepared by the Australian Health Ministers' Advisory Council (AHMAC) in 2006, 2008, 2011 and 2012, are accompanied by substantial detailed analyses, which are accessible on the AIHW website. The HealthInfoNet's reviews also draw on information from the main administrative data collections (such as the birth and death registration systems and the hospital inpatient collections) and national surveys. Information from these sources has been published mainly in government reports, particularly those produced by the ABS and the AIHW.

After providing the context of ear health and hearing, the body of the review outlines the extent of ear and hearing health issues among Indigenous people, provides an overview of the various contributing factors, considers prevention and management strategies, summarises a number of relevant policies and strategies, and provides some brief concluding comments. Rather than commence with an executive summary, the review is preceded by a section devoted to 'Key facts', which presents the summarised information in a more concise form.

Further information about the ear health and hearing of Indigenous people is accessible from the relevant section (www.earinfonet.org.au) of the HealthInfoNet's website (www.healthinonet.edu.au), which provides access to: the complete Indigenous-specific literature; details of policies and strategies, programs and projects, and organisations involved in the area; and databases of health promotion and health practice resources.

We welcome your comments and feedback about the review.

Neil Thomson, Director, on behalf of the HealthInfoNet team

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Key facts

Indigenous population

- At 30 June 2011, the estimated Australian Indigenous population was 669,736.
- NSW² had the highest number of Indigenous people (208,364, 31% of the total Indigenous population); the NT had the highest proportion of Indigenous people in its population (30% of the NT population is Indigenous).
- In 2011, the majority of Indigenous people lived in cities and towns; around one quarter of Indigenous people lived in remote or very remote areas.
- The Indigenous population is much younger than the non-Indigenous population.

Ear disease

- For Indigenous children in particular, hearing loss is widespread and much more common than in the broader Australian population.
- Some Indigenous communities have a prevalence of chronic suppurative otitis media up to 10 times higher than the 4% that the World Health Organization (WHO) identifies as being 'a massive public health problem' requiring 'urgent attention'.
- The 2008 NATSISS found that 8.6% of males and 8.7% of females had ear/hearing problems, with 3.2% of males and 2.9% of females having otitis media, 2.8% of males and 2.7% of females having total or partial hearing loss and 2.5% of males and 2.9% of females having other ear/hearing problems.
- The 2004-2005 NATSIHS found that:
 - 12% of Indigenous people reported ear/hearing problems
 - 10% of Indigenous children aged 0-14 years reported having ear or hearing problems compared with 3% of non-Indigenous children
 - there was higher prevalence of OM among Indigenous children aged 0-14 years (4%) than among non-Indigenous children (2%) and a higher prevalence of complete or partial hearing loss or deafness (5%) than among non-Indigenous children (1%).

Factors contributing to ear disease

- Indigenous people are vulnerable to ear and other health conditions. Indigenous children are particularly vulnerable

to infections such as upper respiratory infections which can lead to ear infections. Very young babies can get ear infections from older toddler siblings.

- Breastfeeding appears to be associated with a reduced risk of OM for infants, while bottle-feeding increases the risk.
- Other factors that increase the risk of ear health issues include:
 - social disadvantage
 - limited access to primary health care and treatment
 - nutritional problems
 - crowded housing conditions
 - inadequate access to water, functioning sewerage and waste removal systems
 - passive smoking
 - use of dummies beyond the age of 11 months
 - use of day-care for children.

Costs of ear disease for Indigenous people

- In 2008, the cost of ear disease cases for Indigenous people was estimated as \$8-\$16 million.
- Other indirect financial costs are:
 - caring costs for children with ear disease including productivity losses, losses of taxation revenue and travel costs
 - reduced employment of people with permanent hearing loss; if they are not working they are likely to receive welfare and income support.

² The acronyms used for states and territories in this review are: New South Wales (NSW), Victoria (Vic), Queensland (Qld), Western Australia (WA), South Australia (SA), Tasmania (Tas), Australian Capital Territory (ACT) and Northern Territory (NT).

Introduction

Indigenous Australians experience some of the highest levels of ear disease and hearing loss in the world, with rates up to ten times more than those for non-Indigenous Australians [4]. Children and adolescents are particularly vulnerable to ear infections [4-7]. The most common ear disease among Indigenous children is otitis media (OM), which is inflammation/infection of the middle ear typically caused by bacterial and viral pathogens [7]. Indigenous children living in urban, rural and, particularly, remote areas, are more likely than their non-Indigenous counterparts to have OM at younger ages, more often, at a greater level of severity, and with more likelihood of further complications [5, 8]. Ear infections are responsible for the bulk of hearing problems with lifelong consequences, many of which are preventable and treatable [7]. Hearing loss can be a major contributor to poor education and to unemployment, which are risk factors for contact with the justice system [7].

Ear conditions

Conditions affecting the ear may be classified according to the part of the ear (the external, middle, or inner ear) in which the condition occurs. The external ear is shaped to help collect sound waves. The middle ear, a small air-filled cavity is separated from the ear canal by the tympanic membrane (ear drum); it contains three tiny, interconnected bones (malleus, incus and stapes, otherwise known as 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 also contains the semi-circular canals, the main organs of balance and orientation.

The ear condition with the most important impact on hearing for Australian Indigenous populations is OM: inflammation and/or infection of the middle ear. OM can present in different ways and can be regarded as a spectrum of disease ranging from mild to severe (see Box 1) [9].

Complications from OM can occur throughout the spectrum of disease including; acute OM (AOM), OM with effusion (OME), or chronic suppurative otitis media (CSOM) [10].

Complications³ can include:

- extracranial complications, such as mastoiditis, cholesteatoma (an abnormal skin growth in the middle ear and/or mastoid process) and tympanic membrane perforation
- intracranial complications such as meningitis, brain abscess and sigmoid sinus thrombosis
- hearing loss.

3 The extracranial and intracranial complications are beyond the scope of this review; attention will be directed at hearing loss and its impacts.

The ear canal can also become infected, but this is not a causal factor or type of OM. Otitis externa is inflammation and/or infection of the external ear (ear canal) associated with pain, swelling and discharge. Otitis externa is sometimes referred to as 'tropical ear' and 'swimmers ear' [9].

Box 1: Types of otitis media (OM)

Otitis media (OM): inflammation and/or infection of the middle ear. Active inflammation or infection is nearly always associated with middle ear effusion (fluid in the middle ear space).

Otitis media with effusion (OME): presence of fluid behind the eardrum without any acute symptoms. OME may be episodic or persistent. Other terms used include: 'glue ear', 'serous otitis media' and 'secretory otitis media'.

Persistent (chronic) otitis media with effusion: presence of fluid in the middle ear for more than three months without any symptoms or signs of inflammation.

Acute otitis media (AOM): general term for both acute otitis media without perforation and acute otitis media with perforation. It is defined as the presence of fluid behind the eardrum plus at least one of the following: bulging ear drum, red eardrum, recent discharge of pus, fever, and ear pain or irritability. A bulging eardrum, recent discharge of pus, and ear pain are the most reliable indicators of AOM.

Acute otitis media without perforation (AOMwoP): presence of fluid behind the ear drum combined with one or more of the following: bulging eardrum, red eardrum, fever, ear pain, or irritability. The most reliable indicators of AOMwoP are a bulging eardrum and/or ear pain.

Acute otitis media with perforation (AOMwiP): discharge of pus through a perforation (hole) in the eardrum within the previous six weeks. The perforation is usually very small (pinhole size) when the eardrum first ruptures. The perforation can heal and re-perforate after the initial onset of AOMwiP.

Recurrent acute otitis media (rAOM): occurrence of three or more episodes of AOM within six months, or more than four episodes within 12 months.

Chronic suppurative otitis media (CSOM): persistent perforation in the eardrum. Diagnosis of CSOM is only appropriate if the tympanic membrane perforation is seen and if it is large enough to allow discharge to flow out of the middle ear space. Definition of CSOM varies in the duration of persistent ear discharge (from 2 weeks to 12 weeks).

Dry perforation: perforation of the eardrum, without any signs of discharge or fluid behind the eardrum. Some people refer to this as inactive CSOM.

Source: [9]

Factors contributing to ear disease and hearing disorders among Indigenous people

The factors contributing to ear disease and hearing disorders among Indigenous people are complex. They reflect a combination of broad historical, social, cultural, and economic factors, as well as the more commonly described proximal behavioural and biomedical risk factors. The main risk factors addressed in this review are behavioural and biomedical risk factors; it is beyond the scope to discuss in detail historical, psychosocial and socioeconomic aspects.

Indigenous people are vulnerable to ear and other health conditions due to a number of factors [11]. There is a clear relationship between the social inequalities experienced by Indigenous people and their current health status [12]. This social disadvantage, directly related to dispossession and characterised by poverty and powerlessness, is reflected in measures of education, employment, and income. OM is thought to be more common and severe among Indigenous children than among non-Indigenous children largely because of poverty, crowded housing conditions, nutritional problems [5, 7], inadequate access to water and to functioning sewerage and waste removal systems and limited access to primary health care and treatment [5]. According to the 2004-2005 National Aboriginal and Torres Strait Islander Health Survey (NATSIHS) [13], Indigenous children who lived in overcrowded households or in the lowest socioeconomic status (SES) group, were more likely to have ear and hearing problems (both 15%) than Indigenous children who did not live in overcrowded households (8%) or who were in the highest SES group (11%) [14]. A higher proportion of Indigenous children aged 12-14 years who reported they did not eat vegetables daily (21%) and/or did not eat fruit daily (14%) reported ear and hearing problems than those who did eat fruit and vegetables daily (both 8%).

Indigenous children are particularly vulnerable to infections: many studies have reported a link between early first onset of OM and the increased risk of subsequent and recurrent infections [7]. Upper respiratory infections can lead to OM, they have a higher incidence in winter and lower incidence in summer [8, 15]. Young children are particularly susceptible to ear disease; if early OM is not recognised, infants may be predisposed to a cycle of recurrent OM or chronic OM conditions. Infection can occur as early as 2 months [16]. Generally, the incidence of OM peaks in two age groups: between the ages of 6 and 24 months (when many infants are weaned and exposed to environmental conditions); and at age 4-5 years (when children start kindergarten) [8]. Breastfeeding appears to be associated with a reduced risk of OM for infants,

while bottle-feeding increases the risk [7, 15]. Very young babies can get ear infections from older toddler siblings [17]. The use of dummies beyond the age of 11 months has also been associated with increased risk of OM [18]. There are indications that recent increases in OM and middle ear effusions in the general population may be due to a greater use of day-care [8].

Passive smoking increases the risk of OM [7]. According to the 2004-2005 NATSIHS, ear and hearing problems were reported for a higher proportion (13%) of Indigenous children aged 0-14 years living in households with regular smokers who smoked indoors at home, than for those not living with regular smokers who smoked indoors at home (8%) [14]. A study in Kalgoorlie, WA, also found that passive smoking increased the risk of OM in Aboriginal children [19].

Other risk factors that have been found to be associated with OM nationally and internationally include:

- genetics
- exposure to allergens
- male gender
- Down Syndrome
- cleft palate and craniofacial abnormalities
- pollution [15].

Characteristics of ear disease among Indigenous infants and children

The pattern of ear disease among Indigenous infants and children varies across the country, but severe forms of OM occur most often among Indigenous infants living in remote communities. These infants are particularly susceptible to bacterial colonisation of the upper airways, which has been shown to relate directly to the early onset of OM [7]. Early invasion of the nasopharynx by bacteria can overwhelm the immature immune system resulting in an inadequate antibody response [7]. Nasopharyngeal carriage of bacteria and other organisms can lead to middle ear infection, infection in the Eustachian tube, rhinitis [8, 20] and chronic adenoiditis [8]. The three predominant bacterial pathogens associated with OM are: *Streptococcus pneumoniae*, non-typeable *Haemophilus influenzae* and *Moraxella catarrhalis* [21]. Viruses that cause upper respiratory tract infections associated with AOM and new-onset OME, include respiratory syncytial virus, rhinovirus, coronavirus, adenovirus and parainfluenza virus.

OM symptoms include ear ache, ear rubbing, fever, excessive crying, restless sleep and poor appetite [8]. Non-Indigenous children can

be treated for the symptoms of OM without antibiotics and 80% will be symptom-free in three days (middle ear effusion may remain), but Indigenous children may suffer rAOM that can lead to chronic otorrhoea (ear discharge) and CSOM.

The complications of AOM and OME occur commonly among non-Indigenous children, but the complication of CSOM occurs most commonly among Indigenous children [10]. CSOM is very uncommon in developed countries [22].

Box 2: Techniques for examining ears

A number of techniques can be used for examining ears.

The optimal method for testing for OM is otoscopy, which assesses the tympanic membrane (TM) colour, translucency and resting position. On examination, an intact red, bulging, and cloudy eardrum will be seen in AOM. (A normal eardrum is translucent, with a ground-glass, usually pearl-grey appearance that turns red if a patient cries.) Pneumatic otoscopy adds information about the mobility of the TM so that OM can be diagnosed more accurately.

Tympanometry measures the impedance of the middle ear to sound energy. The placement of a sealed sounding source and microphone in the external auditory canal measures the sound energy that is reflected by the middle ear. Usually, a single low frequency tone is delivered (220Hz) and the ear canal compliance at varying ear pressures enables a plot of pressure versus compliance to be generated (a tympanogram). An abnormal plot can indicate ear problems, but a false positive can result from impacted cerumen (ear wax), TM perforation, canal stenosis (narrowing), or improper placement of the instrument tip.

Source: [7]

Box 3: Hearing impairment

There are two main categories of hearing impairment, which can co-exist:

- conductive (intermittent or persistent hearing loss caused by a middle ear condition such as OM)
- sensorineural (permanent hearing loss caused by a lesion in the cochlea or the auditory nerve and its central connections).

Hearing impairment is classified largely according to the hearing loss in the 'better ear', as measured by average pure-tone threshold audiometry at 500Hz, 1000Hz and 2000Hz. Hearing ranges from normal (without any loss) – an average threshold value of 20dB HL (decibels Hearing Level) or less in the better ear – to profound loss – an average threshold value of 91dB HL or greater in the better ear.

For Indigenous children, there are exacerbating factors that can contribute to significant disability and handicap as a result of OM and associated hearing loss.

Factors include:

- disease severity e.g. early OM onset, recurrent, persistent, or chronically deteriorating OM
- social environment: e.g. generational educational disadvantage
- language environment: e.g. differences between community languages and standard English; and limited exposure to English prior to school entry
- learning environment: e.g. poor acoustic conditions, inexperienced teachers, lack of access to pre-school.

Sources: [23]

For more information about hearing impairment see Appendix 1.

The extent of ear and hearing problems among Indigenous people

Prevalence

Exceptionally high levels of ear disease and hearing loss have been reported in many Indigenous communities, particularly those in remote areas [4, 7, 24]. Some Indigenous communities have a prevalence of CSOM up to 10 times higher than the 4% that the World Health Organization (WHO) identifies as being 'a massive public health problem' requiring 'urgent attention' [7, 25]. For Indigenous children in particular, hearing loss is widespread and much more common than in the broader Australian population [5].

The 2008 National Aboriginal and Torres Strait Islander Social Survey (NATSISS) reported on ear and hearing problems (including total or partial deafness; ringing in ears (tinnitus); runny ears or glue ear (OM); and tropical ear or swimmer's ear (otitis externa)) for Indigenous children aged 4-14 years [26]. For these Indigenous children, 8.6% of males and 8.7% of females had ear/hearing problems: 3.2% of males and 2.9% of females had OM, 2.8% of males and 2.7% of females had total or partial hearing loss and 2.5% of males and 2.9% of females had other ear/hearing problems [14]. The extent of ear or hearing problems reported for Indigenous children was higher for those living in remote areas (10%) than in non-remote areas (8%). The proportion of Indigenous children with total or partial hearing loss was higher in remote areas (4%) than in non-remote areas (2%). The highest proportion of ear and hearing problems among Indigenous children was in the NT (12%) followed by NSW (10%). During 2008, 23% of Indigenous children living in remote areas with an ear or hearing problem received treatment from a hearing specialist compared with 40% of those living in non-remote areas. For Indigenous children living in remote areas, 16% with ear or hearing problems did not receive treatment (as it was either not sought or treatment was unavailable or too expensive) compared with 9% of those with ear or hearing problems living in non-remote areas.

The most recent, comprehensive information about ear conditions and hearing loss was collected by the 2004-2005 NATSIHS, which found that 12% of Indigenous people reported ear/hearing problems [13]. Ear/hearing problems were reported slightly more frequently by Indigenous people living in remote areas (13%) than by those living in non-remote areas (12%). Complete or partial deafness was reported by 9% of Indigenous people living in both remote and non-remote areas, but the level of OM was higher for Indigenous people living in remote areas (4%) than for those living in non-remote areas (2%). After age adjustment, OM was around 2.8 times more common for Indigenous people than for non-

Indigenous people. The levels for complete or partial deafness were higher for Indigenous than for non-Indigenous people for all age groups except people aged 55 years or older, for which the levels were similar (25% compared with 26%). (It should be noted that self-reporting will invariably underestimate the prevalence of the condition.)

Information about Indigenous children collected by the 2004-05 NATSIHS includes the following [14]:

- approximately 10% of Indigenous children aged 0-14 years reported having ear or hearing problems compared with 3% of non-Indigenous children
- there was higher prevalence of OM among Indigenous children aged 0-14 years (4%) compared with non-Indigenous children (2%) and a higher prevalence of complete or partial hearing loss or deafness (5%) compared with non-Indigenous children (1%)
- prevalence of diseases of the mastoid was higher among Indigenous children aged 5-14 years (12%) than those aged 0-4 years (6%).

Other evidence of the level of ear disease among Indigenous people

The Australian Government's Child Health Check Initiative (CHCI) and associated Closing the Gap initiatives in the NT included health checks for Indigenous children aged up to 15 years who lived in prescribed areas of the NT [27]. From checks undertaken between August 2007 and June 2012, 5,474 Indigenous children were referred to an audiology or ear, nose and throat (ENT) service. The highest prevalence of middle ear conditions was found in the 0-5 year age group with 77% of children diagnosed with at least one middle ear condition (see Table 1) [27]. For children aged 6-11 years, the prevalence was 63% and for children aged 12 years and over (a majority of children in this group were under 16 years) the prevalence was 60%. For children aged 0-5 years, the most common conditions were OME (35%), CSOM (14%) and AOM (13%). The prevalence of these conditions was lower among children aged 12 years and over: 14% for OME, 14% for CSOM and 2% for AOM. The prevalence of dry perforation increased from 10% for children aged 0-5 years, to 15% for children aged 6-11 years and to 23% for children over 12 years.

Table 1. Numbers and percentages of Indigenous children who received an audiology or ENT service, by age group and type of middle ear condition, NT, August 2007 to June 2012

Type of middle ear condition	Age group						All ages	
	0-5 years		6-11 years		12+ years		Number of children	Per cent
	Number of children	Per cent	Number of children	Per cent	Number of children	Per cent		
At least one middle ear condition	1,355	77	1,692	63	603	60	3,650	67
AOM	225	13	132	5	23	2	380	7
CSOM	245	14	294	11	137	14	676	12
OME	620	35	671	25	140	14	1,431	26
ETD	231	13	294	11	75	7	600	11
Dry perforation	167	10	396	15	228	23	791	15
Total number of children	1,762	100	2,701	100	1,009	100	5,474	100

Notes:

- 1 Middle ear condition at most recent ENT service or, if only received audiology service, most recent audiology service
- 2 ETD - Eustachian tube dysfunction
- 3 Total numbers include foreign body/other, no middle ear condition and missing information

Sources: [27, 28]

Of 5,184 children who received an audiology service, 51% had hearing loss in at least one ear [27]. Of 2,664 children who had hearing loss, 61% had bilateral hearing loss and 32% had unilateral hearing loss (information was missing for 9% of children).

Information collected by the Western Australian Aboriginal Child Health Survey (WAACHS) in 2001-2002 revealed that 18% of Indigenous children aged 0-17 years were reported by carers as having had recurring ear infections [29]. Children aged 0-11 years were more likely to have recurring ear infections reported (20%) than were children aged 12-17 years (14%). Abnormal hearing was reported for 7% of the children aged 4-17 years. Of children aged 4-11 years with recurring ear infections with discharge, 28% had abnormal hearing reported compared with 1% of those without ear infections.

In NSW, approximately 60,000 Indigenous children aged 0-6 years were screened for OM: a snapshot analysis of screening for quarters 1 and 2 in 2006-07 and 2007-08 found that 27% and 32% respectively of those screened required further referral, with the vast majority referred to primary health services for follow up [30]. These referrals included 11-12% with problems serious enough for referral to ENT specialists. ENT referrals represented 3-4% of total screenings during the periods.

Other evidence of the level of ear disease includes:

- In 2000, a study to measure the occurrence of middle ear disease and hearing loss for Indigenous school children aged 4-12 years in a selection of schools in NSW, found that more than 61% of children had ear problems of some type [31]. Unilateral hearing loss was found in more than 10% of the

children, and 22% of the children suffered bilateral hearing loss.

- In 2001, a survey of over 700 Indigenous children living in remote communities in northern and central Australia found that 91% of children aged 6-30 months had been diagnosed with some form of OM [32]. Perforations of the tympanic membrane (TM) affected 40% of children before the age of 18 months.

Use of health services

Primary health care

Information on general practitioner (GP) encounters, collected by the *Bettering the Evaluation and Care of Health* (BEACH) survey over five years from April 2006 to March 2011, revealed that Indigenous children aged 0-14 years were managed 1.1 times more commonly than their non-Indigenous counterparts for OM/myringitis and 1.2 times more commonly for total diseases of the ear [5]. Ear and hearing problems were responsible for 9.5% of total problems managed among Indigenous children aged 0-14 years and 8.5% of total problems managed among other patients of that same group [14]. Acute OM/myringitis was the most common ear and hearing problem managed at GP encounters with Indigenous children, responsible for 6.1% of total problems managed among Indigenous patients aged 0-14 years; it made up a greater proportion of problems managed in the 0-4 year age group (7.6%).

A study of clinical records for Indigenous children 0-4.75 years in two remote Indigenous communities in tropical northern

Australia, found that respiratory infections and ear infections were common reasons for presentation between 1 January 2002 and 30 September 2005 [33]. There were 7,273 clinical presentations for 174 children 0-4.75 years, including 1,288 presentations (18% of presentations) for ear disease. Upper respiratory tract infection was the most common reason for presentation, noted in 32% of presentations.

A study of clinic attendances in five remote communities of northern Australia for 320 Indigenous children born in the period 1 January 2001 to 31 December 2006, found that 82% of the children presented with ear disease and 73% had more than one presentation during their first 12 months of life [34].

In remote Far North Queensland (FNQ), a review of the FNQ Paediatric Outreach Service's medical database for the period 2001-2006 found that OM was one of the three most common diseases/health problems for 3,562 children [35]. The prevalence of CSOM for Indigenous children in the communities visited by the services was estimated as 15%.

Hospital services

In 2010-11, the hospitalisation rate for diseases of the ear and mastoid process for Indigenous people living in NSW, Vic, Qld, WA, SA and NT was 1.3 times the rate for their non-Indigenous counterparts [36]. More detailed information is available for the period July 2008 to June 2010, when there were 56,614 hospitalisations from diseases of the ear and mastoid process among children aged 0-14 years living in NSW, Vic, Qld, WA, SA and NT; 6% of these hospitalisations were for Indigenous children [14]. Of all hospitalisations among Indigenous children aged 0-14 years, disease of the ear and mastoid process accounted for 5% of hospitalisations. Indigenous children were hospitalised for disease of the ear and mastoid at 1.3 times the rate of non-Indigenous children; the rates were the same for Indigenous and non-Indigenous people aged 15 years and over. The highest Indigenous:non-Indigenous rate ratio (5.6) for hospitalisations for disease of the ear and mastoid process between people was in the NT. Rates for hospitalisations for disease of the ear and mastoid process for Indigenous children aged 0-14 years were highest in the NT (18.2 per 1,000) followed by WA (12.5 per 1,000).

Hospitalisations for disease of the ear and mastoid process for Indigenous children included 1,274 hospitalisations among those aged 0-4 years (3.0% of all hospitalisations among Indigenous children) and 2,091 hospitalisations among those aged 5-14 years (8.1% of all hospitalisations among Indigenous children) [14]. Indigenous children aged 0-4 years were less likely to be hospitalised for disease of the ear and mastoid process than were non-Indigenous children, but Indigenous children aged 5-14 years were twice as likely as their non-Indigenous counterparts to be

hospitalised for these diseases. The majority of hospitalisations for Indigenous children for ear conditions were for diseases of the middle ear and mastoid, including OM. Indigenous children aged 5-14 years were hospitalised for these diseases at twice the rate of non-Indigenous children. The rates of tympanoplasty procedures (a reconstructive surgical treatment for a perforated eardrum) for hospitalisations with a principal diagnosis of OM were over 7 times higher for Indigenous children aged 0-14 years than for their non-Indigenous counterparts. Differences in hospitalisations for OM may be due to the chronic nature of the disease for Indigenous children, resulting in greater damage to the eardrum.

More detailed information is available for hospitalisation in 2008-09 for children living in NSW, Vic, Qld, WA, SA and the NT (Table 2) [37]. Indigenous children aged three years or younger were hospitalised for suppurative and unspecified OM at a rate of 4.6 per 1,000, a rate 1.2 times that of their non-Indigenous counterparts (3.7 per 1,000). For children aged 4-14 years, hospitalisation rates for suppurative and unspecified OM (2.0 per 1,000 for Indigenous children and 1.0 per 1,000 for non-Indigenous children) were less than one-half those of children aged 0-3 years (4.6 per 1,000 for Indigenous children and 3.7 for non-Indigenous children) for both Indigenous and other children.

The overall hospitalisation rate for disease of the ear and mastoid was lower for Indigenous children aged three years or younger (9.1 per 1,000) than for their non-Indigenous counterparts (12.5 per 1,000) [37]. For children aged 4-14 years, the hospitalisation rate for disease of the ear and mastoid was 1.7 times higher for Indigenous children (8.1 per 1,000) than for their non-Indigenous counterparts (4.9 per 1,000).

Table 2. Age-specific hospitalisations for principal diagnosis of disease of the ear and mastoid process, by Indigenous status, age group and specific diagnosis, NSW, Vic, Qld, WA, SA and the NT¹, 2008-09

Principal diagnosis	Indigenous no.	Indigenous per 1000	Other ² per 1000	Rate ratios
Children aged 0-3 years				
Diseases of external ear	20	0.4	0.2	2.0
Diseases of middle ear and mastoid	466	9.1	12.5	0.7
Suppurative and unspecified OM	237	4.6	3.7	1.2
Other disorders of ear	11	0.2	0.6	0.3
Children aged 4-14 years				
Diseases of external ear	28	0.2	0.2	1.0
Diseases of middle ear and mastoid	1,099	8.1	4.9	1.7
Suppurative and unspecified OM	276	2.0	1.0	2.0
Other disorders of the ear	44	0.3	0.2	1.5

Notes:

- 1 Only public hospitals in the NT
- 2 Includes separations where Indigenous status was reported as non-Indigenous or not stated

Source: AIHW National Hospital Morbidity Database (unpublished) [37]

The hospitalisation rate for diseases of the middle ear and mastoid for Indigenous children aged 0-14 years living in remote areas (14.7 per 1,000) was 2.3 times the rate for their non-Indigenous counterparts (6.4 per 1,000) [37]. For those living in major cities, the rate for Indigenous children aged 0-14 years (5.5 per 1,000) was less than that for their non-Indigenous counterparts (7.3 per 1000).

The impact of ear and hearing problems among Indigenous people

Social and educational impacts

Hearing loss associated with ear problems can lead to educational issues, social isolation, truancy, early school-leaving and difficulties gaining employment [8]. Indigenous children with hearing problems can feel isolated and 'stupid'; they are more likely to have behavioural problems, and they generally drop out of school early [38]. Language development depends on hearing, and mainstream schools rely heavily on spoken instruction [39]. When children experience CSOM in the first two years of life, the consequent hearing loss has the potential to have serious effects on language development and contribute to delays in school progress [7]. OM-associated hearing loss can continue into adolescence and have continuing negative effects on learning and development [29]. In terms of disability, the burden of disease due to OM among Indigenous people was estimated for 2008 as ranging from 887 to 2,178 disability adjusted life years (DALYs) [15].⁴

Hearing loss associated with OM can affect cognitive development, auditory processing skills, attention, behaviour, speech and language [40]. The negative effects of hearing loss on language acquisition and subsequent reading, writing and learning are likely to be magnified by a range of issues that impact on the educational experiences and outcomes of Indigenous students [41]. An associated problem is that teachers have often had minimal training on the educational effects of conductive hearing loss [39]. Indigenous school-children with bilateral loss can be more disruptive in class than other students and are often either teased or tease others. Behavioural problems in school can contribute to reduced educational achievements and may have life-long consequences for employment, income and social success [40]. This is particularly the case for children with bilateral conductive hearing loss.

4 The WHO global burden of disease (GBD) measures burden of disease using the disability-adjusted life year (DALY) measure. This time-based measure combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health.

Economic impacts

The top-down health system expenditure in 2008 on OM for Indigenous people was estimated to be \$38.7 million (\$32.4 million for Indigenous children aged less than 15 years), but this is likely to be an underestimate due to the actual costs of health service provision in remote areas [15].⁵ The bottom-up Indigenous cost of cases was around \$8.5 million for the low-case estimate and around \$16.2 million for the high-case estimate. The true health system cost of OM lies between the top-down and bottom-up estimates. There are, of course, other financial costs that are indirect and often apply to the patient's family as carer costs, due to the young age of most individuals who suffer from OM. These include productivity losses, losses of taxation revenue and travel costs. As most sufferers of OM are children, absenteeism is from schooling rather than the workforce [15]. Other losses are from the reduced employment of people with permanent hearing loss; if people are not working they are likely to receive welfare and income support.

Hearing loss and the justice system

The Australian Parliament's *Senate Inquiry into hearing health in Australia* heard evidence of a link between early onset hearing impairment and increased engagement with the criminal justice system [4]. The factor linking hearing impairment with criminal activity was identified as poor educational outcomes. Impaired language development and the stigmatising effects of hearing impairment on self-concept and social skills also had links with criminal activity.

In the NT, high rates of hearing loss have been found among prisoners. An investigation of 44 Indigenous inmates within the Darwin Correctional Centre found that more than 90% had a significant hearing loss [42]. Inmates found to have a hearing loss also completed a verbally administered questionnaire (face-to-face using a hand held amplification device). It was found that hearing impairment is a significant disability in a custodial environment that contributes to the breakdown in communications with prison officers. Some corrections officers had developed skills that helped them communicate more effectively with inmates with hearing loss, and the use of amplification devices was found to lessen communication problems experienced by inmates with hearing loss. These results suggest that there are potential benefits in addressing widespread hearing loss among Indigenous inmates, at least those in the NT.

5 Two ways of estimating health cost elements are: Top-down: data may be able to provide the total costs of a program element and then costs can be allocated. Bottom-up: data may be available for the number of people with a disease who experience a cost impact from the disease and the average cost impact. The product is the total cost, e.g. the number of medical specialist visits to treat OM in a year multiplied by the average cost of a specialist visit.

Management of Indigenous ear health and hearing

Guidelines

The *Recommendations for clinical care guidelines on the management of otitis media in Aboriginal and Torres Strait Islander populations* was updated in 2010 [9].⁶ The guidelines outline prevention, diagnosis, prognosis, medical, audiological and practical considerations in health care delivery. They also outline priorities of primary health care services in different settings. The guidelines highlight the significant challenges involved in the management of OM, and provide two diagnostic and six management algorithms. They outline the circumstances in which antibiotics and other medical therapies, audiological interventions, and surgical interventions are recommended for the various forms of OM. The guidelines are intended for use by the variety of health care professionals and others who work with Indigenous populations: these include Indigenous health workers, Indigenous ear health workers, primary care and specialist physicians, nurses, remote nurses and nurse practitioners, audiologists, audiometrists, speech therapists, and child development specialists (including advisory visiting teachers and teachers of the deaf).

Use of antibiotics

Antibiotics are not routinely recommended for OME or dry perforation [9]. Antibiotics, such as amoxicillin, can be considered as an option for infants at high risk of developing CSOM and also for children with AOMwoP. Antibiotics are recommended for AOMwiP and rAOM. Excessive use of antibiotics for the treatment of AOM in children who are not at risk of developing complications has contributed to the development of antimicrobial resistance. Conversely, it has been suggested that early and prophylactic antibiotic use can be of benefit for Indigenous children because of their high risk of developing complications from OM [21]. Advice about the use of antibiotics is included in the *Recommendations for clinical care guidelines on the management of otitis media in Aboriginal and Torres Strait Islander populations* [9].

Surgery

Surgery may be necessary in the management of OM, particularly when it hasn't responded to medical treatment [44]. The insertion

6 The original 2001 guidelines were directly linked to the *Systematic review of existing evidence and primary care guidelines on the management of otitis media in Aboriginal and Torres Strait Islander populations* [43]. The current version was developed using recent research and a process of explicit searching of the medical literature and critical appraisal. They were prepared by the Darwin Otitis Guidelines Group in collaboration with the Office for Aboriginal and Torres Strait Islander Health, Otitis Media Technical Advisory Group.

of grommets – also referred to as tympanostomy tubes or ventilation tubes – may be recommended for rOME and rAOM to re-establish ventilation in the middle ear [9]. This process assists in clearing middle ear effusion and exposing the mucosa to air again to settle mucosal inflammation and biofilms that could have become established [44]. By resolving underlying disease at a young age, surgery can be considered a tool for limiting the social consequences of hearing impairment [44].

Tympanoplasty is a surgical procedure for correcting damage to the eardrum and restoring its integrity and that of the bones of the middle ear [9]. It is probably most appropriate for Indigenous children with bilateral, large, dry tympanic membrane perforations associated with frequent episodes of discharge or a moderate hearing loss [22]. The outcomes of tympanoplasty do not appear as positive for Indigenous children and adults as they are for other populations.

Myringoplasty, a basic form of tympanoplasty, may be required to repair a damaged eardrum [9]. Surgical closure of the tympanic membrane stops the aural discharge and improves hearing sufficiently to avoid the need for hearing aids in most cases [44]. A major challenge is to improve the success rates of myringoplasty for Indigenous people as its success appears to be lower than for non-Indigenous people, probably due to a range of reasons including the poorer health status and environmental health conditions for Indigenous people [44, 45]. There is some indication that the quality and cultural appropriateness of post-operative follow-up could be important determinants of the outcome [44]. Post-operative follow-up has been recognised as more likely to be timely and successful when it is community-based; community engagement before surgery offers the best chance of achieving compliance with post-operative care instructions [44].

Public health strategies

Examples of practical broad public health strategies are included in the *NSW Aboriginal ear health program guidelines*, which focus on targeting risk factors to prevent ear problems, raising awareness, early identification, treatment and support [30]. The guidelines refer to an analysis of risk factors for OM, which found the main modifiable factors were: cross-infection associated with children in day-care; exposure to tobacco smoke; a history of sustained antibiotic use; bottle-only feeding; and treatment cost and setting.

The guidelines relate to effective primary prevention strategies that focus on environmental health (housing and overcrowding), smoking, nutrition (including breastfeeding) and integration with existing surveillance and healthcare programs.

The strategies addressed three areas:

Prevention and awareness

- Reduce exposure to tobacco smoke - reduce the number of Indigenous women who smoke during pregnancy and reduce babies' exposure to environmental tobacco smoke.
- Breastfeeding and nutrition - increase the number of Indigenous babies who are fully breastfed from birth.
- Environmental health - reduce the exposure of Indigenous children to environmental risk factors associated with OM, including poor hygiene and overcrowding.

Early identification

- Professional development - improve early identification of OM by educating human services professionals on the symptoms of the disease and its clinical diagnosis.
- Parents' and carers' knowledge - increase early identification of OM by educating parents and carers on the symptoms of OM, and the necessity of obtaining medical management for the disease.
- Children's knowledge - educate Indigenous children about ear health to increase their awareness of risk factors, disclosure of symptoms, and compliance with treatment procedures.

Treatment and support

- Timely medical care - provide timely medical, educational and social management of OM.
- Best practice management - provide best practice medical, educational and social management for Indigenous children with OM.
- Reducing recurrent infection - reduce recurrent infection by educating parents and carers on how to prevent the disease from returning.

Hearing and specialist services

In 2011-12, Australian Hearing provided services to 4,536 Indigenous children, representing 15.3% of the total number of children who received hearing services [46]. In 2011, there were 1,565 Indigenous children who were fitted with hearing aids. Australian Hearing, under the Community Services Obligations (CSO) component of the Hearing Services Program, was expected to provide services for 11,500 eligible Indigenous people over four years from 2011 [47].

The focus on Indigenous hearing health has increased since an analysis in 2002 of the access of Indigenous people to the Australian Government's Hearing Services Program identified a number of problems:

- the wide geographic spread and isolation of some Indigenous communities impacts on cost leading to low frequency of visits by audiologists, and the increased cost of transport for clients attending a service
- lack of access to specialist services, including ENT specialists and audiologists
- lack of support in many communities for those fitted with hearing aids
- the relatively complicated nature of entry to the Hearing Services Voucher System
- significant ongoing deficiencies for:
 - planning and coordination to support the continuity of ear and hearing care across the spectrum from primary to tertiary interventions
 - integration of ear services within routine comprehensive primary care services and effective detection and early intervention, particularly in the 0-3 year age group
 - the clinical skills of the primary health workforce which fell short of those required to produce real reductions in OM related hearing loss. [48]

In the NT in 2010-11, under the *Expanding health service delivery initiative* for children receiving a hearing service, 1,193 children received the service (the target was set at 2,636 children) [49]. Since 2010, there had been a reduction in the number of audiology services due to weather conditions and a slowdown in service delivery during reorganisation of hearing health services.

In the NT, a number of problems related to the management of OM have been identified [28]:

- persistence of OM for an extended time
- the extent of morbidity from OM
- the need for treatment to be provided at critical times in the disease process
- commitment of time and effort from caregivers for a substantial time
- the need for frequent monitoring
- the need for managing the coordination of multiple health service providers (for example, GPs, paediatricians, child health nurses, audiologists and ENT specialists)
- the condition requires adjustment in a non-medical environment (especially in school but also later in vocational pursuits).

Challenges for managing OM and delivering services to communities include:

- logistic limitations due to the weather and road closures
- families not wishing to access follow-up services on the days available

- child and family unable to be contacted during ENT outreach visit to the community
- carers unable to be contacted to attend specialist consultations with children, particularly in the town camps in central Australia with access restrictions during community events such as ceremonies, deaths and major sports events.

Addressing ear health and hearing issues in schools

Some ear health programs are run in schools; these include programs focused on variations of breathing, coughing and nose-blowing activities (originating in the 1990s) [50]. A study exploring health and education professionals' perceptions of the health benefits and barriers of different ear health programs used in lower primary school classes, took place in two district education areas in the Goldfields South East Health Region in WA [51]. Staff members who provided services to children in kindergarten to year three primary school classes were sent a questionnaire about ear health programs provided in their school. Teachers, community health nurses and Indigenous health workers identified that ear health programs were effective in improving health and behavioural outcomes for children. It was recommended that further research is needed to increase evidence-based practice and more clearly inform health and education policies and procedures about ear health programs.

Sound amplification in the classroom

Sound field amplification in a classroom allows control of the acoustic environment [52]. A teacher wears a small microphone that amplifies their voice by a few decibels and sound is transmitted to a receiver system attached to loudspeakers around the classroom. This provides uniform amplification throughout the classroom without making speech too loud for children with normal hearing. In a study of Indigenous children in Cherbourg and Yarrabah, Qld, where 67% of the children had slight hearing loss at the beginning of the trial, sound amplification improved interaction of the children with their peers and teachers [52].

Sound field amplification systems work best where attention is paid to modifying the classroom environment to minimise noise from various sources inside and outside the classroom [41]. The Senate Committee report, *Hear us: Inquiry into hearing health in Australia*, included the recommendation that Australian Hearing be enabled to supply and maintain sound field systems in all new classrooms and in all existing classrooms where there is a significant proportion of Indigenous children [4]. In the Government response, it was explained that this is a matter for state/territory governments, however, acknowledging the links between hearing and early literacy, funding had been provided

for the *Kimberley sound amplification project* to provide sound amplification equipment in all classrooms in Kimberley schools [47]. This project was in response to evidence that on any one day in a Kimberley classroom, up to 65% of Indigenous students can experience intermittent hearing loss. In the NT, funding has been provided to support the NT Department of Education to install sound field systems in targeted remote schools. Most state education departments also have guidelines for the classroom acoustic environment to enhance communication between teachers and students (e.g. South Australia [53]).

Another reason for providing sound amplification in classrooms is that some students have expressed concerns related to hearing aids. A sample of NT Indigenous adolescents boarding at high schools in Alice Springs participated in a study to explore attitudes towards hearing aids [54]. Another aim of the study was to reduce the stigma and negative attitudes towards hearing aids by using a discussion-based brief intervention. It was concluded that stigma and negative attitudes are contributing to the low use of hearing aids. A recommendation was made that educators, health professionals and audiologists need to collaborate to decrease the stigma associated with hearing aids and increase the use of amplification.

It has been suggested that amplification alone is not sufficient to make speech both audible and intelligible and that phonological awareness programs, with or without amplification, are recommended as part of a reading program from pre-school for Indigenous children learning English as 'school' language [55]. In a study that considered the effects of hearing loss and native-language phonology, Indigenous children with hearing loss experienced additional difficulties to those they were already experiencing with the English language. Hearing loss tended to affect the discrimination of unfamiliar English consonants more than those in native language.

Prevention of ear disease

Strategies for the prevention of ear disease and hearing loss include: environmental modifications that address over-crowding and passive smoking; vaccination; prolonged antibiotic use for children with documented recurrences; appropriate treatment of CSOM; surgery for some conditions; and early detection of hearing loss and related communication delays to enable the implementation of treatment and rehabilitative systems [7]. For children living in remote communities, primary health care priorities include: support for strategies that reduce the transmission of infections to infants and toddlers; encouraging timely immunisation; providing frequent and accurate assessment of middle ear disease in the first 18 months of life; educating families about the appropriate management of different types of ear disease; and helping families

give prolonged antibiotics to their children with prolonged persistent suppurative OM [32].

Swimming pools in Indigenous communities may reduce some infectious diseases, such as skin diseases, but a reduction in ear infections has not been demonstrated [56]. A recent, well-controlled evaluation of swimming pools in the Anangu Pitjantjatjara Yankunytjatjara Lands (APY Lands) did not find improved ear health among children using swimming pools [57]. A study measuring the impact of 4 weeks of daily swimming among Aboriginal children with a tympanic membrane perforation found that there were no statistically significant changes in the microbiology of the nasopharynx or middle ear in swimmers [58].

Vaccination

OM is a polymicrobial disease, so vaccine strategies need to be directed at the likely causative bacteria [21]. For *S. pneumoniae*, the vaccine needs to include the major serotypes responsible for disease. Vaccination for the prevention of OM includes the seven-valent pneumococcal conjugate vaccine (PCV or 7PCV) for children under two years of age and the pneumococcal polysaccharide vaccine (23vPPV) recommended for others at risk (Indigenous people medically at risk and all people aged 65 years or over) [15]. Pneumococcal – Haemophilis influenzae protein D conjugated vaccine, PhiD-CV10 or Synflorix has also been found to offer protection from OM caused by non-capsular H. influenza [59, 60].

The Menzies School of Health Research is conducting a study, 'PneuMum', to determine if maternal vaccination with the 23vPPV given antepartum or immediately postpartum, can reduce nasopharyngeal carriage of vaccine type pneumococci and the prevalence of middle ear disease among Indigenous children [61].

Examples of programs and projects

Many programs and projects have been undertaken around the country; locally, regionally and state-wide. *Deadly ears* is a Queensland state-wide Aboriginal and Torres Strait Islander ear health program targeting the prevention and management of ear disease and its associated impacts for children [62]. The multi-disciplinary *Deadly ears* team works with communities performing ear and hearing assessments and surgical procedures. They also implement health promotion strategies for raising the awareness of ear health issues.

Many Indigenous community-controlled health services run ear health programs. For example, Derbarl Yerrigan in Perth, WA, runs the *Do you hear what I hear* program and provides regular ear health screening to schools with a high percentage of Indigenous children, as well as offering screening at the clinic [63]. The program includes a partnership with an ENT specialist and his team and is also linked with Australian Hearing Services.

The Telethon Speech and Hearing in WA operated a mobile hearing screening service, the Ear Bus Program [64]. The buses travelled to primary schools, kindergartens and child care centres with high numbers of Indigenous children in the Perth metropolitan area and the south-west of WA, to check the hearing and middle ear health of children. Each bus is fitted with audiological equipment for screening children's ear health and hearing problems and a facility for recording and transmitting images of tympanic membranes for remote diagnosis and referral ('tele-otology').

In the NT, the Hearing Health Program (HHP) delivers services to remote communities and homelands (K. Currie, personal communication, 23 May 2013). The HHP provides tele-otology to complement the face to face ENT outreach available through Specialist Outreach Northern Territory (SONT). This enables more children across geographically remote locations to have access to ENT services. If surgery is deemed appropriate, a child will be added to a theatre waitlist without needing to attend a regional centre for a face-to-face appointment; this helps address long outpatient waiting lists. Tele-otology is also used for children requiring hearing aid clearance for referral to Australian Hearing for rehabilitative audiological services. The HHP in the NT is developing and implementing a Hearing Health Information Management System (HHIMS) to provide clinical decision support and guidance to primary health practitioners, increase efficiencies in existing tele-otology processes and integrate all clinical data to support a shared care plan.

The *Northeast Arnhem Land regional ear health campaign*, funded by the Australian Government, aims to increase the understanding of ear health for the Yolngu people of north-east Arnhem Land [65]. The campaign concentrates on increasing understanding of foundational concepts related to ear health, including: the germ theory of disease; hearing and early childhood development; and the anatomy of internal structures of the ear. It includes the production of short radio broadcasts on Yolngu Radio about OM.

Close the perf is a research project being conducted by Menzies School of Health Research. It will assess a comprehensive case management support program for the prevention of hearing loss associated with AOMwiP in Indigenous children 0 to 5 years of age [66]. The project aims to reduce the prevalence of AOMwiP and associated hearing loss. Interventions for the prevention of AOMwiP include regular review (well child checks), immunisation, hygiene interventions, early diagnosis and appropriate case management of AOM (including advice on hygiene strategies, communication and minimisation of the impact of hearing loss).

Objectives of the project include:

- updating current systematic reviews relevant to prevention of OM in high-risk populations

- updating current recommendations for management of OM in Indigenous children
- conducting a randomised controlled trial of a case management support system (diagnostic and management algorithm) for children with a diagnosis of AOMwiP
- conducting an annual community-based surveillance of ear status in all children less than 2 years of age, to be compared with data from the Primary Care Information System (PCIS).

The National Acoustics Laboratory is undertaking a research project to establish the prevalence of spatial listening disorder among Indigenous children in selected remote community schools in the NT and selected primary schools in metropolitan Sydney [5]. The disorder may affect the listening and learning ability of children and may be more prevalent in those with an existing hearing loss.

Policies and frameworks for addressing ear and hearing problems

Senate Inquiry - Hear us: inquiry into hearing health

Over 180 submissions were made to the *Senate Inquiry, Hear us: inquiry into hearing health in Australia*; the Inquiry's report was tabled in Parliament in May 2010 with 34 recommendations [4]. The report stated that urgent priority should be given to hearing screenings and follow-up for all Indigenous children from remote communities on commencement in school. The Australian Government response noted that this was a responsibility of state and territory governments, but it offered to work with them to identify opportunities for national collaboration [47]. The response detailed that the *Health assessment for Aboriginal and Torres Strait Islander people* is available annually, via Medicare funding; when provided for a child, the assessment takes into account any previous hearing screening including neonatal screening. It includes a hearing examination and audiometry testing where indicated, particularly for school aged children. Also, the *Healthy kids check* is available for children aged between 3 to 5 years and includes a physical examination and assessment of hearing.

The Senate Committee for the Inquiry recommended that the Department of Education, Employment and Workplace Relations and the Department of Health and Ageing jointly establish a workforce to work across portfolios and jurisdictions and systematically and sustainably address the educational needs of hearing impaired Indigenous children [4]. It was anticipated that these needs would be incorporated under an Aboriginal and Torres Strait Islander Education Action Plan [47]. It was also

recommended that: education programs for teachers posted to schools in Indigenous communities should emphasise that the likelihood of hearing loss among their students would be very high; and that induction for teachers should include training on the effects of hearing health on education and effective, evidence based strategies to manage classrooms where a majority of children are hearing impaired [4]. The Department of Health and Ageing agreed to provide funding and resources for a national biennial Indigenous ear health conference and make the outcomes of the conferences publicly available to assist researchers and practitioners in the field of hearing health [47].

The Aboriginal and Torres Strait Islander health performance framework

The *Aboriginal and Torres Strait Islander health performance framework* was developed under the auspice of the Australian Health Ministers' Advisory Council to provide the basis for measuring the impact of the *National strategic framework for Aboriginal and Torres Strait Islander health*. The health performance framework (HPF) monitors progress in 'closing the gap' in Indigenous health outcomes, health system performance and broader determinants of health; one of the 68 measures of the framework is Ear health [5]. HPF reports provide details of what is known, current commitments and guidance on further comprehensive and coordinated efforts to address the issues.

Other initiatives

Care for kids' ears campaign

The *Care for kids' ears* campaign has been initiated by the Australian Government to increase awareness of ear disease and hearing loss in Indigenous communities [67]. The campaign is the first national campaign to target Indigenous ear disease and is part of the Australian Government's commitment to improving eye and ear health services for Indigenous people for better education and employment outcomes.

The campaign, which provides a variety of resources for health workers, nurses and doctors, parents and carers, teachers and early childhood workers, to inform Indigenous families about ear health, aims to contribute to a reduction in ear disease by:

- increasing awareness of the role that modifiable behaviours (such as regular ear examinations/surveillance, treating early infections to completion, smoking, hygiene, breastfeeding and nutrition) have in preventing the development of ear disease
- increasing awareness of the signs and symptoms of ear disease
- increasing understanding of the link between ear disease and associated hearing loss

- increasing awareness that ear disease and hearing loss can have significant long-term consequences to language and cognition
- increasing awareness of effective surveillance, prevention and treatment pathways. [67]

Australian Government funding was allocated for eye and ear health initiatives under the *Improving eye and ear health services for Indigenous Australians for better education and employment outcomes* measure, totalling \$58.3 million over four years from 2009 [68]. For ear health, the aim was to reduce the number of Indigenous people suffering avoidable hearing loss, improve the coordination of hearing health care, and give Indigenous children a better start to education. The Australian Government has funded the purchase and supply of ear and hearing equipment for Aboriginal Medical Services (AMSs) and in 2010, commenced developmental work for training programs for ear and hearing health workers.

The Department of Health and Ageing's Office for Aboriginal and Torres Strait Islander Health (OATSIH) is responsible for coordinating:

- the maintenance and purchase of medical equipment for hearing screening
- additional ear surgery, particularly for remote Indigenous clients
- ear and hearing promotion activities. [69]

The Australian Government provided \$2.311 million in 2011-12 for the *Australian Hearing Specialist Program for Indigenous Australians* (AHSPiA), an outreach service designed to meet the audiological needs of people in remote Indigenous communities [5]. A further \$2.149 million was provided to Australian Hearing to provide hearing services for eligible Indigenous people over 50 years of age. Indigenous people over the age of 50 years or those who were participants in a Community Development Employment Program, can access free hearing services from Australian Hearing [70]. The Australian Government Budget 2013-14 included allowances for Department Outcome 7, Hearing Services [70]. The Government aims to reduce the incidence of avoidable hearing loss in the community and the consequence of hearing loss for eligible people, and provide access to high quality hearing services and devices. It offers free hearing services for hearing impaired children and young people less than 26 years of age and other eligible Australian citizens.

Training and equipment

The National Aboriginal Community Controlled Health Organisation (NACCHO) was given the task of training health workers for ear health and hearing screening with funding provided by the Aboriginal and Torres Strait Islander Health

Workforce Section, Department of Health and Ageing [69]. In 2010, OATSIH commissioned Access Economics to undertake a scoping report on the status of existing ear and hearing equipment and the need for updated equipment for Aboriginal community controlled health services (ACCHSs) and AMSs. NACCHO was aware, and the Access Economics report identified, that some of the existing equipment was getting old and may not be in good condition. The report guided decision making on the purchase and distribution of relevant equipment. OATSIH developed 'user-friendly' equipment guides and established an equipment support contract for maintenance. Equipment, including pneumatic otoscopes, video-otoscopes and tympanometers, was distributed in 2011 by OATSIH. It had been identified by the Aboriginal and Torres Strait Islander Health Registered Training Organisation National Network (ATSIHRTONN) that there were needs for ear and hearing health education and learning for AHWs, to better prepare them to undertake an ear and hearing health role. Recommendations were made for education and training models that would enable the provision of high quality and culturally appropriate ear and hearing services in Indigenous communities.

Discussion between the DoHA Workforce Section and NACCHO regarding strategies on expanding the AHW workforce took place in 2010 [69]. NACCHO identified that training in ear health and hearing had been ad hoc for the last 6 years and the previous training had not been accredited resulting in the lack of confidence among AHWs in the use of equipment. Back filling services while Aboriginal Health Workers (AHWs) attended training was not available and could prove to be a barrier to training uptake. As a result of discussions, NACCHO was funded to undertake ear and hearing training for the *Aboriginal Health Worker (AHW) workforce project* in 2010.

The four phases were:

1. Equipment training - develop a training kit for equipment use for each jurisdiction in line with the OATSIH rollout of ear and hearing equipment to ACCHSs and AMSs nationally and develop and deliver professional development training on the use of the new ear and hearing equipment for the AHW workforce.
2. Accredited training - develop, pilot, evaluate and refine a national ear and hearing training program and accredited material.
3. National training rollout - establish a sustainable model for national delivery of the accredited ear and hearing training skill-set for the AHW workforce, and consider ongoing professional development needs.
4. Evaluation - evaluate the national training rollout and refine it on the basis of outcomes.

The *Aboriginal Health Worker ear and hearing health care training manual* was developed to assist with training and provided to AHWs located at ACCHSs and AMSs [17].

Education

In the *Response to the Senate Community Affairs References Committee report: Hear us: Inquiry into hearing health in Australia*, the Department of Education, Employment and Workplace Relations and the Department of Health and Ageing welcomed and supported the opportunity of working together and with other agencies to address the educational needs of hearing impaired Indigenous children [47]. The dialogue between the Departments centred on the implementation of an Aboriginal and Torres Strait Islander education action plan. *The Aboriginal and Torres Strait Islander education action plan 2010-2014* included the aim for national collaboration to support students with disabilities [71]. In the annual report on the plan for 2011, it was reported that during 2010 officials representing the Ministerial Council for Education, Early Childhood Development and Youth Affairs (MCEECDYA) and the Australian Health Ministers' Conference met and agreed to initially prioritise three themes of collaborative work, one of which was centred on 'otitis media'. These areas were aligned with the *National Disability Strategy* and the *National Framework for Protecting Australia's Children* [72]. In 2011, education, health and community services portfolio officials from each state and territory and the Australian Government met to develop a proposal to improve connections across sectors. This proposal sought to use arrangements established under the *National Indigenous Reform Agreement* to initially target collaboration around the three themes including 'otitis media and related speech and language delay issues' (modified from the initial meeting).

Some states and territories have developed their own initiatives. In the NT for example, the Department of Education and Training has provided enhanced services and support for students with conductive hearing loss under the *Smarter schools* and *Closing the gap in the Northern Territory national partnerships* [47]. By May 2011, there were 37 targeted remote schools that had accessed services such as professional learning programs for classroom teachers, special education teachers and assistant teachers.

Prisons

In 2011, the House of Representatives Standing Committee on Aboriginal and Torres Strait Islander Affairs tabled the report of its inquiry into the high level of involvement of Indigenous youth in the criminal justice system, *Doing time – time for doing: Indigenous youth in the criminal justice system* [73]. It included evidence that hearing loss affects a large number of Indigenous youths and has the potential to have a negative impact on their contact with

police, the courts and the corrections system. Australian Hearing told the Committee that children with hearing loss have free access to their services, but the Hearing Service Program does not extend to people in juvenile detention centres.

Recognising the link of hearing loss with the criminal justice system the Committee made recommendations that:

- the Commonwealth Government provide all Indigenous children starting pre-school with comprehensive hearing tests with appropriate follow-up support as required and all Indigenous children between kindergarten and year 2 be tested as an urgent priority due to the high incidence and impacts of hearing impairment among Indigenous children, particularly in rural and remote areas.
- the Commonwealth Government allocate funding for sound amplification systems in schools with high Indigenous enrolments throughout Australia with urgent attention to schools in remote areas.
- the Attorney-General discuss with the Ministerial Council for Police and Emergency Management a proposed program of training for police to better identify and respond to individuals with hearing loss, particularly those living in Indigenous communities.

In the Australian Government response, it was stated that training of police to identify hearing loss should be incorporated as a part of a suite of training for all police officers working with Indigenous people [74]. It plans to work on initiatives to improve police training through the Standing Council of Police and Emergency Management.

Relating to custodial institutions, the Senate inquiry recommended that the DoHA work closely with state and territory jurisdictions to develop and implement a national plan that:

- provides resources to conduct hearing assessments for all Australians serving custodial sentences who have never received such an assessment, including youths in juvenile detention
- facilitates prisoner access to those hearing assessments
- encourages a high level of participation in those hearing assessments and
- makes the findings of the hearing assessments available to the public (within privacy considerations). [4]

The response of the Australian Government stated that states and territories have responsibility for both the management and operation of prisons and juvenile justice centres and screening for hearing impairment and the recommendation will be brought to their attention [74]. The Australian Government is committed to supporting the delivery of initiatives and services to hearing impaired Australians, including those in custodial settings. A person

who already has a hearing problem diagnosed and is in receipt of Commonwealth funded hearing services at the time they become incarcerated, may continue to receive Commonwealth funded hearing services during the period of incarceration, provided that the prisoner initiates the provision of those services. Any medical attention leading to the diagnosis of a hearing problem or the need for provision of hearing services which is initiated by custodial authority, or carried out on behalf of a custodial authority, must be funded by the relevant state or territory.

Concluding comments

There is little doubt that Indigenous people, particularly children and adolescents, suffer more from ear disease and hearing loss than other Australians. All Indigenous children are at risk, but those living in remote areas are particularly vulnerable. Prevention is a key to success and this relies on targeting contributing factors, such as addressing poor environmental conditions and improving nutrition. Effective early intervention can reduce the extent of ear disease and the adverse consequences of OM-related hearing loss, leading to better social, educational and employment opportunities. Reducing ear disease also reduces the associated financial costs of treatment and potential ongoing support for hearing loss.

Schools can assist in supporting Indigenous children with hearing loss by providing sound amplification systems, but it appears that there are ongoing issues regarding funding.

With high rates of incarceration for Indigenous people, there is a need to further investigate hearing loss among Indigenous people and its consequences related to contact with the justice system. People who work in the justice system also need training on how to recognise problems associated with hearing loss and how to support those affected.

There have been recent developments in raising awareness of ear disease, prevention, treatment, training of Indigenous Ear Health Workers and improving services. Some of these improvements have resulted from the Senate Inquiry, *Hear us: Inquiry into hearing health in Australia*, the updated *Recommendations for clinical care guidelines on the management of otitis media in Aboriginal and Torres Strait Islander populations*, and funding under the *Improving eye and ear health services for Indigenous Australians for better education and employment outcomes* measure. The *Aboriginal and Torres Strait Islander health performance framework* monitors progress in the 'closing the gap' measure of *Ear health*; the reports can be used to review current commitments and guide further comprehensive and coordinated efforts to address the issues.

Attention to ear disease among Indigenous people has increased, but to 'close the gap' in ear health between Indigenous and other Australians, it will be necessary to continue raising awareness, improving strategies for prevention, providing funds for further research and improving access to services.

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Appendix 1 Hearing impairment and its assessment

There are two main categories of hearing impairment, which can co-exist:

- conductive (intermittent or persistent usually caused by OME and CSOM)
- sensorineural (permanent hearing loss caused by a lesion in the cochlea or auditory nerve and its central connections) [7].

Conductive hearing loss (CHL) is often associated with fluctuations related to changes in an OM condition [9]. Hearing can change significantly over time resulting in inconsistent auditory input.

When rAOM, OME and CSOM are not treated adequately, there can be significant conductive hearing loss with a resultant speech and language delay, especially where English may be a child's second or third language [8]. Indigenous children have been found to suffer a mean of 32 months of hearing loss in childhood compared with 3 months among non-Indigenous children.

Assessment and classification of hearing impairment

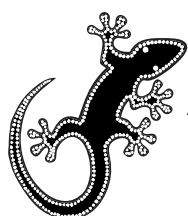
Audiology assessment of hearing provides information about the status of middle ear function, diagnosis of hearing loss and can also be used to monitor changes in hearing associated with medical and surgical management of middle ear conditions [28]. The assessment can be used to make recommendations for clinical care and rehabilitation, such as communication strategies, classroom amplification, hearing aids, speech therapy and educational support.

Hearing impairment classification describes the degree of disability associated with hearing loss in the 'better ear' (see Table 1) [9]. The scale of hearing loss recorded through audiometry is based on the degree of deviation from normal thresholds in the 'better ear'; it is typically calculated as a 3 frequency average (3FA) of the threshold of hearing (in decibels Hearing Level (dBHL)) at 500Hz, 1000Hz and 2000Hz. For hearing loss associated with OM, there can be variation in severity over time and it can have a substantial effect upon hearing for frequencies outside those routinely tested. The classification is based on pure tone audiometry on the day of the test and does not account for the impact of early onset, language, processing ability and environmental factors, so average hearing levels based on a single assessment can underestimate the degree of impairment.

Table 1 Grades of hearing impairment

Grades of impairment	Audiometric value
0 No hearing loss	20dB or better (better ear)
1 Mild hearing loss	21-45dB (better ear)
2 Moderate hearing loss	46-65dB (better ear)
3 Severe hearing loss	66-90dB (better ear)
4 Profound hearing loss	91 dB or greater (better ear)

Source: [9]



Australian Indigenous HealthInfoNet

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.

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Dragonfly

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