EVALUATION OF THE ROYAL FLYING DOCTOR SERVICE AND AUSTRALIAN HEARING, HEARING SCREENING TRIAL

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Royal Flying Doctor Service

Acknowledgments

This evaluation report has been prepared by the Royal Flying Doctor Service (RFDS) Research and Policy Unit using data collected during the hearing screening trial, and data from external sources. The report has benefited from review by RFDS and Australian Hearing staff. We are grateful for their assistance and would like to acknowledge these staff.

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Commitment to Indigenous Reconciliation

The RFDS respects and acknowledges Aboriginal and Torres Strait Islander peoples as the first Australians and our vision for reconciliation is a culture that strives for unity, equity and respect between Aboriginal and Torres Strait Islander peoples and other Australians. The RFDS is committed to improved health outcomes and access to health services for all Aboriginal and Torres Strait Islander Australians, and our Reconciliation Action Plan (RAP) outlines our intentions to use research and policy to drive improvement. RFDS reports include Indigenous data as part of a broader effort to improve health outcomes and access to health services for Indigenous Australians as a contribution to the 'Close the Gap' campaign. This evaluation report contributes to the aims of the RAP.

Royal Flying Doctor Service Research and Policy Unit

In mid-2015, the RFDS established a Research and Policy Unit, located in Canberra. The Unit's role is to gather evidence about, and recommend solutions to, improving health outcomes and health service access for patients and communities cared for by RFDS programs. The Research and Policy Unit can be contacted by phone on (02) 6269 5500 or by email at enquiries@rfds.org.au.

Notes about this report

Use of the term 'Indigenous'

The term 'Aboriginal and Torres Strait Islander peoples' is preferred in RFDS publications when referring to the separate Indigenous peoples of Australia. However, the term 'Indigenous Australians' is used interchangeably with 'Aboriginal and Torres Strait Islander peoples' in order to assist readability.

Data limitations

Data in RFDS reports come from a number of different administrative datasets and surveys, all of which have limitations that should be considered when interpreting the results.

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Abbreviations

ACCHS	Aboriginal Community Controlled Health Services
ACCHOs	Aboriginal Community Controlled Health Organisations
AATSIHS	Australian Aboriginal and Torres Strait Islander Health Survey
app	application
AutoAud	automatic audiometry screening tool
ASGS	Australian Statistical Geography Standard
CHW	Community Hearing Worker
COMHeLP	Chronic otitis media & hearing loss practice
CRM	customer relationship management
DALY	disability-adjusted life years
dB	decibels
ENT	ear nose and throat
GP	general practice
HSP	Hearing Services Program
MBS	Medicare Benefits Schedule
MDU	Mobile Dental Unit
NAL	National Acoustics Laboratories
NDIS	National Disability Insurance Scheme
OAE	otoacoustic emissions
PEACH	Parents' Evaluation of Aural/Oral Performance of Children
PHC	primary health care
PSQ	Patient Satisfaction Questionnaire
RFDS	Royal Flying Doctor Service
SD	Standard deviation
VS	Voucher Scheme

About the Royal Flying Doctor Service (RFDS)

The RFDS is one of the largest and most comprehensive aeromedical organisations in the world. Using the latest in aviation, medical and communications technology, the RFDS delivers extensive primary health care (PHC) and 24-hour emergency service to those who live, work and travel throughout Australia.

The RFDS also operates a 24/7 remote telehealth consultation system. In the RFDS, remote consultations describe telephone calls that that come into an RFDS base from individuals or health workers in rural and remote areas who require medical assistance or advice from an RFDS doctor. This service supports the aeromedical retrieval service and provides a service to rural and remote residents who require doctor or nurse consultations. In most cases, the patient has no permanent medical services available and limited, if any, access to a hospital[1].

Other health services provided by the RFDS include: non-emergency patient ground transport services in Victoria, New South Wales (NSW), Tasmania and South Australia (SA); emergency patient ground transport services in SA; repatriation services; evacuations by charter aircraft from tour vessels along the Kimberly coast; assistance with staffing other aeromedical services that provide rescue activities; medical chests; oral health services; outreach programs; health promotion and education activities; clinic charter services; telehealth services, including access to specialist services via videolink in Victoria and a national trial of GP telehealth services which connects patients with GPs using videolink; and mental health, psychology and social and emotional wellbeing services.

About Australian Hearing

Australian Hearing is Australia's largest provider of government-funded hearing services.

Australian Hearing was established in 1991 under the *Australian Hearing Services Act 1991* and has a legacy extending back to 1947 when its predecessor organisation was established by the Australian Government to provide hearing services to children whose hearing was affected by a series of rubella epidemics and to assist veterans who experienced hearing damage during World War II.

Australian Hearing's mission is to provide world leading research and hearing services for the wellbeing of all Australians. It provides:

- Hearing health services through a national network of hearing centres; and
- Research in hearing habilitation and rehabilitation and the prevention of hearing loss through the National Acoustics Laboratories (NAL).

Australian Hearing clients include:

- Children;
- Young adults under the age of 26;
- Veterans;
- Aboriginal and Torres Strait Islander people; and
- Pensioners.

Executive summary

Hearing loss affects some 3.6 million Australians and is predicted to more than double by 2060, in line with Australia's ageing population[2]. In 2017, hearing loss was estimated to affect one in seven people in Australia, including as many as three out of four people aged over 70 years[3]. For every 10,000 live births, between nine and 12 children have a moderate or greater hearing loss in both ears. Another 23 children per 10,000 will acquire a hearing impairment by the age of 17 years— through accident, illness (e.g. otitis media), or other causes[4]. People living outside major cities (15%) fare the worst, and are more likely to experience hearing disorders than people living in major cities (12%)[5]. Aboriginal and Torres Strait Islander (Indigenous) Australians are also disproportionately impacted by poor ear health and hearing problems, compared to non-Indigenous Australians.

The Royal Flying Doctor Service (RFDS) does not routinely conduct hearing screening in rural and remote Australia. However, the organisation is committed to identifying appropriate service models to inform the national deployment of a hearing screening program. To achieve this, the Queensland Section of the RFDS collaborated with Australian Hearing to develop an appropriate service model focused on conducting hearing assessments, raising hearing awareness and facilitating appropriate referrals, and to conduct a hearing screening trial. The trial was evaluated by the RFDS of Australia (Federation Company) and results are presented in the current report.

A Community Hearing Worker (CHW) was recruited to provide hearing screening during the trial. The CHW employed a mixture of otoscopy, tympanometry, otoacoustic emissions testing, hearScreen and Sound Scouts to screen clients. The hearing screening service was paired with the RFDS Mobile Dental Unit (MDU) to take advantage of the current RFDS 'footprint' in rural and remote Queensland. By including the CHW on rotations (2-week trips to rural/remote Queensland towns) with the MDU, no additional infrastructure costs were incurred in delivering the hearing screening trial. The trial took advantage of the existing RFDS travel, management, brand, clinical governance and community engagement platforms.

The aims of the trial were to:

- Utilise the existing public and charitable funded outreach of the RFDS to achieve Australian Hearing's objective of increasing access to hearing services;
- Offer hearing screening services to people living in towns where the RFDS MDU visited;
- Identify people with a potential hearing problem;
- Help people with a potential hearing problem connect with services, including Australian Hearing; and
- Determine whether this service had a positive impact for people living in rural and remote areas.

The trial was conducted over a 12-month period between 1 August 2017 and 31 July 2018 and was free for all members of the communities visited by the CHW. The CHW visited 27 towns (41 facilities), including schools and primary health services. Specifically, 819 people had a hearing assessment, comprising 591 children, 224 adults and four people whose age was unknown. On average, 63 people per rotation received services from the CHW, comprising 45 children and 18 adults. This exceeded the trial goal of 40–60 hearing screenings per rotation.

People accessing the service ranged in age from newborn to 91 years. The average age was 21.3 years and the median age was 10.0 years. 72.5% of people screened were aged under 18 years. 61.7% of people screened were primary school aged children, 10.6% were preschool aged or younger, and the remainder were young adults or adults.

Based on results from all tests, 92 children (15.6% of all children) were identified as having hearing outside the normal range and 79 received a referral to at least one other service. Similarly, 81 adults (36.2% of all adults) were identified as having hearing outside the normal range and received a referral to at least one other service. Clients were mainly referred to Australian Hearing, primary health care or other services, such as ear nose and throat specialists.

As part of the hearing readiness assessment adults completed, they were asked if they 'have hearing trouble'. Almost all (92.9%) adults who responded 'yes' to this question, and more than one-third who answered 'sometimes' to this question had hearing outside the normal range and received a referral for follow-up care, compared to 20.2% of adults who did not identify any issues with their hearing.

Similarly, parents/carers were asked if they had any 'concerns about their child's hearing'. The results demonstrated that more than one-third (35.4%) of children whose parents/carers had concerns about their child's hearing, had hearing outside the normal range and received a referral for follow-up care, compared to just 10.6% of children whose parents had no concerns.

These data suggest that self-reported and parental/carer reported perceived hearing loss, may be an easy, affordable and time-efficient method of identifying people who would benefit from additional audiometric testing, especially in a PHC setting. There is strong support for pairing self-report measures with user-friendly, affordable, audiometry screening tools, such as hearScreen.

Screening tools that capitalise on technology and connectivity advances are emerging at a rapid rate, and these provide affordable and accessible models of service delivery for community-based hearing screening.

Rather than recommending a single service model to inform the national deployment of a hearing screening program, the evidence suggests that there are **several principles** that should be employed when developing hearing screening programs and conducting hearing screening. In addition to pairing self-report measures with user-friendly, affordable audiometry screening tools, and capitalising on technology and connectivity advances, the following principles should be implemented by the RFDS in any future service development model. Screening tests should be:

- Able to provide a reasonable assessment of risk for a disease or disorder to limit unnecessary referrals and missed cases;
- Easy and quick to administer;
- Reproducible;
- Minimally invasive and not cause harm;
- Inexpensive;
- Free of stigma;
- Culturally appropriate;
- Age appropriate; and
- Appropriate to the community in which they are conducted[6].

There is strong evidence that encouraging the inclusion of hearing checks as part of PHC services, from childhood to older age, supports better identification of hearing issues across the lifespan. However, population-based screening should not be conducted alone. It requires a co-ordinated approach encompassing prevention, treatment and management of ear health and hearing. Well-developed referral pathways, and access to appropriate services are required to support rural and remote people, who are identified with potential ear health problems or hearing loss.

1.0 Introduction

The Royal Flying Doctor Service (RFDS) operates a 24-hour, seven-days-a-week (24/7) aeromedical retrieval service, supported by a 24/7 telehealth system, to patients who live, work or travel in rural and remote[1] Australia, are unable to access normal medical services, and who experience a medical emergency requiring definitive care in a tertiary hospital. On average, 42 people each year are transported by the RFDS to a major hospital for diseases of the ear and mastoid process. The majority of these transfers are for acute presentations of mastoiditis or otitis media.

The RFDS also provides extensive primary health care (PHC) services in rural and remote Australia through general practice (GP) and nursing clinics. RFDS PHC clinics are held on a regular basis and the frequency of visits depends on local needs.

Other health services provided by the RFDS include: non-emergency and emergency patient ground transport services; repatriation services; assistance with staffing other aeromedical services that provide rescue activities; medical chests; oral health services; outreach programs; health promotion and education activities; clinic charter services; telehealth services; and mental health, psychology and social and emotional wellbeing services.

Basic hearing screening[2] is conducted by some RFDS primary health care services. However, a compressive mobile screening service, delivered by a specially trained hearing health professional, to residents in rural and remote Australia, has not previously been trialled by the RFDS. Consequently, the RFDS and Australian Hearing sought to collaborate to develop, implement and evaluate a mobile hearing screening service. The RFDS sought to evaluate the outcomes of the hearing screening trial to determine whether a mobile hearing screening service could be adopted nationally by the RFDS.

1.1 Trial context

The Queensland Section of the RFDS collaborated with Australian Hearing to undertake a one-year hearing screening trial in remote Queensland towns between 1 August 2017 and 31 July 2018.

These towns were visited by the RFDS Mobile Dental Unit (MDU) on a rotational basis, for approximately two weeks at a time.

A Community Hearing Worker (CHW), appointed by RFDS and Australian Hearing, travelled with the MDU on these visits to raise awareness of hearing health, increase access to services, conduct hearing screening assessments, assist people with a hearing problem, and promote new apps and tools to help people and services independently identify hearing loss. The CHW also provided services to some communities served by the RFDS Queensland primary health care program, where no other hearing screening services were provided.

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1 In this report, the term 'rural and remote' includes all areas outside Australia's major cities, i.e. areas that are classified as inner and outer regional (RA2 and RA3 respectively) and remote or very remote (RA4 and RA5 respectively) under the Australian Statistical Geography Standard (ASGS). For more information on how the RFDS defines remote and rural Australia, go to https://www.flyingdoctor.org.au/what-we-do/research/defining-rural-remote/.

2 Screening describes any measurement that is implemented to identify individuals who may benefit from an intervention for hearing loss. Screening is not diagnostic. Individuals who are identified with a potential ear health or hearing problem require referral to additional services for audiometric testing (e.g. Australian Hearing) or management of ear health problems (e.g. PHC or specialist).

The hearing screening service was paired with the MDU to take advantage of the current RFDS 'footprint' in rural and remote Queensland. In travelling with the MDU, no additional infrastructure costs were incurred in delivering the hearing screening program. The trial took advantage of the existing RFDS travel, management, brand, clinical governance and community engagement platforms.

The RFDS of Australia, Federation Company, evaluated the hearing screening trial.

1.2 Trial aims

The aims of the trial were to:

- Utilise the existing public and charitable funded outreach of the RFDS to achieve Australian Hearing's objective of increasing uptake of hearing screening;
- Offer hearing screening services to people living in towns where the RFDS MDU visited;
- Identify people with a potential hearing problem;
- Help people with a potential hearing problem connect with services, including Australian Hearing; and
- Determine whether this service had a positive impact for people living in rural and remote areas.

1.3 Trial evaluation

This evaluation reports trial outcomes and outputs against the project deliverables outlined in Table 1.1. It considers how well the trial achieved the proposed outputs regarding **hearing assessment, hearing awareness and facilitating appropriate referrals.** The evaluation specifically considers:

- Intended benefits—were the intended benefits achieved around strengthening community wellbeing and partnerships/linkages? Is there greater community awareness around hearing loss and supports available? Are people being referred to appropriate services and what level of uptake is occurring?
- Metrics—were the proposed metrics achieved regarding the number of child and adult hearing screenings per visit, instances of awareness-raising to service providers per visit, and referrals to Australian Hearing per visit?
- Outcomes—were the outcomes identified in Table 1.1 achieved?

The evaluation also proposes options for the national deployment of a hearing screening program for the RFDS. Specifically, it identifies principles for future service delivery models that could be implemented by the RFDS to provide hearing screening services to clients in other Australian states and territories.

Table 1.1 Project deliverables and proposed evaluation

Intended Benefits	Metrics	Outcomes
Output 1. Hearing assessments		
> Contributing to building and strengthening health and wellbeing in the communities > Increased linkages and partnerships for participants > Increased participation	> 40–60 child or adult hearing screenings per rotation	> Number of children and adults who had their hearing assessed by the CHW > Number of children and adults who were identified with hearing outside the normal range > Uptake of HearScreen and Sound Scouts by health services and schools (estimation of number of times used) > Hearing satisfaction survey–done prior to screening to assess patient readiness for amplification
Output 2. Hearing awareness		
> Contribute to growing community awareness of hearing loss as a serious health problem > Defuse the myths and facts about hearing loss > How to offer support to people with hearing problems	> 5–10 instances of awareness-raising to service providers per visit	> Number of episodes of hearing service awareness raising or training carried out by CHW, by location, nature and service type (school, health service) > Number of formal and informal community-focussed awareness raising activities carried out by CHW, by location and topic > Health service and school perception of, and satisfaction with, service delivery model > Pre and post program questionnaire for health services and schools
Output 3. Referrals		
> Identify people with hearing loss and make good quality, targeted referrals > Increase number of referrals to Australian Hearing > Reduce the time between identification and first appointment > Strengthen referral networks within the community > Client outcomes	> 20–30 referrals to Australian Hearing per visit	> Number of adults wanting rehab audiology who are ineligible for hearing services > Number of child and adult referrals to Australian Hearing > Number of child and adult referrals who go on to fittings > Time between receipt of referral and first appointment with Australian Hearing, compared to average time for these or similar communities in the region > Aided client usage, satisfaction and benefit measures, including for quality of life > Client perception of and satisfaction with service delivery model > Modified Patient Satisfaction Questionnaire (PSQ) or program specific questionnaire

2.0 Background

2.1 About hearing loss

Hearing loss occurs when there is a problem within the hearing pathway in the outer, middle or inner ear[4]. There are three types of hearing loss: conductive, sensorineural or mixed[7].

Conductive hearing loss occurs when the outer and/or middle ear is blocked or damaged, and can be either transient or permanent[7]. In conductive hearing loss, eustachian tube dysfunction may be present and is especially common among children—it can lead to fluid in the middle ear, or otitis media, in which a bacterial or viral agent infects the middle ear or ear drum[7].

Sensorineural hearing loss is caused by damage to, or malfunction of, the cochlea (sensory) or the auditory nerve (neural), and is permanent[7]. People can be born with sensorineural hearing loss or it can develop in response to factors such as excessive noise exposure, ageing, diseases and disorders, use of some drugs or physical trauma[3].

Mixed hearing loss may also occur and may be caused by severe head injury, chronic infection, genetic disorders, or when a transient conductive hearing loss occurs in conjunction with a sensorineural hearing loss[3].

Hearing loss is measured in decibels (dB). Hearing loss severity is classified as mild, moderate, severe, severe to profound or profound, with prevalence rates decreasing as the severity increases[2, 4]. The degrees of hearing loss used by Australian Hearing are:

- Normal (up to 20dB);
- Mild (21–40dB)–soft sounds may be difficult to distinguish;
- Moderate (41–60dB)–conversational speech is hard to hear, especially if there is background noise (such as a television or radio);
- Severe (61–80dB)–it is very difficult to hear ordinary speech;
- Severe to profound (81–90dB)–conversational speech cannot be heard; and
- Profound (91+dB)–almost all sounds are inaudible[2].

Conversational speech is around 65 dB[2].

2.2 Hearing loss in Australia

Hearing loss currently affects 3.6 million Australians and is predicted to more than double by 2060, in line with Australia's ageing population[2].

In 2017, hearing loss was estimated to affect one in seven people in Australia[3], including as many as three out of four people aged over 70 years[2]. Hearing loss can be present at birth (congenital) or occur later in life (acquired)[7].

For every 10,000 live births, between nine and 12 children have a moderate or greater hearing loss in both ears[4]. Another 23 children per 10,000 will acquire a hearing impairment by the age of 17—through accident, illness or other causes[4].

Each year in Australia, 15 children aged 14 years or under, who experience otitis media, will suffer permanent hearing loss, and over 250,000 will experience temporary hearing loss[8].

2.3 Hearing loss in rural and remote populations

People living outside major cities (15%) are more likely to experience hearing disorders than people living in major cities (12%)[5].

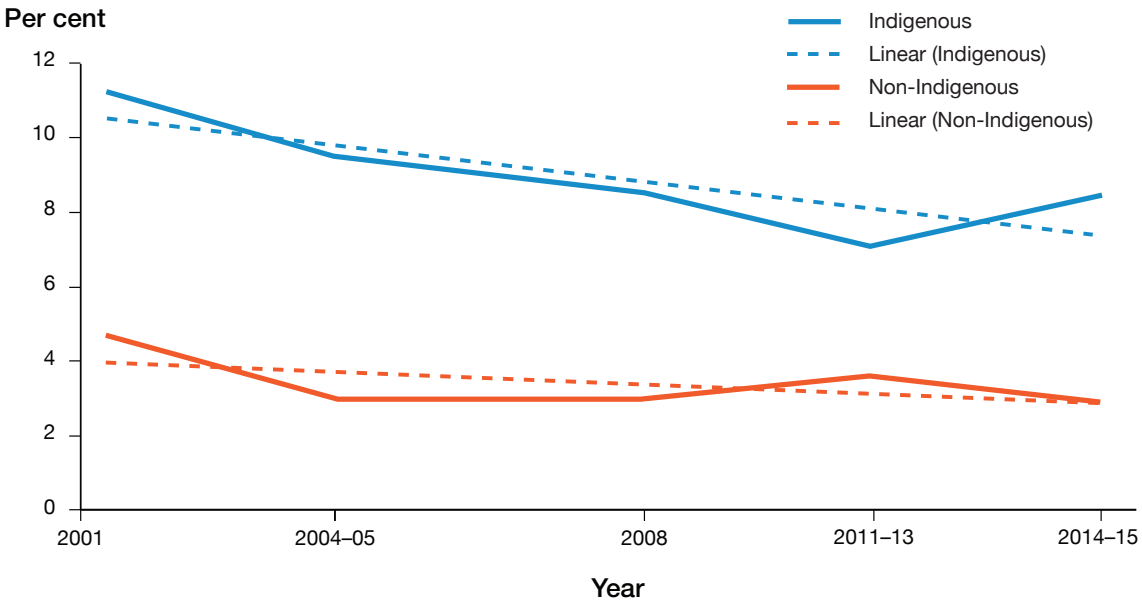
Premature hearing loss, related to occupational noise exposure, affects more than half of all Australian farmers[4]. There are multiple sources of noise on farms including, for example, from tractors, workshop tools, livestock, heavy machinery and guns[9]. Almost all farmers aged 55 years or older, who have been exposed to loud noise, experience hearing loss[4].

2.4 Hearing loss among Indigenous peoples

In 2014–15, ear and hearing problems were reported for 8.4% of Aboriginal and Torres Strait Islander children aged 0–14 years, which was almost three times higher than for non-Indigenous children (2.9%)[10, 11]. Specifically, Indigenous children have high rates of ear disease, such as otitis media, which impacts hearing[10]. These disparities are even more marked in remote areas of Australia.

Figure 2.1 demonstrates long term hearing problems by Indigenous status. It indicates that the prevalence of hearing problems was higher for Indigenous children for all years, from 2001 to 2014–15.

Figure 2.1 Children aged 0–14 with a self-reported long-term hearing problem, by Indigenous status, 2001 to 2014–15



Source: Australian Institute of Health and Welfare. Australia's health 2018. Australia's health series no. 16. AUS 221. Canberra: Australian Institute of Health and Welfare; 2018[11]. Developed using data from Australian Bureau of Statistics. National Aboriginal and Torres Strait Islander Social Survey, 2014–15. ABS cat. no. 4714.0. Canberra: Australian Bureau of Statistics; 2016[12], Table S6.4.1.

Similarly, 12.2% of Indigenous adults who participated in the 2012–13 Australian Aboriginal and Torres Strait Islander Health Survey (AATSIHS) identified that they had a long-term ear or hearing problem[13]. Ear or hearing problems were reported by the same proportion of those in non-remote areas and remote areas[13]. After age-adjustment, the rate of ear/hearing problems for Indigenous Australians was 1.3 times higher than for non-Indigenous Australians[13].

2.5 Hearing loss from otitis media

Approximately 1.3 percent of total general practice presentations amongst non-Indigenous children are for acute otitis media[14]. Otitis media is the most common reason that non-Indigenous children under the age of four years visit a GP[14]. In non-Indigenous children, otitis media usually presents as an episodic acute infection behind an intact ear drum, or otitis media with effusion (fluid in the middle ear), and rarely as eardrum perforation. Otitis media with chronic effusion impacts the hearing of approximately five percent of five-year-old non-Indigenous children[14].

Conversely, otitis media significantly impacts Indigenous children, especially in rural and remote areas[14]. For example, "between 2001 and 2013, 90% of children under three years of age living in remote communities in the Top End region of Australia had some form of otitis media"[10].

In 2001, prevalence of otitis media was measured in 709 Indigenous children, aged between six and 30 months, living in remote Indigenous communities[15]. Researchers found that 91% of the Indigenous children had experienced otitis media between six months and 30 months of age and that 44% of the children had a history of eardrum perforation[15].

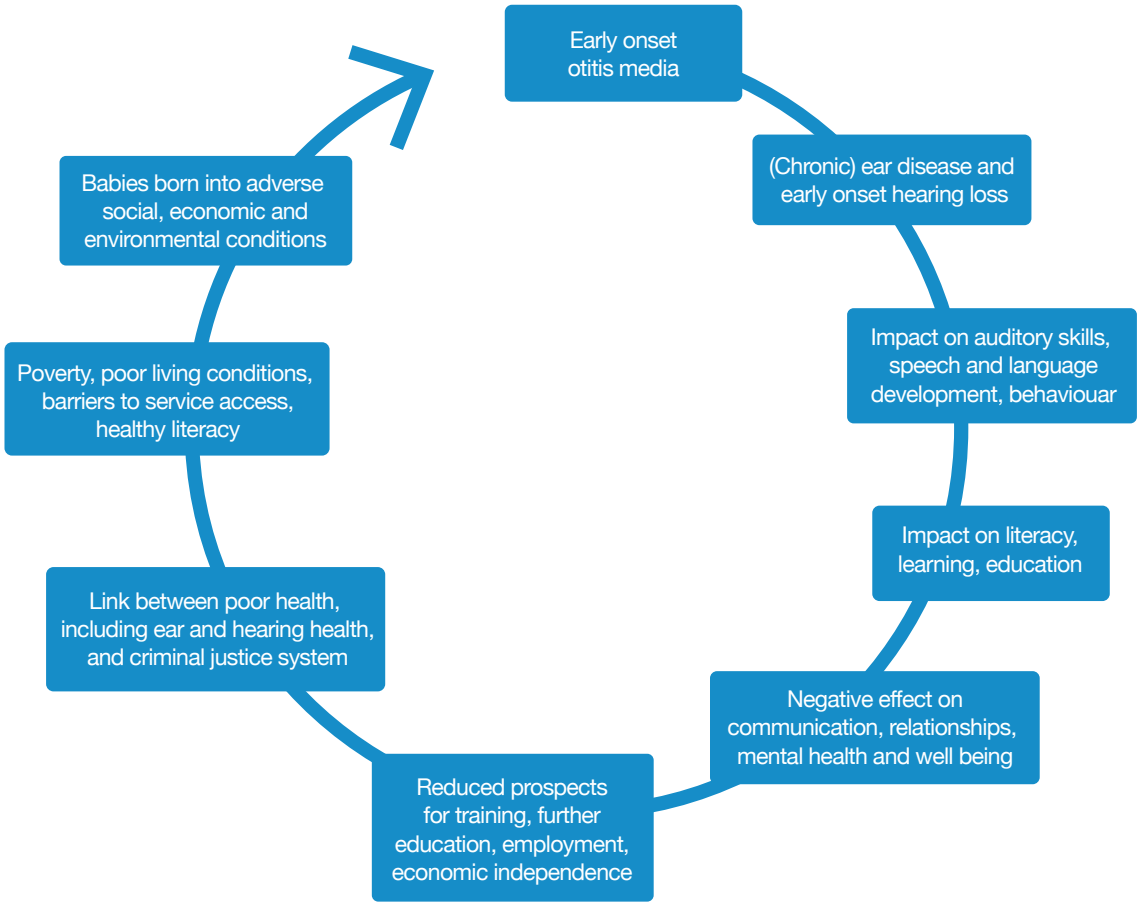
Indigenous children experience an average of 32 months of hearing loss in childhood, compared with three months for non-Indigenous children[8].

2.6 Impact of hearing loss on health and wellbeing

Hearing loss can impact language acquisition, education, employment and overall wellbeing[16]. For example, "in children, hearing loss impairs speech and language development, which in turn undermines the ability to learn"[5]. More specifically, hearing loss among children "can profoundly affect a child's life, impeding cognitive development, auditory processing skills and speech and language development. Hearing loss can lead to social isolation and problems with school attendance, which, in turn, can have life-long negative social consequences"[11].

In particular, hearing loss associated with otitis media is believed to have an effect across the life span, and may result in: behavioural problems and social isolation; poor school attendance and low levels of literacy and numeracy; poor employment opportunities; and increased poverty[17]. Up to 90 percent of Indigenous inmates in the criminal justice system are impacted by otitis media[17]. Figure 2.2 visually represents the generational cycle of chronic otitis media and hearing loss in disadvantaged communities, e.g. in remote Indigenous communities.

Figure 2.2 The Ear Ring: Generational cycle of chronic otitis media and hearing loss in disadvantaged communities



Source: Audiology Australia. Chronic otitis media & hearing loss practice (COMHeLP): A manual for audiological practice with Aboriginal and Torres Strait Islander Australians Melbourne: Audiology Australia; 2012[14].

Hearing loss imposes a significant reduction on wellbeing. In 2017 this was estimated as 90,223 disability adjusted life years (DALY)[3].

2.7 The economic cost of hearing loss

The economic cost of hearing loss encompasses the direct costs of providing hearing services, productivity losses due to reduced workforce participation, and the impact of reduced wellbeing for individuals[2].

In 2017, the financial cost of hearing loss to the economy was estimated to be $15.9 billion[3], with the associated value of the loss of wellbeing being $17.4 billion[2].

2.8 Identifying and measuring hearing loss

A hearing test, comprising a number of different examinations and sound delivery methods, can help a clinician (e.g. audiologist, GP, nurse), identify whether a person is experiencing hearing loss, and to what extent. The type of test procedure depends on what information is required about the auditory system, and the age, and level of co-operation, of the person being tested[18].

Prior to conducting a hearing test, a clinician may ask clients (or parents/carers of children) questions about their hearing, such as whether they think they have hearing loss, whether they have been subject to loud noises, whether there is a history of hearing loss in their family, etc.

Tests that may be performed include, for example: otoscopy; pure tone audiometry, air and bone conduction; otoacoustic emissions (OAE) test; speech test; and tympanometry. Not all of these tests were employed in the current trial. However, they are included in this report as examples of ways in which hearing can be assessed.

2.8.1 Otoscopy

Using an instrument called an otoscope, a clinician looks into the ear and examines the external auditory canal, which is the tunnel that leads from the outer ear (pinna) to the eardrum[19]. The clinician can also inspect the eardrum. Inspection of these structures provides information about what is happening within the external auditory canal and middle ear[19].

2.8.2 Pure tone audiometry[3]

This tests a person's ability to hear a number of different frequency-specific sounds that are played to a person through a pair of soundproof headphones[20]. It is one of the most common hearing testing methods for older children and adults[21].

Pure tone signals are delivered to the ear via air conduction and bone conduction at a variety of frequencies. Each time a sound is heard by the person being tested, they indicate this to the person conducting the test. The intensity of sound is adjusted to find the softest level a person can detect – in each ear, for each different sound [21].

2.8.2.1 Air conduction test[3]

Sound vibrations from everyday noise travel into the ear and to the eardrum[21]. They are turned into a mechanical vibration, which is delivered into the inner ear (the cochlea) through air conduction[21]. Loudspeakers, headphones or small insert earphones can all be used to deliver sound for air conduction testing[21].

2.8.2.2 Bone conduction test[3]

A bone conduction test may be used to measure a person's ability to hear pure tones, by placing a small bone conductor on the bone behind their ear[20]. Sounds vibrate through the skull bones, straight into the cochlear[21]. The clinician measures the softest sounds that can be heard[21]. The bone conduction test will reveal if there is a problem in the middle ear cavity[20].

2.8.3 Otoacoustic emission (OAE) test

OAEs are sounds made by the inner ear either spontaneously or in response to sound. They can be measured in the ear canal and are a sign of healthy outer hair cell activity. "Sound vibrations are sent through a patient's ear canal and middle ear to the outer hair cells of the cochlea. If the middle ear is clear of fluid and infection and the cochlea is functioning properly, the outer hair cells will echo the sound back"[22].

OAEs are "an objective measure of cochlear function that does not require language comprehension or cooperation beyond allowing the placement of a probe into the ear canal"[23]. In an OAE test, the emissions are being evoked by presenting a series of short clicks or tones into the ear, and then measured by the machine as they enter in the ear canal.

Where there is a temporary (conductive) or permanent (sensorineural) hearing loss, or where the room is noisy, OAE testing will give a 'refer' result.

OAES are very useful if present and confirm hearing in the normal or near-normal range, but their absence cannot always be interpreted as hearing outside the normal/near-normal range.

OAEs are mainly useful when hearing can't otherwise be measured accurately using play or standard audiometry. For example, with children who are too young for play audiometry, or in older children with a developmental delay.

2.8.4 Speech test[3]

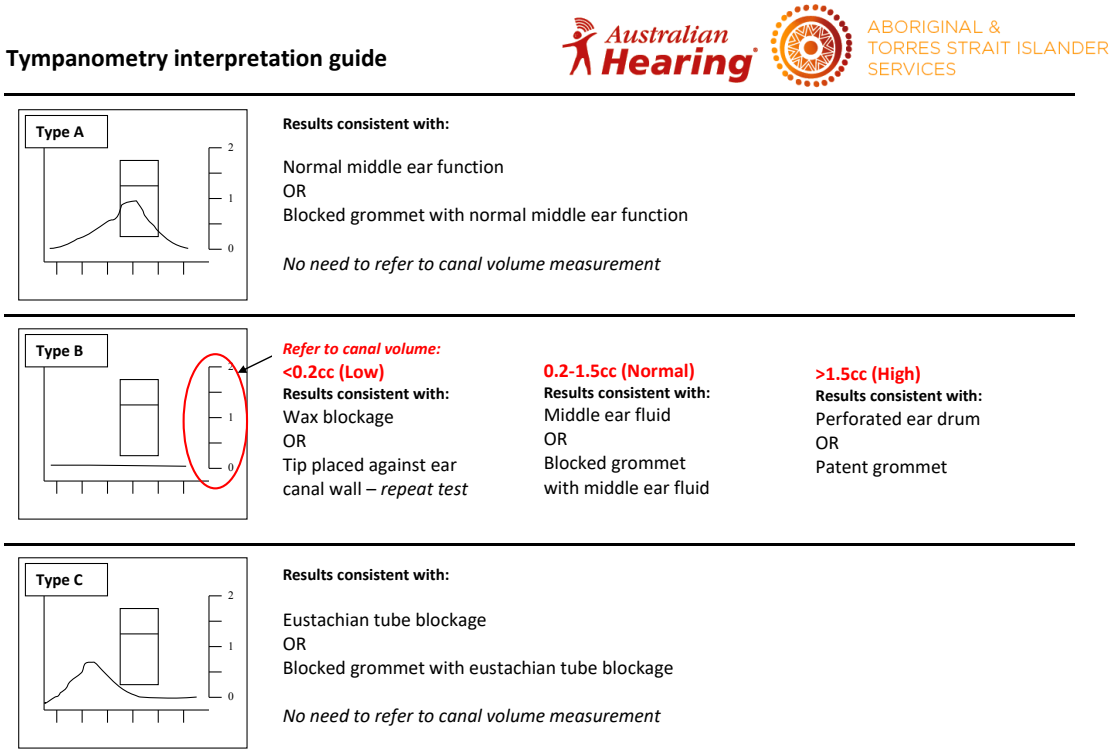
3 These tests were not employed in the current trial.

A speech test may be conducted to determine how well a person understands speech[20]. It may allow a clinician to identify whether there could be problems with the auditory nerve, which sends signals from the ear to the brain, or whether there could be problems understanding speech and sounds in the brain itself[20].

2.8.5 Tympanometry

Tympanometry tests the condition of the outer and middle ear, and the mobility of the eardrum[20, 24]. There are three types of tympanometry results (Figure 2.3). A Type A result indicates that there is normal middle ear function (or that there is a blocked grommet with normal middle ear function). Type A results, therefore, indicate normal ear function. A Type B result is consistent with wax blockage, middle ear fluid (or blocked grommet with middle ear fluid), or perforated ear drum (or patent grommet). A Type C result is consistent with eustachian tube blockage (or blocked grommet with eustachian tube blockage). More information on interpreting tympanometry results is available here. Both type B and C results typically indicate that additional hearing screening is required to identify whether hearing loss is present.

Figure 2.3 Tympanometry interpretation guide



Source: Australian Hearing. Tympanometry training for primary health services 2017 [Available from: https://www.hearing.com.au/For-health-professionals/GP-education/Tympanometry-training-for-primary-health-services [24].

2.8.6 Audiogram

The results of these tests may be presented in an audiogram, which identifies the degree of a person's hearing loss. An audiogram is widely accepted as the "gold standard" of hearing function[21]. From the audiogram, it is possible to determine whether a person would benefit from hearing aids, or other interventions to assist them to hear better[20].

2.9 Hearing services in Australia

There are a variety of hearing screening services in Australia. Services can be provided through state and territory governments, Aboriginal Community Controlled Health Services (ACCHS), Commonwealth hearing screening programs, private audiology services such as Australian Hearing, PHC services, not-for-profit organisations, such as the RFDS etc.[14].

Australia also has a universal newborn hearing screening program where newborn babies are screened for hearing loss at birth[2]. Babies identified as having a possible hearing loss may undergo further testing in the hospital where they are born and are referred to Australian Hearing if a permanent hearing loss is detected[2].

2.10 Addressing hearing loss

Hearing loss is commonly addressed through the use of hearing devices such as hearing aids or cochlear implants. Some types of conductive hearing loss can also be corrected medically or surgically[2].

2.10.1 Hearing aids

Hearing aids are small electronic devices that amplify sounds to enable people to hear better. They comprise a microphone, speaker, amplifier and battery [25]. Sound waves are received by the microphone and turned into electronic signals which are amplified and sent to the ear through a speaker [25]. Hearing aids come in a variety of sizes, shapes and colours.

The Australian Government Department of Health's Hearing Services Program (HSP) subsidises up to 80 per cent of the hearing aids sold in Australia, with Australian Hearing dispensing approximately one-third of the subsidised devices [2].

2.10.2 Cochlear implants

Cochlear implants may be offered to people with severe or profound hearing loss who can't overcome their hearing loss with hearing aids[26]. To be a candidate for a cochlear implant, a person must also have auditory nerves that work [26].

A cochlear implant is surgically placed in a person's inner ear (the cochlea) to help them hear[26]. It is a small electronic device which stimulates the hearing nerve and provides sound signals directly to the brain [26]. It also contains external components—the external component looks similar to a hearing aid.

Children with severe hearing loss, or those who are born deaf may benefit from having a cochlear implant fitted prior to 18 months of age as this facilitates development of normal language skills [26].

2.10.3 Medical management of otitis media

The Department of Health has published clinical care guidelines on the management of otitis media for Indigenous children, who are disproportionately affected by otitis media. Its management depends on the severity and type of otitis media, and age of the person presenting with the illness. Treatment options for otitis media, for both Indigenous and non-Indigenous Australians, may include: patient and family education; medical review; treatment with oral and/or topical antibiotics; audiology referral; speech therapy referral; ear nose and throat (ENT) referral (for example, for surgery such as tympanostomy tubes (grommets)); pain relief; and cleaning treatment [27].

3.0 Methodology

The following section describes the methodology employed in the RFDS and Australian Hearing hearing screening trial.

3.1 Community hearing worker

A CHW was recruited specifically for the trial. Their role was to:

- Provide hearing screening services for children and adults, including otoscopy, tympanometry and validated hearing screening tests;
- Administer hearing screening questionnaires to clients and parents/carers, as needed;
- Refer clients to Australian Hearing if a problem with hearing was identified;
- Refer clients to other health services, where indicated;
- Enter data into the Australian Hearing and RFDS customer relationship management (CRM) database;
- Complete written reports for clients and provide these to the clients and their nominated primary health care service, if indicated;
- Provide education about hearing to communities, including information about hearing loss and general information regarding accessing hearing services; and
- Provide on the spot refresher training in tympanometry, and general information about accessing hearing services to service providers, if requested.

The CHW underwent a three-week orientation period with Australian Hearing, prior to commencing delivering services with the RFDS. During this time the CHW:

- Experienced a range of client appointments with children and adults;
- Learned about rehabilitative hearing services;
- Became familiar with the Hearing Services Program;
- Trained in the use of hearing screening equipment, questionnaires etc.;
- Was trained in the hearing assessment protocol that would be implemented for the trial; and
- Underwent training in how to enter patient data into the CRM database.

3.2 Timeline

The RFDS/Australian Hearing hearing screen trial was conducted over a 12-month period. It commenced on 1 August 2017 and concluded on 31 July 2018.

3.3 Participants

Hearing assessments were accessible for all residents of the towns visited, including children (0–17 years) and adults (18 years of age or older). Both Indigenous and non-Indigenous Australians were able to access the service.

3.4 Cost

The cost of the trial was met by Australian Hearing and the RFDS, who contributed equal cash amounts to facilitate the trial, including the cost of the CHW salary.

The hearing assessment service was free for all members of the communities visited by the CHW.

3.5 Trial information

Information sheets, which explained the hearing screening service, were produced by Australian Hearing and the RFDS and distributed to members of the community in the towns where screening was undertaken. Posters were also produced and placed in health services in the towns the CHW was visiting.

3.6 Consent

Taking part in the trial was voluntary. Adults completed a consent form to indicate their willingness to participate. Consent from parents/carers was obtained for all children who participated in the trial.

3.7 Service delivery

3.7.1 Proposed locations

The CHW travelled with the MDU, to deliver hearing screening services to Queensland towns visited by the MDU, on a rotational basis. Each rotation was scheduled to run for approximately two weeks.

Locations that the MDU was scheduled to visit during the trial included: Dajarra, Jundah, Sapphire, Clermont, Rollerston, Theodore, Monto, Collinsville, Greenvale, Richmond, Winton and Tambo. Visits were also scheduled to additional locations, where the RFDS provides primary health care services, but where the MDU does not visit. Hearing screening services were also proposed for clients in Doomadgee, Chillagoe, Georgetown, and Greenvale, due to the absence of hearing screening in these communities.

The CHW contacted schools and communities prior to visiting them, to ensure they were aware of the service, and how to access it. Posters and information sheets were provided to communities.

During each visit to a town, the CHW delivered services from a range of locations, including health services and schools.

Prior to the visit, the CHW asked local schools and community health services to:

- Promote the visit to staff and encourage them to attend if they were concerned about their hearing;
- Promote the visit to the wider community, through usual communication channels and the visit poster;
- For schools, send the information and consent form home for families/carers to complete. The CHW was only able to see children who had a signed form, or whose parent/carer was attending the visit;
- For schools, to advise parents, carers and family that they were welcome to attend the appointment with their child;
- Provide a quiet, private, well lit room with power, a rubbish bin, chairs and a table, to facilitate the hearing testing.

3.7.2 Booking appointments

Clients were able to book an appointment to see the CHW. They were also able to present for an unscheduled hearing assessment, and were seen if the CHW had availability.

3.7.3 Assessment

The CHW asked adult clients, and parents/carers of children, a number of questions about their ear health and hearing, looked in both ears (otoscopy) and did a measurement of middle ears

(tympanometry). The CHW conducted an OAE test, as required (See Appendices 1, 2, 3 and 4 for hearing screening clinical pathways, by age group). Specifically:

- Adults had an eardrum and middle ear check, were asked some questions about how they perceived their hearing ability and hearing needs, and had a hearScreen check. The hearScreen check involved listening to beeps through headphones and reporting when they heard them;
- School aged children had the same hearScreen check as adults and, if needed, also completed a validated hearing test game called Sound Scouts. Parents/carers were asked some questions about their child's hearing. These questions were taken from the Parents' Evaluation of Aural/Oral Performance of Children (PEACH) questionnaire. The CHW also checked a child's eardrums and middle ears; and
- Younger children had a test to check their inner ear function, and parents/carers were asked questions about their child's listening behaviour (PEACH). Younger children also underwent an OAE test.

The CHW also discussed availability of hearing services and factors impacting hearing loss with clients.

3.7.3.1 Adult hearing questionnaire

Prior to their appointment, adults were invited to complete a six-item readiness questionnaire. Three of the items related to perceived clarity of conversation in quiet and noise. Two questions related to the extent to which the person assessed themselves as having trouble hearing overall, and whether those around them suggested a hearing test was needed. The remaining questions asked about hearing aids, specifically, did the person think they needed a hearing aid, and if they had one, whether it was helping.

3.7.3.4 Parents' Evaluation of Aural/Oral Performance of Children (PEACH)

Parents/carers were asked to complete the PEACH. The PEACH is a listening behaviour questionnaire for children. It is used to record how a child is hearing and communicating with others. To complete the PEACH, parents/carers were asked to think about their child's listening behaviour and estimate how often they saw their child doing certain behaviours in a range of everyday hearing and communication scenarios in the previous week.

The PEACH can be given from the age of three months upwards.

Results from the PEACH are compared against validated normalised data to identify whether a child's listening behaviour is in the normal developmental range. If the child's results were outside the normal range for their age, it suggested they may not be hearing well enough.

3.7.3.2 hearScreen

hearScreen is a smartphone application (app) that is paired with calibrated headphones to test hearing. The app has real-time noise monitoring and facilitates pure-tone audiometric screening[28]. The point-of-care screening provided through hearScreen can be supported by cloud-based data management services and can be programmed to link with referral services. hearScreen can be used by minimally trained people and is suitable for use in school-aged children and adults[28]. The outcome of a hearScreen assessment was reported as either a pass or refer result.

3.7.3.3 Sound Scouts

Sound Scouts is a tablet-based app, used with children from four years and nine months to 12 years. It is an interactive game which tests for conductive and sensorineural hearing loss, and central auditory processing disorders[2]. It requires a quiet environment, access to the app on a tablet and a set of headphones[2]. The outcome of a Sound Scouts assessment was reported as either a pass or refer result.

3.7.4 Referral

The CHW explained results of the hearing screening and next steps. Clients received a report, which was also sent to the health service and/or school they nominated, including to primary health services and to specialist hearing services, such as Australian Hearing.

Families or adults seeking further assistance were invited to attend a tele-consult with an experienced Australian Hearing audiologist during the visit. Clients were encouraged to make use of Hearing Help, Australian Hearing's tele-support line, as needed.

Additionally, the CHW was available to provide on the spot refresher training in tympanometry for health professionals in the towns visited, and general information about accessing hearing services.

3.7.5 After the visit

The CHW liaised with adult clients, who were identified as requiring additional support or testing, during their consultation.

The CHW followed up directly on results and recommendations with parents/carers of students for whom there were concerns, using the phone numbers provided on the consent forms.

Reports, which outlined results and recommended next steps, were completed and sent within one week, unless discussed otherwise with CHW. If a personal email address was provided, reports were emailed directly to adult clients and families/carers of children. Reports were also emailed to the school to print and send home with the students, for children who accessed the service through their school.

3.7.6 Feedback from services and clients

Services that the CHW visited, such as schools and health centres, had the opportunity to provide feedback via an electronic post-visit survey, that was emailed to all schools and health services that participated in the trial. The survey for services comprised 15 questions, including questions regarding: perceived level of hearing in their community; community access to hearing services; service delivery by the CHW; suggestions for how the RFDS/Australian Hearing service could be improved; and the best thing about the service.

Individual clients were also invited to complete a short survey about their experience with the CHW. The survey for individual clients comprised 11 questions, including questions regarding: how they found out about the RFDS/Australian Hearing service; service delivery by the CHW; anything they were unhappy about; and the best thing about the service.

Verbal feedback from services and individual clients, regarding improvements to the hearing screening service, was also captured in an adhoc manner.

3.7.7 Feedback from RFDS and Australian Hearing staff

Verbal and written feedback from RFDS and Australian Hearing staff, regarding challenges with the service delivery and recommendations for improving the service, were captured in an adhoc manner.

3.8 Collecting and recording data

In order to report these outcomes, client data were collected in a purpose-built customer relationship management (CRM) database. Any data that were collected via paper-based surveys were entered into the CRM. Referrals and other relevant documents were scanned and attached to a client's record.

Data items collected and recorded for the trial are listed in Table 1.1. Some of the data were recoded. For example, client's age was recoded into discrete 5-year age groups to prevent the possibility of identification of individuals.

4.0 Results

The following section describes the results from the RFDS and Australian Hearing hearing screening trial.

Data were analysed using IBM SPSS Statistics for Windows, Version 25.0 or Microsoft Excel 2016. All analyses used unweighted data and excluded missing cases (e.g. where age/gender was unknown).

4.1 Service delivery

Hearing screening services were provided through 13 rotations, conducted in Queensland between 1 August 2017 and 31 July 2018.

4.2 Communities visited

The CHW visited 27 towns (41 facilities) during the trial (See Table 4.1 and Figure 4.1). Eleven of these visits co-occurred with rotations by the MDU. The CHW also travelled with the RFDS primary health team to additional communities, not served by the MDU, but where no hearing screening services were provided, on two occasions. Specifically, one scheduled MDU rotation was to Cherbourg. This is a community well serviced by hearing programs, so the decision was made for the CHW to accompany the RFDS Primary Health team to Doomadgee, Chillagoe, Georgetown and Greenvale, which are poorly serviced for hearing screening services. The CHW also made an additional visit to Greenvale, independent of the MDU rotation.

Table 4.1 Communities (and facilities) visited during the trial, by date and rotation number

Town	Facilities visited	Date	Rotation number
Dajarra	Dajarra Primary Health Clinic Dajarra State School	22/8/2017 22/8/2017	1
Boulia	Boulia Primary Health clinic	24/8/2017	
Jundah	Jundah Primary Health Clinic	12/9/2017	2
Stonehenge	Stonehenge Community Centre	13/9/2017	
Windorah	Windorah Primary Health Clinic	14/9/2017	
Sapphire	Sapphire Clinic (QLD Health) Bush Kids Sapphire Private appointments Sapphire	4/10/2017 4/10/2017 7/10/2017	3
Anakie	Anakie State School	11/10/2017	
Capella	Capella State School	25/10/2017	4
Clermont	C & K Creche and Kindergarten Clermont Kindergarten St Joseph's Catholic School Clermont State School	24/10/2017 27/10/2017 31/10/2017 31/10/2017	
Kilcummin	Kilcummin State School	20/10/2017	
Rolleston	Rolleston State School Rolleston Primary Health Clinic	5/12/2017 6/12/2017	5
Doomadgee	Doomadgee Community Health Doomadgee Day Care	15/1/2018 16/1/2018	6
Chillagoe	Chillagoe Community Health	22/1/2018	
Greenvale	Greenvale Hall	24/1/2018	
Georgetown	Unknown	25/1/2018	
Theodore	Theodore State School HACC Theodore	6/2/2018 7/2/2018	7
Monto	Monto State High School Monto Kindergarten St Therese Catholic School	6/3/2018 7/3/2018 8/3/2018	8
Mulgildie	Mulgildie State School	7/3/2018	
Scottsville	Scottsville State School	26/3/2018	9
Collinsville	Collinsville State High School Collinsvale Hospital Collinsvale State School	21/3/2018 27/3/2018 28/3/2018	
Greenvale	Greenvale Hall	10/4/2018	10
Hughendon	St Francis Catholic School	1/5/2018	11
Richmond	Richmond Hospital	2/5/2018	
Winton	Winton Hospital Little Swaggies Kindergarten	25/5/2018 22/5/2018	12
Longreach	Longreach C & K Kindergarten	23/5/2018	
Tambo	Tambo multipurpose centre	14/6/2018	13
Augathella	Augathella State School	12/6/2018	

Figure 4.1. Map of Queensland communities visited during the trial

Created in Google Maps.

4.3 Hearing Assessments

Hearing assessments were provided to residents in each of the 27 towns visited by the CHW. Residents either made an appointment to visit the CHW (n=669) or were walk-ins (n=146). Eight people who had made an appointment did not present for their appointment, primarily due to illness. However, their data are included in the analysis as they had either completed pre-consultation questionnaires, had previously had a hearing screening test and provided the results to the CHW, or were seen at a subsequent visit by the CHW.

Specifically, 819 people had a hearing assessment, comprising 591 children[4], 224 adults and four people whose age was unknown. On average, 63 people per rotation received services from the CHW, comprising 45 children and 18 adults. This exceeded the trial goal of 40–60 hearing screenings per rotation.

Table 4.2, and Figures 4.2 and 4.3 describe the characteristics of people who accessed the hearing screening service. People accessing the service ranged in age from newborn to 91 years. The average age was 21.3 years (standard deviation (SD) 22.5 years) and the median age was 10.0 years. 72.5% of people screened were aged under 18 years. 61.7% of people screened were primary school aged children, 10.6% were preschool aged or younger, and the remainder were young adults or adults. Children aged 5–9 years (37.8%) were the group most likely to receive a hearing assessment, and those aged 20–24 years (1.0%) were the group least likely to receive a hearing assessment. Approximately equal numbers of males and females received hearing assessments.

4 The oldest person in the 15–19-year age group was 17 years of age, so all data reported for people aged 0–19 years represents data for “children” aged under 18 years.

Table 4.2 Characteristics of people who accessed the hearing screening service

	Male	Female	Total
Number (percent)	407 (49.9%)	408 (50.1%)	815
Age			
Range	0–87 years	0–91 years	0–91 years
Mean	19.2 years	23.5 years	21.3 years
Median	10.0 years	11.0 years	10.0 years
Standard deviation (SD)	22.2 years	22.8 years	22.5 years

Figure 4.2 Number and age of respondents who received hearing assessments, by gender

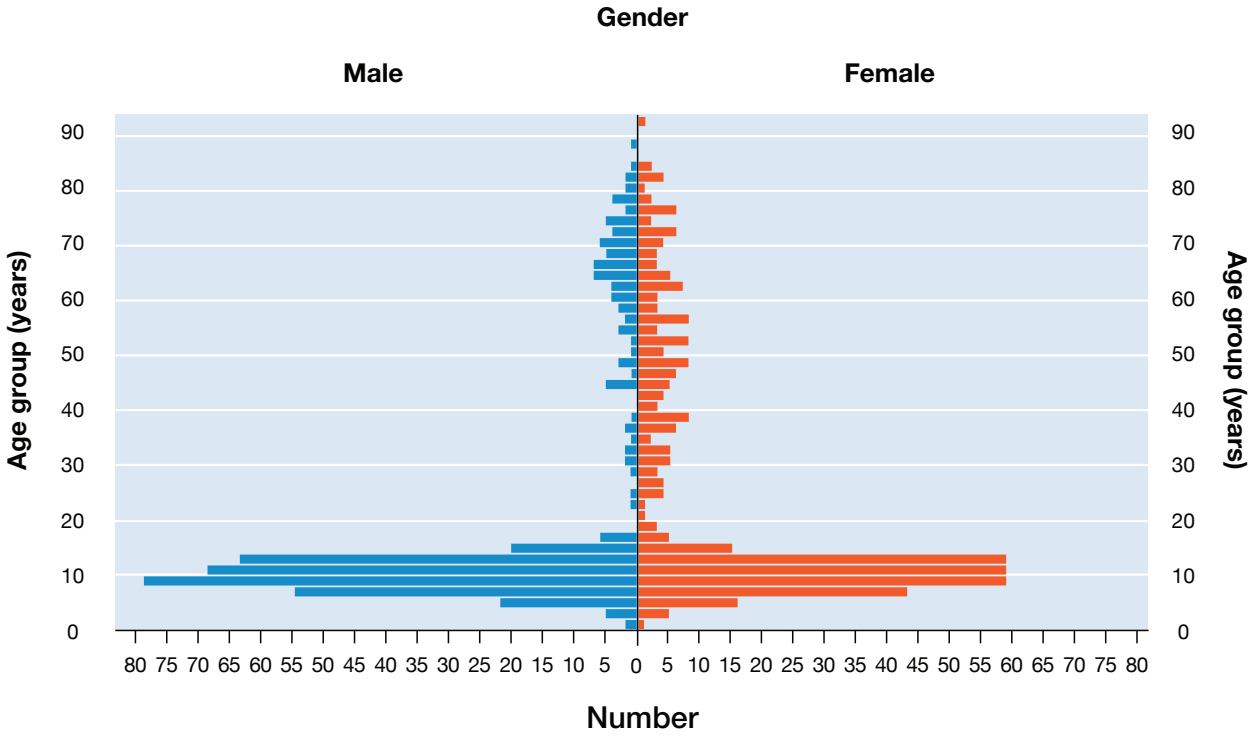
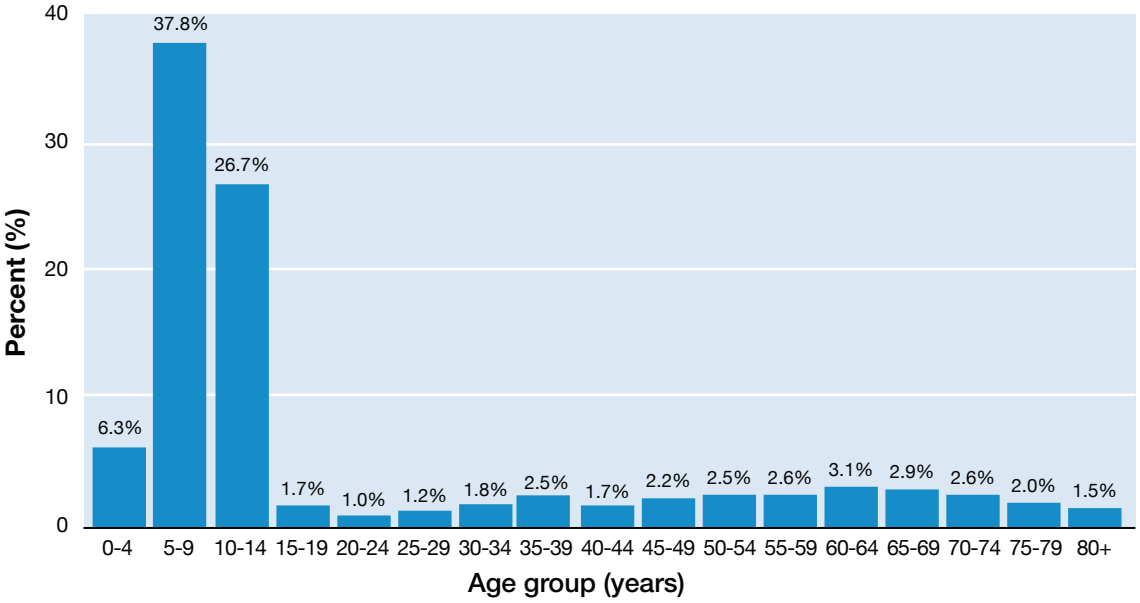


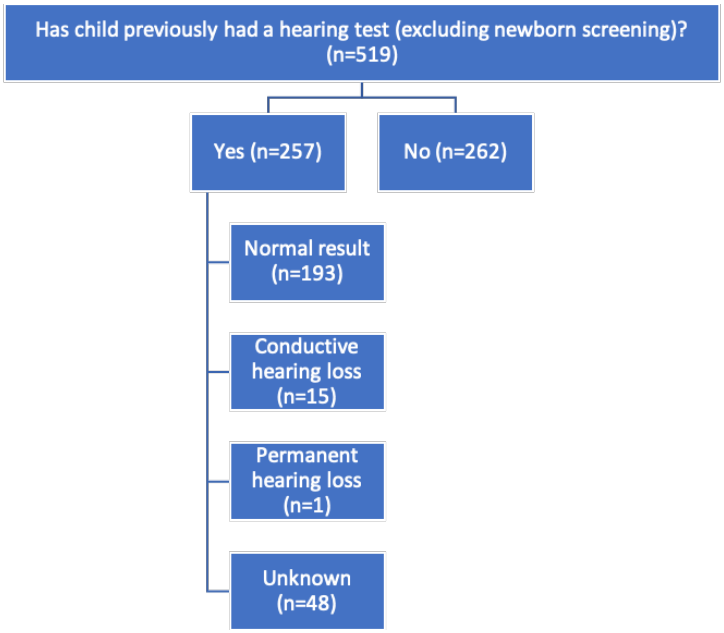
Figure 4.3 Proportion of people who received hearing assessments by 5-year age group



4.3.1 Child hearing assessments

Prior to their hearing assessment by the CHW, parents/carers were asked if their child had previously had a hearing test, outside of newborn hearing screening. Of the 519 children for whom responses were received, almost half (49.5%) had previously had their hearing assessed, while 51.5% had not (Figure 4.4). Fifteen children (5.8%) who had previously had their hearing checked were identified with conductive hearing loss, and one (0.4%) was identified with permanent hearing loss.

Figure 4.4 Previous hearing test and outcome (children)



Hearing assessments conducted by the CHW comprised a combination of otoscopy, tympanometry, OAE testing, hearScreen testing, and Sound Scouts testing. The types of assessment employed by the CHW depended on the age of the child, clinical history and ability of the child to follow instructions.

591 children underwent a hearing assessment during the trial. Figure 4.5 describes the number and types of hearing tests performed with children, and the results. Figure 4.5 demonstrates that otoscopy was performed on 560 (94.8%) children, tympanometry was performed on 541 (91.5%) children, 479 (81.0%) children had a hearScreen assessment and 100 (16.9%) had a Sound Scouts assessment.

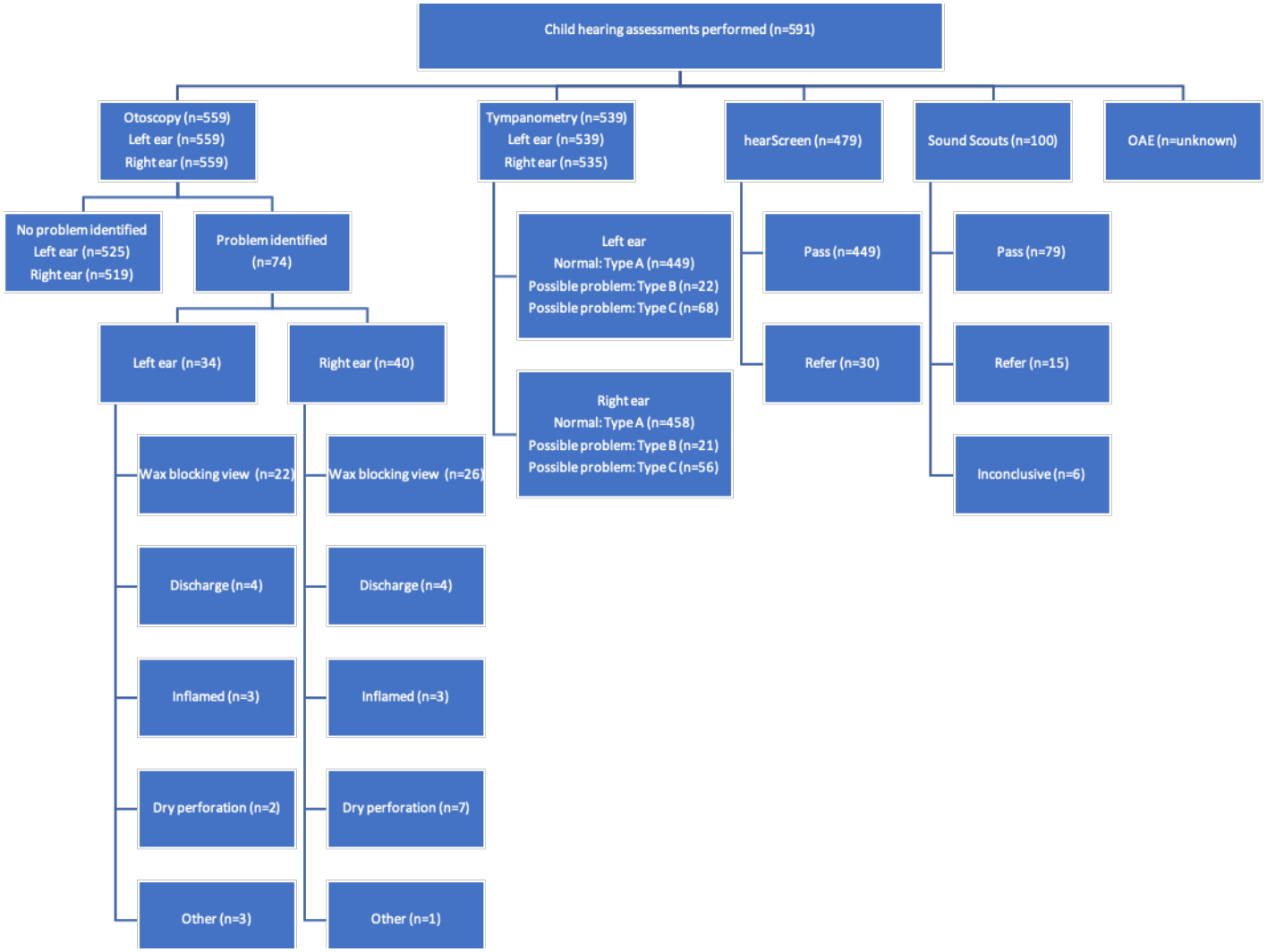
Otoscopy identified a problem in the left ears of 34 children and the right ears of 40 children. The main problems included: wax blocking view; discharge, inflammation or dry perforation.

Middle ear state, as measured by tympanometry, identified potential problems in the left ears of 90 children and the right ears of 77 children. The machine for measuring middle ear function (tympanometry) failed at some clinics, therefore, not all children underwent tympanometry.

hearScreen was used to assess the hearing of 479 children and 449 (93.7%) of the children who underwent a hearScreen assessment passed the test. 30 children did not pass the hearScreen test. Not all children underwent a hearScreen assessment. There were several reasons for this. Children did not have a hearScreen test if they: were too young; could not be 'conditioned' to the test i.e. had difficulty following instructions or didn't know what to do when they heard a sound; already had hearing aids; or had ear discharge or other ear problems precluding a test. Additionally, the hearScreen test was not conducted if there was insufficient time to complete the test during the consultation, or very loud background noise.

Sound Scouts was used to asses 100 children's hearing and 79 (79.0%) children passed the Sound Scouts test. Results were inconclusive for 6 children and 15 people were referred for additional testing, 14 to Australian Hearing and one unknown.

Figure 4.5 Number of child hearing assessment tests performed, by type of test, and result

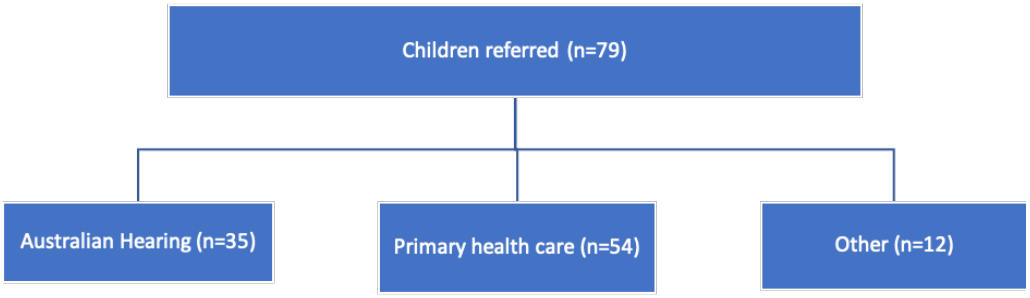


Based on results from all tests, 92 children (15.6%) were identified as having hearing outside the normal range and 79 received a referral to at least one other service[5]. Children were referred to the following services for follow-up (see Figure 4.6):

- Australian Hearing;
- Primary health care; or
- Other service (such as ear nose and throat surgeon).

Some children did not receive a referral as they were already under the care a service provider for their ear health or hearing.

Figure 4.6 Referral pathways recommended for children, by type and number[a,b]



Note: [a]Some children were referred to multiple services; [b]Children could be referred due to their result in one, or more, of the hearing assessments.

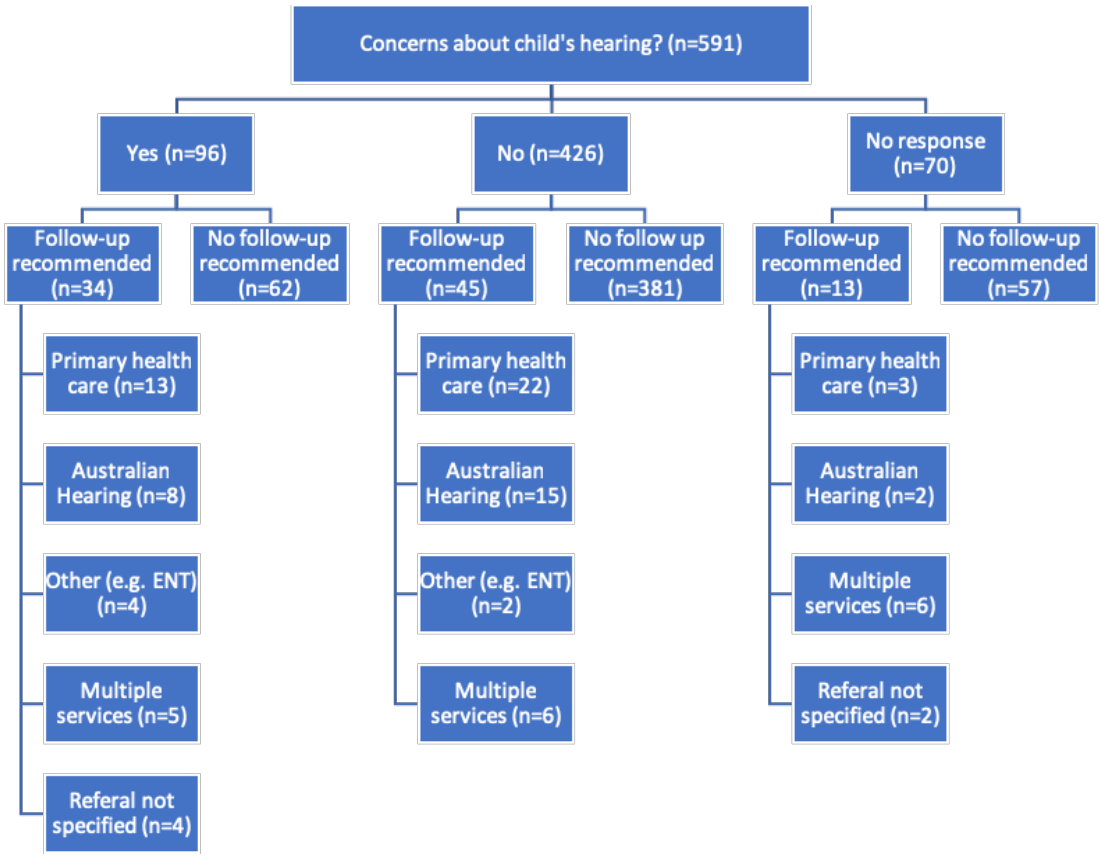
Specifically, children were most likely to be referred to primary health care or Australian Hearing.

As part of the PEACH, parents/carers were asked if they had any 'concerns about their child's hearing'—522 (88.3%) parents/carers responded to this question. Of the parents/carers who provided this information, 96 (18.4%) were concerned about their child's hearing. Figure 4.7 shows referral pathways for all children screened in the trial by type of service recommended, and parental/carer concern regarding their child's hearing. Results demonstrated that:

- 35.4% of children whose parents/carers had concerns about their child's hearing, had hearing outside the normal range and received a referral for follow-up care;
- 10.6% of children whose parents/carers did not have concerns about their child's hearing, had hearing outside the normal range and received a referral for follow-up care; and
- 18.6% of children whose parents/carers provided no information regarding concerns about their child's hearing, had hearing outside the normal range and received a referral for follow-up care.

5 A single child could have a number of issues, such as a problem with both their left and right ears, as identified by otoscopy, a potential problem in their right and left ears, as identified by tympanometry, and may not have passed the hearScreen and/or Sound Scouts tests.

Figure 4.7 Follow-up actions for children screened in the trial, by type of service recommended, and parental/carer concern regarding their child's hearing



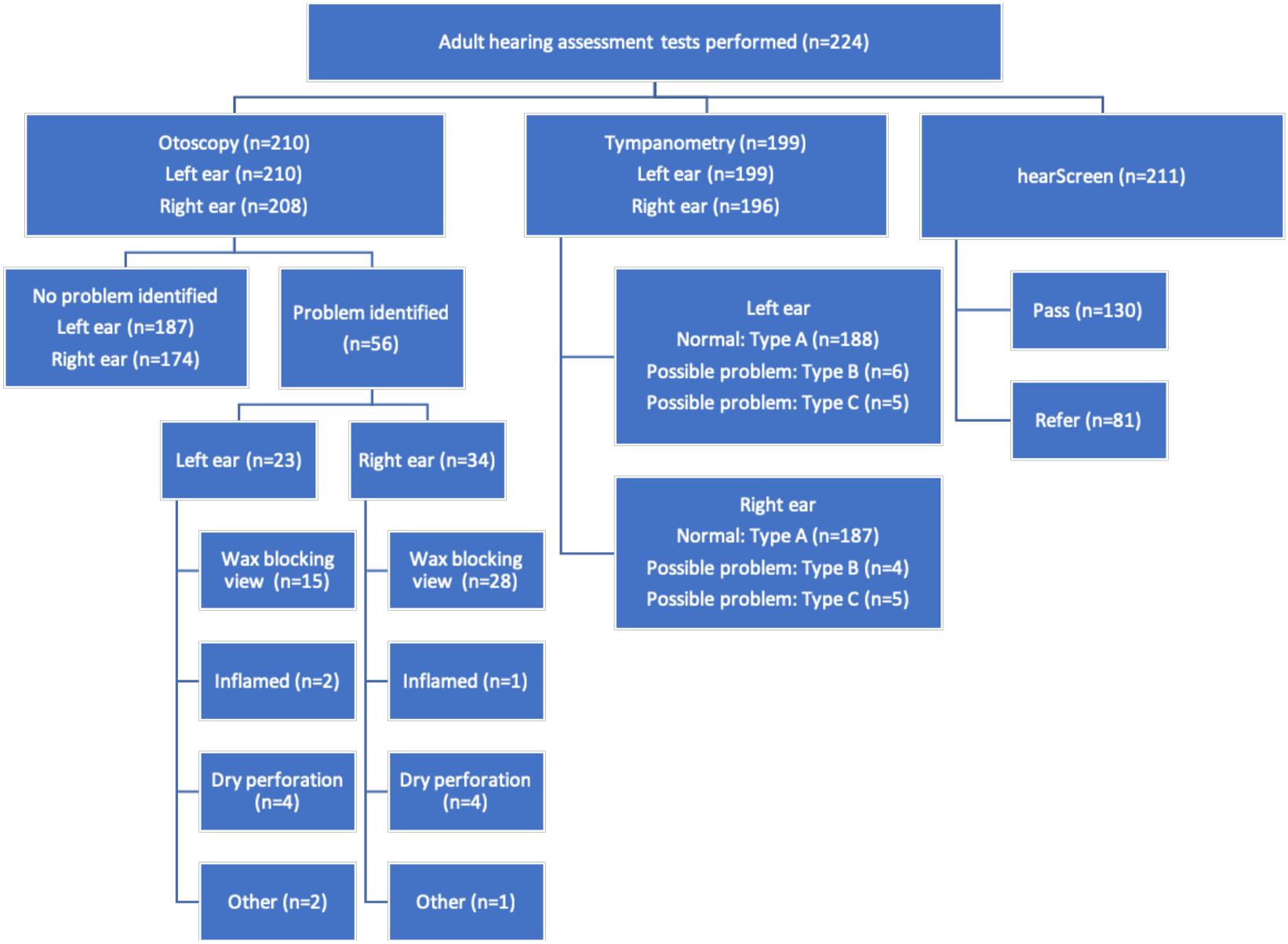
4.3.2 Adult hearing assessments

Prior to their hearing assessment with CHW, adults were invited to complete a six-item readiness questionnaire. Of the 224 adults that underwent a hearing assessment during the trial, all (100%) completed at least one question on the six-item readiness scale. This enabled the CHW to understand potential problems prior to conducting the hearing assessment.

Adult hearing assessments comprised a combination of otoscopy, tympanometry, and hearScreen testing. The types of assessment employed by the CHW depended on the clinical history and preference of the adults attending the consultation.

Figure 4.8 describes the number and types of hearing tests performed with adults, and the results. Figure 4.8 demonstrates that otoscopy was performed on 210 (93.8%) adults, tympanometry was performed on 199 (88.8%) adults, and 211 (94.2%) adults had a hearScreen assessment.

Figure 4.8 Number of adult hearing assessment tests performed, by type of test, and result



Otoscopy identified a problem in the left ears of 23 adults and the right ears of 34 adults. The main problems included: wax blocking view; dry perforation; or inflammation.

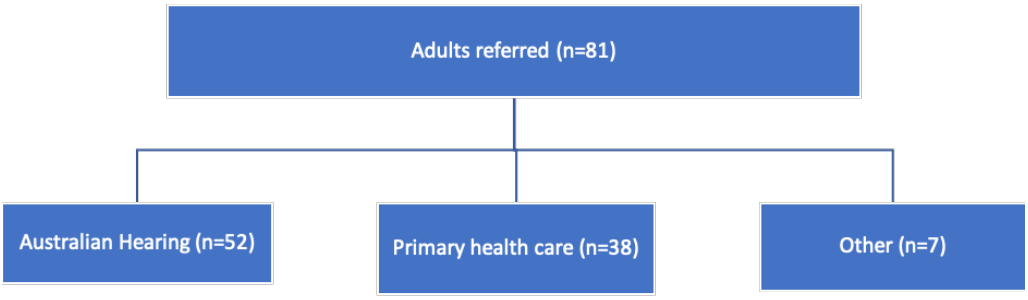
Middle ear state, as measured by tympanometry, identified potential problems in the left ears of 11 adults and the right ears of nine adults. The machine for measuring middle ear function failed at some clinics, therefore, not all adults underwent tympanometry.

hearScreen was used to assess the hearing of 211 adults and 130 (61.6%) of the adults who underwent a hearScreen assessment passed the test. 81 (38.4%) adults did not pass the hearScreen test. The majority of adults (94.2%) who saw the CHW underwent a hearScreen assessment. Adults who already had hearing aids, had ear discharge, or other ear problems did not undergo a hearScreen assessment. Additionally, the hearScreen test was not conducted if there was insufficient time to complete the test during the consultation, or very loud background noise.

Based on results from all tests, 81 adults (36.2%) were identified as having hearing outside the normal range and received a referral to at least one other service[6]. Adults were referred to the following services for follow-up (see Figure 4.9):

- Primary health care;
- Australian Hearing; and
- Other service (such as an ENT surgeon).

Figure 4.9 Referral pathways recommended for adults, by type and number



Note: [a]Some adults were referred to multiple services; [b]Adults could be referred due to their result in one, or more, of the hearing assessments.

Adults clients were also asked whether they thought they needed a hearing aid. 213 people provided a response—200 respondents believed they did not need a hearing aid and 13 people believed they did need a hearing aid. Of those who thought they did need a hearing aid, three already had one—one client indicated that the hearing aid only worked 'sometimes', and the other two clients said their hearing aid 'never works'.

Overall, 17 adults already had an existing hearing aid. Of these clients:

- Three thought they needed a hearing aid, and 14 thought they did not;
- One indicated the hearing aid 'always works,' but they didn't believe they needed it;
- Three thought their hearing aid 'sometimes works';
- 12 thought their hearing aid 'never works';
- One person did not provide an answer regarding how well their hearing aid worked.

As part of the hearing readiness assessment adults completed, they were asked whether they had 'hearing trouble'. 223 adults provided a response. More than half (57.9%) indicated that they had 'trouble hearing', at least some of the time.

6 A single adult could have a number of issues, such as a problem with both their left and right ears, as identified by otoscopy, a potential problem in their right and left ears, as identified by tympanometry, and may not have passed the hearScreen and/or Sound Scouts tests.

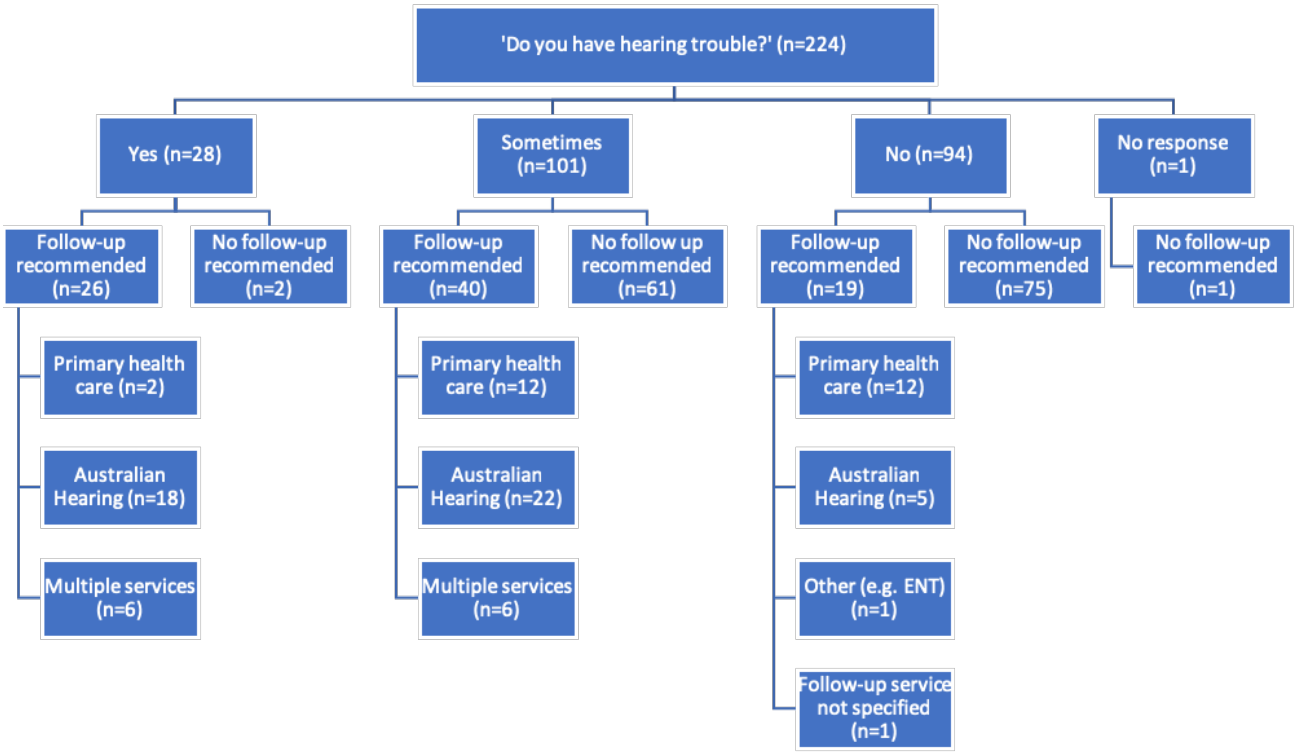
Responses included:

- 'Yes'–12.6% of adults;
- 'Sometimes'–45.3% of adults; and
- 'No'–42.2% of adults.

Figure 4.10 shows referral pathways for all adults screened in the trial by type of service recommended, and respondent's self-identified belief regarding 'hearing trouble.' Results demonstrated that:

- 92.9% of adults who responded 'yes' to the question about whether they have 'trouble hearing' received a referral for follow-up care;
- 39.6% of adults who responded 'sometimes' to the question about whether they have 'trouble hearing' received a referral for follow-up care; and
- 20.2% of adults who responded 'no' to the question about whether they have 'trouble hearing' received a referral for follow-up care.

Figure 4.10 Follow-up actions for adults screened in the trial, by type of service recommended, and self-reported hearing trouble



4.4 Uptake of referrals to Australian Hearing

Of the 35 children referred to Australian Hearing, four were already known to the service, and three of these were already aided. In total, 18 of the 35 children (51.4%) referred were seen. Aside from the three children already aided, three additional children were aided as a result of the referral from the RFDS program.

Of the 52 adults referred to Australian Hearing, six were already clients of the service and four of these were already aided. In total, 18 of the 52 adults (34.6%) referred were seen. Aside from the four clients already aided, seven additional adults took up aid use as a result of the referral from the RFDS program.

The average wait time between referral by the RFDS program and first appointment with Australian Hearing was 37 days.

Clients were seen at a combination of locations—a permanent Hearing Centre, a visiting location, or through the Australian Hearing Outreach program, each of which had differing levels of availability.

For clients referred outside the RFDS program, the average wait time for an appointment at a Hearing Centre is two weeks, at a visiting site, one month, and at an Australian Hearing Outreach site, up to three months.

4.5 Feedback

Feedback was sought from schools and services that participated in the trial, clients and RFDS and Australian Hearing staff.

4.5.1 Schools and health services

An electronic post-visit survey was emailed to all schools and health services that participated in the trial. Eleven responses were received, from schools (5), health services (3), early childhood centres (1) and other (1) across 10 locations.

Responses demonstrate a wide range of perceptions around level of hearing loss in each community, from 'very few people have hearing loss' to 'many people have hearing loss' (Table 4.3). One service from Richmond thought that 'some people have hearing loss', while a second service from Richmond didn't know what level of hearing loss there was in the community.

Table 4.3 Perception of 'level of hearing loss in your community' by schools and health services (n=11)

Response	Number	Communities
Many people have hearing loss	1	Dajarra
Some people have hearing loss	2	Jundah, Richmond
Few people have hearing loss	1	Windorah
Very few people have hearing loss	1	Rolleston
Don't know	6	Clermont, Capella, Collinsville, Monto, Hughenden, Richmond

Additionally, there was a wide range of perceptions around the degree to which the community is served by hearing services, from 'well' to 'not at all' served by hearing services (Table 4.4). One service from Richmond thought that the town was 'not very well' served by hearing services, while another service in Richmond thought it was 'not at all served' by hearing services.

Table 4.4 Perception of 'community's level of access to hearing services' by schools and health services (n=11)

Response	Number	Communities
Well served by hearing services	1	Dajarra
Quite well served by hearing services	2	Capella, Rolleston
Not very well served by hearing services	4	Collinsville, Monto, Hughenden, Richmond
Not at all served by hearing services	4	Clermont, Jundah, Windorah, Richmond

Schools and health services were also asked a range of questions around service delivery (Table 4.5). The majority of respondents agreed that: visits were planned and confirmed in a timely manner; the CHW discussed results and recommendations with schools and health services; reports provided were clear and contained relevant and useful information; the CHW was flexible and accommodating of the needs and priorities of schools and health services; and the CHW had realistic expectations of how schools and health services could support their visit. Respondents strongly endorsed the RFDS/Australian Hearing service as meeting a need in their community—and that people in the community responded positively to the service.

Table 4.5 Number of schools and health services who agree ('strongly agree' or 'agree') and disagree ('strongly disagree' or 'disagree') with statements about the hearing screening service (n=11)

Statements	Agree	Disagree
Visits are planned and confirmed with enough notice	6	2
The CHW discussed results and recommendations with me	7	2
Reports are clear and have relevant and useful information	7	0
The CHW is flexible and accommodating of our needs and priorities	9	0
The CHW has realistic expectations of how we can support their visit	4	1
The service meets a need in our community	10	0
People responded positively to the RFDS/ Australian Hearing hearing service	10	0
I learned more about access to hearing services and the telephone support line Hearing Help	4	1

Note: 'Neither agree nor disagree' and 'can't comment on this one' responses are not shown.

Schools and health services identified the best things about the hearing screening service (Table 4.6) and made recommendations for how the service could be improved (Table 4.7). There was general consensus among the eight respondents regarding the best thing about the hearing service—that the service facilitated improved access to hearing services. Two respondents thought that the service played a positive role in identifying students with hearing loss that were previously unaware of their hearing loss, and for those that experienced issues. Five recommendations for making the service better were received. All of the responses indicated more frequent and regular visits by the hearing service, and more timely provision of information to schools and health services regarding visits by the CHW.

Table 4.6 Schools and health services views regarding the 'best thing about the hearing screening service' (n=8)

Responses
> Access in town.
> Easy for parents to choose to use the service.
> It provided a much-needed service to our community, particularly for children.
> Some students were identified with significant hearing losses that did not know previously, so it was very beneficial.
> Thank you so much for coming to see us. It means a lot to remote student to be able to access multiple tests in one year. Especially for those who have experienced issues.
> That it occurred.
> That we didn't have to travel!
> The hearing worker was extremely accommodating to community needs and a pleasure to have visiting.

Table 4.7 Schools and health services 'recommendations for making the service better' (n=5)

Responses
> A little more lead up time and we could have promoted the service being in town a little further.
> Make contact with school prior to school holidays.
> More frequent visits.
> More timely and better info re: service and what could be provided; some expectations were high.
> Visit on a regular timeline e.g. yearly. Converse with PHC staff and advertise with plenty of time.

4.5.2 Clients

Seven responses were received from clients of the service. Four respondents heard about the service through the school, one heard about it from a health service, one read about it in a flyer at the health centre, and one heard about it through community broadcasts of local daily news via email.

Table 4.8 shows the number of clients who agreed and disagreed with statements about the hearing screening service. Respondents predominantly disagreed that it was 'hard to get to see the CHW'. The majority of respondents agreed that: their concerns were listened to; they understood what each test was for, and what to do; the results were well explained; 'next steps' were clear and seemed reasonable; the CHW was professional and respectful; and they would recommend this hearing screening program to others.

Table 4.8 Number of clients who agree ('strongly agree' or 'agree') and disagree ('strongly disagree' or 'disagree') with statements about the hearing screening service (n=7)

Statements	Agree	Disagree
It was hard to get to see the CHW	1	6
My concerns were listened to	6	1
I understood what each test was for, and what to do	5	1
The results were well explained	5	1
'Next steps' were clear and seemed reasonable	5	1
The CHW was professional and respectful	6	1
I would recommend this hearing screening program to others	6	1
Additional client comments		
> It's amazing that we have these services brought to our town. It was a little difficult getting in to see the Hearing Worker, as she was sick and the hospital didn't seem to be able to help with when and where she was going to be.		
> I was experiencing pain and my fears were allayed. Each test was thoroughly explained to me. I was reassured and told I would be referred to Townsville. [The CHW] was polite, respectful, engaging and positive. I think this service should be advertised locally well in advance so that more people are aware of it.		

Note: 'Neither agree nor disagree' and 'can't comment on this one' responses are not shown.

Five clients made recommendations on what would make the service better (Table 4.9). Clients were also asked if there was anything they were unhappy about. All clients responded 'no' to this question.

Table 4.9 Client's 'recommendations for making the service better' (n=5)

Responses
> Opportunity for follow up conference with parents to further clarify/explain results or answer questions.
> Quicker following up times.
> Great service, thank you!
> No. I was very happy with the service. It is a great advance in remote health care. Happy to comment further or lobby for more funding. Thank you from [name removed].
> All seemed to work well for me—a very good encounter thanks!

4.5.3 RFDS and Australian Hearing staff

RFDS and Australian Hearing staff also provided feedback on the hearing screening trial. Including:

- Excellent opportunity to learn new skills, and build positive relationships with local communities and residents;
- Possible duplication of service where communities already have existing hearing services available, either locally or fly-in, fly-out;
- Where hearing deficits are identified, patients may face difficulties seeking further testing or clinical intervention due to remoteness;
- The need to identify suitable facilities (and amenities) to base the service from, within the community; this includes mechanisms to attract clientele to utilise the service;
- Lack of local community interest to engage with the offered hearing testing;
- Mismatch between demand and supply e.g. offering two weeks of hearing testing, and only one week's worth of clientele;
- Consideration as to which service (if applicable) the hearing program is paired with when travelling e.g. in Queensland, hearing worker travels with dental team, and demand for either service can be disproportionate; and
- Have established a positive working relationship between RFDS and Australian Hearing.

Throughout the trial, potential improvements to the service were suggested by clients and services, and noted by the CHW. These are presented in Table 4.10, and actions undertaken to facilitate the improvements are detailed.

Table 4.10 Improvements suggested and actions undertaken

Improvement suggested	Action
Consent forms completed by parents/carers did not initially include fields for contact phone numbers or for child's class. The absence of both of these put an additional burden on schools, when the CHW was required to ask them for this information retrospectively.	These fields were added to the consent forms completed by parents/carers and copied into the database.
The initial screening pathway for school-aged children was to have a hearScreen screening assessment first, with a progression to Sound Scouts assessment if they did not pass the hearScreen. Some parents thought their children were not hearing well, even if they passed hearScreen.	The screening pathway was amended to include 'parental concern about hearing' as an additional decision point for Sound Scouts assessment.
Better setting of services' expectations about the visit—schools and health services wanted additional information on what they needed to do to prepare for a visit by the CHW.	A one-page pre-visit fact sheet was designed to ensure that schools and health services were better informed and prepared for the visit. The fact sheet was attached to confirmatory emails sent to schools and health services prior to the visit by the CHW.
Better end of visit feedback and awareness-raising—schools and health services sought additional information informing them about resources they could access after the CHW visit.	A one-page 'What next?' fact sheet was developed to complement existing face-to-face conversations and inform health services and schools about resources they could make use of, including Sound Scouts for hearing assessments and Hearing Help for advice, following the visit.
Clients sought to be able to access the feedback survey in paper version and electronically.	The feedback survey for adult clients and for parents/carers of children was made available in electronic and paper form and the client could choose how to complete it.

4.6 Hearing awareness

One of the goals of the trial was to deliver formal hearing awareness sessions to service providers and community members to improve awareness of hearing loss as a serious health problem, and defuse the myths and facts about hearing loss.

The CHW identified that service providers in the trial communities had a good knowledge of hearing loss and hearing health. Consequently, formal hearing awareness training sessions were not delivered to service providers.

However, the RFDS and Australian Hearing developed a one-page pre-visit fact sheet to ensure that services such as schools and primary health services, that participated in the trial, had a good knowledge of hearing loss, and understood the role of the CHW. In addition, a brief one-page 'What next?' fact sheet was produced to complement existing face-to-face conversations, and to inform health services and schools about resources they could make use of, including Sound Scouts for hearing assessments and Hearing Help for advice, following the visit.

4.7 Cost of trial

Australian Hearing and the RFDS each contributed $75,000 to fund the trial. The funding covered the costs of the CHW salary (and oncosts), travel and accommodation, training, development of the CRM, and equipment.

During the 12 months of the trial, 819 hearing assessments were provided – the average cost, per occasion of service, was $183.15.

4.8 Summary of results

Table 4.11 summarises the results of the trial against the measures and outcomes proposed in Table 1.1. It demonstrates that the majority of proposed trial outcomes were achieved.

Table 4.11 Summary of results against proposed measures and outcomes

Measurement	Proposed outcomes	Outcome achieved	Comments
			Hearing screening
40–60 child or adult hearing screenings per rotation	Number of children and adults who had their hearing assessed by the CHW	Yes	> 13 rotations conducted. > 63 people per rotation had their hearing assessed—45 children and 18 adults, exceeding the goal of 40–60 hearing screenings per rotation.
	Number of children and adults who were identified with hearing outside the normal range	Yes	> 173 people were identified as having hearing outside the normal range—81 adults and 92 children.
	Uptake of HearScreen and Sound Scouts by health services and schools (estimation of number of times used)	Yes	> 690 people had a hearScreen assessment—211 adults and 479 children. > 100 people, all children, had a Sound Scouts assessment. All health services and schools employed this testing.
	Hearing satisfaction survey (adults only)–done prior to screening to assess patient readiness for amplification	Yes	> All adults (n=224, 100%) who underwent a screening assessment completed a hearing satisfaction survey. > Similarly, 522 parents/carers (88.3%) provided information regarding concerns about their child's hearing by completing the PEACH.
			Hearing awareness
5–10 instances of awareness-raising to service providers per visit	Number of episodes of hearing service awareness raising or training carried out by CHW, by location, nature and service type (school, health service)	Partial	> Informal hearing service awareness raising activities were conducted at all locations by the CHW.
	Number of formal and informal community-focussed awareness raising activities carried out by CHW, by location and topic	Partial	> Informal community-focussed awareness raising activities were conducted at all locations by the CHW.
	Health service and school perception of, and satisfaction with, service delivery model	Yes	> Responses received from 11 services. High levels of satisfaction demonstrated.
	Pre and post program questionnaire for health services and schools	Yes	
			Referrals
20–30 referrals to Australian	Number of adults wanting rehab audiology who are ineligible for hearing services	No	> No data available.
	Number of child and adult referrals to Australian Hearing	Yes	> 79 children received a referral to at least one service, 35 to Australian Hearing. > 81 adults received a referral to at least one service, 52 to Australian Hearing.

Measurement	Proposed outcomes	Outcome achieved	Comments
Hearing per visit	Number of child and adult referrals who go on to fittings	Yes	> Of 35 children referred to Australian Hearing, four were known to the service, and three of these were already aided. > In total, 18 of the 35 children (51.4%) referred were seen. > Three additional children were aided as a result of the referral from the RFDS program. > Of 52 adults referred to Australian Hearing, six were already clients of the service and four of these were already aided. > In total, 18 of the 52 adults (34.6%) referred were seen. > Aside from the four clients already aided, seven additional adults took up aid use as a result of the referral from the RFDS program.
	Time between receipt of referral and first appointment with Australian Hearing, compared to average time for these or similar communities in the region	Yes	> All referrals were actioned promptly. > The average wait time between referral by the RFDS program and first appointment with Australian Hearing was 37 days. > Clients were seen at a combination of locations—a permanent Hearing Centre, a visiting location, or through the Australian Hearing Outreach program, each of which had differing levels of availability. > For clients referred outside the RFDS program, the average wait time for an appointment at an Hearing Centre is two weeks, at a visiting site, one month, and at an Outreach site, up to three months.
	Aided client usage, satisfaction and benefit measures, including for quality of life	Yes	> Data were collected on aided client usage. 11 clients were current/former clients of Australian Hearing, two were currently aided.
	Client perception of, and satisfaction with, service delivery model	Yes	> Responses were received from seven clients. > High levels of satisfaction demonstrated.
	Modified PSQ or program specific questionnaire	Yes	

5.0 Discussion and Recommendations

The following section discusses the results of the RFDS and Australian Hearing trial and makes recommendations for future hearing screening services within the RFDS.

5.1 Service delivery and communities visited

The results demonstrated that the hearing screening service was delivered to residents in 27 Queensland towns through 41 different facilities, including through schools and health services.

Although people of all ages, from newborn to 91 years accessed the hearing screening service, the average age was 21 years and the median age was 10 years. The relatively young median age can be explained by the fact that a large proportion of hearing screening was conducted in schools or day care centres.

Specifically, there was good engagement from schools and day care centres with 23 participating in the hearing screening trial. This suggests that hearing screening services targeted to schools and day care centres in rural and remote Australia are likely to be well utilised, and that parents/carers support the provision of hearing screening services to children in their communities.

Likewise, hearing screening was accessed through other health and community facilities. People screened in these facilities tended to be older. Consequently, offering hearing screening services through a range of facilities is important as it facilitates service access for older people in rural and remote communities.

5.2 Hearing assessments

The service was accessed by 819 people (519 children and 224 adults) in the communities the CHW visited, and exceeded its goal of 40–60 hearing screenings per rotation. The service was well utilised and results suggest that people in rural and remote areas are willing to undergo hearing screening when services are offered in their local communities.

The combination of the use of otoscopy, tympanometry, hearScreen, Sound Scouts and OAEs enabled the CHW to identify people with a potential hearing or ear health problem. One in five people screened were referred to additional services for either formal audiometric testing or other care, indicating that the service played an important role in identifying people with potential hearing loss or related ear problems and provided timely referrals.

There is strong evidence that encouraging the inclusion of hearing checks as part of primary health care services, from childhood to older age, supports better identification of hearing issues across the lifespan [29]. However, population-based screening should not be conducted alone. It requires a co-ordinated approach encompassing prevention, treatment and management of ear health and hearing. Well-developed referral pathways, and access to appropriate services are required to support rural and remote people who are identified with potential ear health problems or hearing loss.

5.2.1 Self-reported or parental/carer reported hearing trouble

As part of the pre-screening questionnaire, adults were asked if they 'have hearing trouble'. Almost all (92.9%) adults who responded 'yes' to this question, and more than one-third who answered 'sometimes' to this question had hearing outside the normal range and received a referral for follow-up care, compared to 20.2% of who did not identify any issues with their hearing.

Similarly, parents/carers were asked if they had any 'concerns about their child's hearing' as part of the PEACH. The results demonstrated that more than one-third (35.4%) of children whose parents/carers had concerns about their child's hearing, had hearing outside the normal range and received a referral for follow-up care, compared to just 10.6% of children whose parents had no concerns.

These data suggest that self-reported and parental/carer reported perceived hearing loss, may be an easy, affordable and time-efficient method of identifying people who would benefit from additional audiometric testing, especially in a primary health care setting.

Previous research by Louw, Swanepoel and Eikelboom [30] demonstrated similar findings. However the researchers cautioned against using screening questions in isolation, as they may not be sufficiently sensitive to detect hearing loss [30]. Other research demonstrated similar findings, including that self-reported hearing loss questions were useful at helping to identify people with hearing loss, but that on their own, should not be regarded as a standard or recommended protocol to identify hearing loss [31].

While evidence indicates that self-report measures may assist in identifying people impacted by hearing loss, there is strong support for pairing self-report measures with user-friendly, affordable audiometry screening tools [30]. Tele-audiometry, which has recently emerged as a component of tele-audiology, is facilitating access to hearing screening for people in rural and remote communities who previously may not have had access to hearing screening services [32]. Tele-audiometry can be performed by people with minimal training using software installed on a computer [32]. hearScreen and Sound Scouts, which were used in the trial, are examples of tele-audiometry applications that are cost effective, user friendly screening tools. Other examples of potentially appropriate screening tools include the computer-based automatic audiometry screening tool (AutoAud), developed by the National Acoustic Laboratory (NAL) and being trialled by the RFDS, NAL and Australian Hearing in Broken Hill.

Screening tools that capitalise on technology and connectivity advances are emerging at a rapid rate, and these provide affordable and accessible models of service delivery for community-based hearing screening [28].

Considering the widespread prevalence of hearing loss and the limited access to hearing screening services in some areas, it is important that organisations such as the RFDS consider new and innovative methods of delivering services, that complement current service delivery methods.

5.3 Referral pathways

Hearing screening services need well developed referral pathways to enable people who are identified with potential ear health or hearing problems to access additional services. In the current trial, 81 adults and 79 children were identified with a potential ear health or hearing problem and were referred to primary health care services, Australian Hearing, or other services, depending on their needs. They were well supported to access these services by the CHW, who provided verbal follow-up, information sheets, and comprehensive reports. More than one-third of adults, and half of all children referred to Australian Hearing took up the referral. This resulted in an additional three children and seven adults receiving hearing aids.

In addition to well-developed referral pathways, people need to be able to access appropriate services. Poor access to specialist services can be a barrier to receiving care for people in rural and remote areas that are identified with an ear health or hearing problem. A systematic review of services available for children with hearing loss in regional, rural and remote Australia identified reduced quality and frequency of hearing services for this group compared with children in major cities [33]. The review highlighted a lack of qualified professionals, high workforce turnover, and poorer educational support for children identified with a hearing problem [33]. Additional barriers to receiving specialist care were identified and examples included: long travel distances to access care; loss of family income when parents/carers took time off work to drive their child to specialist appointments; increased costs associated with overnight accommodation when travelling long distances; extra costs associated with the need for a more reliable car; cultural barriers, especially for Indigenous Australians seeking culturally competent health providers; and poor communication between health care professionals and families with "families reporting the need for more timely information, more connection with other families and better communication between services" [33].

To overcome some of the barriers to accessing specialist services for people identified with potential ear health and hearing problems, research supports the implementation of innovative service models. Examples include:

- Tele-consultations with specialist audiologists. In the current trial, clients were offered the opportunity to have a tele-consult with an Australian Hearing audiologist in a major city. This could be done from their local primary health care facility or from their home, reducing the need to travel for specialist services;
- Accessing Hearing Help, Australian Hearing's free tele-support line. In the current trial, clients were encouraged to make use of Hearing Help and were provided with details about the service. Hearing Help is an online audiology support service which people can use to:
  - Call or live chat with an accredited hearing specialist;
  - Use self-help tools to identify hearing loss;
  - Order a free sample hearing aid; and
  - Get hearing advice and tips [34];
- Delivering specialist hearing interventions via tele-medicine, such as videoconferencing. For example, a speech-language pathology telehealth program, called 'Come N See,' was delivered to children attending schools in rural and remote New South Wales. The program provided therapy interventions remotely, via low-bandwidth videoconferencing, with email follow-up [35]. Over a 12-week period, children were offered therapy blocks of six fortnightly sessions, each lasting a maximum of 30 minutes[35]. The service was feasible and acceptable and improved the speech and language skills of children who participated [36];
- Integrated models of service delivery. For example, a mobile ear-screening service was established in South Burnett in 2009—an Indigenous Health Worker assessed children at a local school and shared results by tele-medicine with ENT specialists [37]. These specialists provided review and biannual surgical outreach to the community [37]. Results indicated that community-based screening, integrated with specialist ENT services may improve ear and hearing health [37]; and
- Outreach services. This involves specialist services visiting communities with high levels of ear health and hearing problems on a regular basis to improve outcomes for people in these communities.

5.4 Feedback

Feedback was received from schools and health services, clients and RFDS and Australian Hearing staff.

When all feedback was considered, several benefits to providing hearing screening were identified in the trial, including:

- Improved access hearing screening and ear health services for people who would not normally have access to these services;
- Prompt identification of clients with potential hearing loss;
- Timely provision of referrals to appropriate services;
- Improved patient satisfaction;
- Improved collaboration between Australian Hearing and the RFDS; and
- Enhanced community acceptance.

It should be noted that only small numbers of people provided feedback regarding the trial, Therefore, results should be interpreted with caution as they may not be representative.

5.4.1 Schools and health services

When schools and health services were asked their perceptions around the degree to which their communities were served by hearing services, there was a range of responses. However, the majority of respondents thought that their communities were either 'not very well served' or 'not at all served' by hearing services. This was further supported by responses from schools and services to the post-visit survey. Specifically, all respondents (100%) agreed that the 'service meets a need in our community' and 'people responded positively to the RFDS/Australian Hearing hearing service.' One service indicated that 'it provided a much-needed service to our community, particularly for children.' This suggests that the towns visited during the trial were in need of hearing screening services and that the trial appropriately targeted rural and remote Queensland towns. However, as this was an opportunistic trial, in that the CHW travelled with the MDU, a community needs analysis should be conducted prior to the implementation of future screening services by the RFDS to ensure a demand driven service is provided.

Feedback about the CHW and the hearing screening service was overwhelmingly positive. Two areas for improvement included; ensuring any future hearing screening service confirms visits to schools and services in in a timely manner; and that staff involved in delivering the hearing screening ensure that they comprehensively discuss results and recommendations with clients. Schools and health services would also value more frequent visits on a regular basis.

5.4.2 Clients

Seven clients also provided positive feedback about the service. Responses indicated strong support for the service and the CHW. For example, one client commented that 'I was experiencing pain and my fears were allayed. Each test was thoroughly explained to me. I was reassured and told I would be referred to Townsville. [The CHW] was polite, respectful, engaging and positive. I think this service should be advertised locally well in advance so that more people are aware of it.'

Clients recommended that follow-up conferences with parents should be held to further clarify results.

5.4.3 RFDS and Australian Hearing staff

Feedback from RFDS and Australian Hearing staff regarding the perceived benefits and limitations of the service was collected. Benefits were related to the opportunity for staff to learn new skills and to forge positive working relationships with local communities and residents. Another benefit included the establishment of a positive working relationships between the RFDS and Australian Hearing.

Some of the limitations that were identified related to concerns about the duplication of the service and a mismatch between supply and demand for the CHW's time. In some towns, other hearing agencies, both privately and publicly funded, were also providing visiting services. The majority of these were targeted towards children. This meant that some schools chose not to participate in the trial.

These findings around duplication are interesting and contrast with responses received from services and schools, and clients, who identified a strong need for screening in their communities. 20% of clients who were screened received a referral to another service, supporting the need for screening and referral services in the communities the CHW visited.

One way to ensure that future hearing screening services are based on need is to conduct a needs assessment of proposed towns prior to delivering the service. It is also pertinent to consider whether future hearing screening services should be paired with existing services, such as the MDU, or whether a stand-alone, or other, service model would be more appropriate.

Several improvements to the service were identified by RFDS and Australian Hearing staff, services and clients and these were presented in Table 4.10. These improvements were addressed by RFDS and Australian Hearing staff during the trial in order to ensure ongoing quality improvement of the service. The improvements resulted in the development of additional collateral including the development of a one-page pre-visit fact sheet for schools and health services and a one-page 'What next?" document for clients and services. Modifications to consent forms and screening pathways also occurred.

The actions implemented in response to suggested improvements indicate that Australian Hearing and the RFDS were responsive to the needs of service users, and willing to implement changes to improve the hearing screening experience.

5.5 Hearing awareness

No formal hearing awareness raising sessions were delivered by the CHW, despite this being one of the intended outcomes of the trial.

There appeared to be a lack of appetite for formal education and awareness-raising around hearing loss identification and hearing services in the towns visited by the MDU. Despite the lack of formal hearing awareness sessions, the CHW discussed hearing awareness with schools and health services, and clients, on an individual basis. The CHW also developed additional information sheets about hearing awareness and provided these to all trial participants.

Another barrier to conducting formal hearing awareness raising sessions was that there were insufficient staff to conduct sessions. Only one CHW was employed in the trial and she was primarily engaged in completing hearing screening assessments, and producing client reports. Her screening workload prevented her from delivering formal hearing awareness raising sessions.

In addition, the RFDS and Australian Hearing did not develop a tangible and practical hearing awareness program for the CHW to deliver.

Any future hearing screening service that wishes to incorporate hearing awareness sessions should review the literature to identify the barriers to delivering these sessions and develop tangible and practical ways in which this could be achieved within the available resources.

5.6 Cost of the trial

The hearing screening trial was delivered in tandem with dental services provided by the MDU. The hearing screening trial leveraged existing infrastructure (travel) and resources (management), thus avoiding duplicating some of the costs associated with service delivery. By utilising the existing public and charitable funded outreach of the RFDS, it achieved the objective of increasing uptake of hearing screening at a proportionally lower cost than if the service was delivered in isolation.

The actual cost of the trial was $150,000, and this cost was met equally by funding from RFDS and Australian Hearing. This cost incorporated the CHW salary and oncosts, travel additional to that provided by the MDU, accommodation, equipment, and development of the database used to collect client data.

When the total cost of the trial was divided by the number of clients that accessed the service, the cost per hearing screening assessment was $183.15.

It is difficult to compare the cost of the trial with other hearing services, without knowing exactly what each service provides in terms of hearing assessment. In Australia, many providers offer free hearing tests for adults and children, including Australian Hearing. Some commercial hearing clinics offer free tests while other charge a fee.

However, price benchmarking of a range of hearing services was undertaken in 2017 [38]. The benchmarking identified the average hourly cost of conducting hearing assessments in the 2016–17 financial year, by different service providers (Table 5.1). The hourly cost of hearing assessments ranged from $138.00 for the Commonwealth Government's Voucher Scheme (VS) to $186.75 for the Medical Benefits Schedule (MBS). The VS is part of the Hearing Support Program (HSP) that provides eligible Australians with access to hearing services. These services aim to reduce the incidence and consequences of hearing loss in the Australian community by facilitating access to hearing services and devices [38]. Eligible clients are able to access government subsidised hearing services through the VS or the Community Services Obligation (CSO) [38]. Each of the schemes have eligibility criteria and offer different levels of support for hearing screening assessment; fitting; rehabilitation; audiological case management; and maintenance[38]. Clients are also able to access fully or partially subsidised assisted hearing technologies (e.g. hearing aids), and implantable technology (such as cochlear implants), accessories (e.g. batteries), and associated services (e.g. repairs) [38].

Table 5.1. Price benchmarking of hearing assessments, 2016–17, average price per hour (excluding GST)

Program	Cost per hour
VS	$138.00
State-based workers' compensation schemes (average)	$182.16
MBS	$186.75
Private market (average)	$171.27
National Disability Insurance Scheme (NDIS) (maximum cost per hour)	$175.57

Source: Adapted from PricewaterhouseCoopers Australia [38]. Comprises data from Department of Health, NDIS, multiple state-based workers' compensation schemes, and PricewaterhouseCoopers analysis. Note caveats in PricewaterhouseCoopers Australia [38].

More broadly, it is possible to extrapolate costs of hearing services that have been provided in Australia. These should not be compared with the costs incurred in the current trial, as each service provider delivered a range of different services to a variety of clients. However, they provide interesting data on costs associated with hearing loss, and incorporate hearing assessment, other diagnostic tests, ongoing support, and provision and maintenance of devices such as hearing aids, as well as other assisted technologies.

In 2015–16, 752,905 clients accessed hearing support through the HSP [38]. The total cost of the scheme was $479.5 million, with an average service cost of $636.90 per client (extrapolated from 38).

5.7 Future service models

One of the outcomes of this evaluation was to identify potential options for the national deployment of a hearing screening program for the RFDS.

To achieve this, it is important to review the types of hearing screening services currently provided in Australia, and the service delivery models employed to ensure these are not duplicated in areas where they are already provided. Examples include:

- Universal neonatal hearing screening: Universal newborn hearing screening programs are conducted in all Australian states and territories. All babies greater than 34 weeks gestation are screened within 24 to 72 hours of birth with an aim to complete screening by four weeks corrected age [39];
- 'Healthy Kids' check: Hearing screening is one part of this check which is conducted in a primary health care setting with pre-school children aged around four years.
- School hearing screening programs: Delivered in schools, these programs aim to screen as many children as possible and to provide timely referral to audiometric screening services and other service providers for children identified with hearing problems;
- Occupational hearing conservation programs: These programs are developed to prevent the occurrence of noise-induced hearing loss or to reduce its progression;
- Ear health programs such as otitis media surveillance;
- Ear and hearing education programs; and
- Noise education and awareness programs.

Research has demonstrated that hearing screening is a valuable method of identifying people who may benefit from a full audiometric evaluation [6]. Rather than recommend a best practice hearing screening service, the evidence suggests that there are several principles that should be employed when conducting hearing screening. These principles should be implemented by the RFDS in any future service development model. Screening tests should be:

- Able to provide a reasonable assessment of risk for a disease or disorder to limit unnecessary referrals and missed cases;
- Easy and quick to administer;
- Reproducible;
- Minimally invasive and not cause harm;
- Inexpensive;
- Free of stigma;
- Culturally appropriate;
- Age appropriate;
- Appropriate to the community in which they are conducted [6].

Additional principles, arising from the trial, should also be considered when designing future hearing screening services for the RFDS, including:

- If working with partner organisations, all stakeholders need to be committed to delivering the program or program expansion;
- Any model should be reviewed within three months of implementation to ensure the correct communities are receiving the required hearing services;
- Appropriate referral processes and protocols, and well-developed referral pathways are required to facilitate a diagnostic audiology assessment or other appropriate care;
- Staff delivering the screening should be trained in the screening tool/s being used;
- Consent should be obtained from parents/carers of children prior to services being delivered to them;
- Appropriate materials regarding hearing health and hearing loss should be developed and provided to clients as part of the service;
- Building and maintaining the capacity of primary health care in Aboriginal Community Controlled Health Organisations (ACCHOs) to provide effective assessment, referral and follow up; and
- Involving local communities in the development of hearing screening services to match community needs, where possible.

6.0 Conclusion

The Queensland Section of the RFDS collaborated with Australian Hearing to develop, and deliver, hearing screening services to rural and remote residents in 27 Queensland towns between 1 August 2017 and 31 July 2018.

The hearing screening service was paired with the RFDS MDU and took advantage of the existing RFDS travel, management, brand, clinical governance and community engagement platforms.

During this trial, the CHW conducted hearing assessments with 819 people. One in five people were identified with hearing outside of the normal range and were referred to additional services for medical management, further audiometric testing or specialist services. Clients were mainly referred to Australian Hearing, PHC or other services, such as ear nose and throat specialists.

The trial achieved, and exceeded, its aims around screening clients, providing timely referrals, and uptake of referrals. It also achieved the objective of increasing uptake of hearing screening at a proportionally lower cost than if the service was delivered in isolation, by utilising the existing public and charitable funded outreach of the RFDS MDU. Although it did not specifically achieve the aim of conducting formal hearing awareness sessions, there were practical reasons why this did not occur. These reasons included poor appetite for formal sessions in towns visited and a high screening workload that prevented the CHW from delivering formal hearing awareness raising sessions. Any future hearing screening service that wishes to incorporate hearing awareness sessions should develop tangible and practical ways in which this could be achieved within the available resources.

Analysis of the data indicated that self-reported and parental/carer reported perceived hearing loss, paired with user-friendly, affordable audiometry screening tools, such as hearScreen, is an easy, affordable and time-efficient method of identifying people who would benefit from additional audiometric testing, especially in a PHC setting. By following the principles described the previous chapter, the RFDS is well placed to develop hearing screening services that could be adopted nationally.

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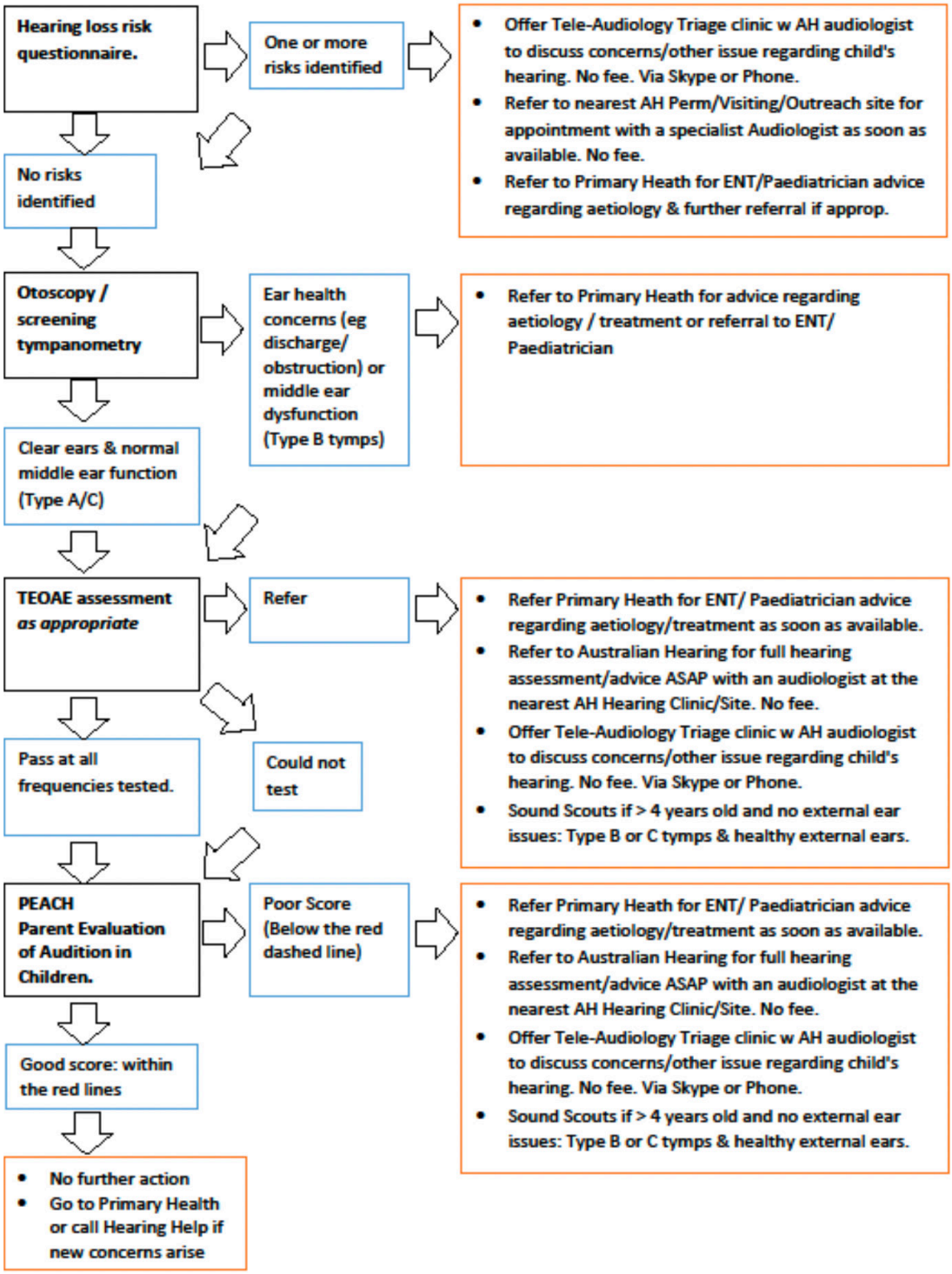
Appendix 1. Australian Hearing and RFDS hearing screening clinical pathways, 0–5-year-olds

AH/RFDS Hearing Screening Clinical Pathways

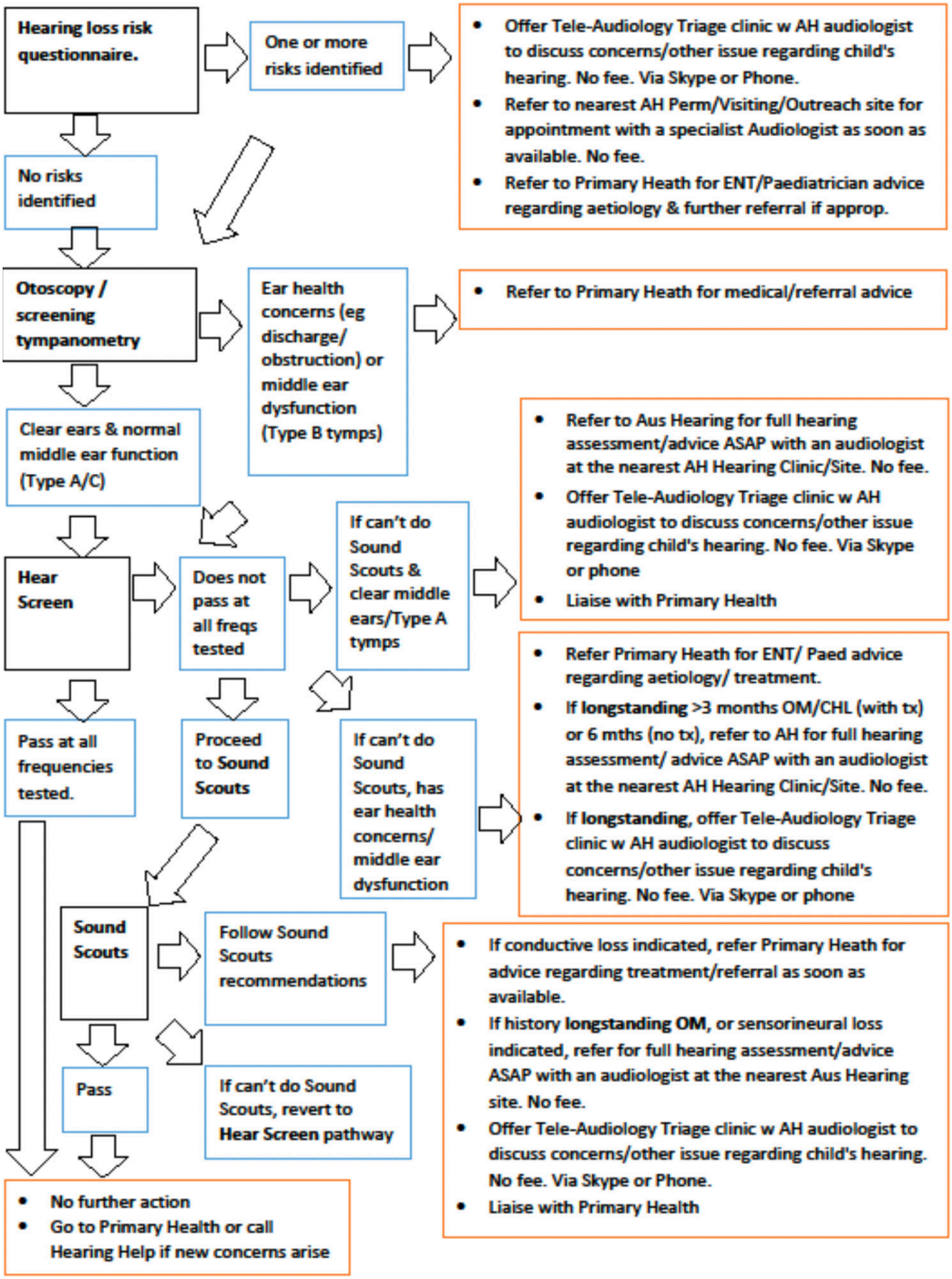
0-5 year olds



Appendix 2. Australian Hearing and RFDS hearing screening clinical pathways, 5–12-year-olds

AH/RFDS Hearing Screening Clinical Pathways

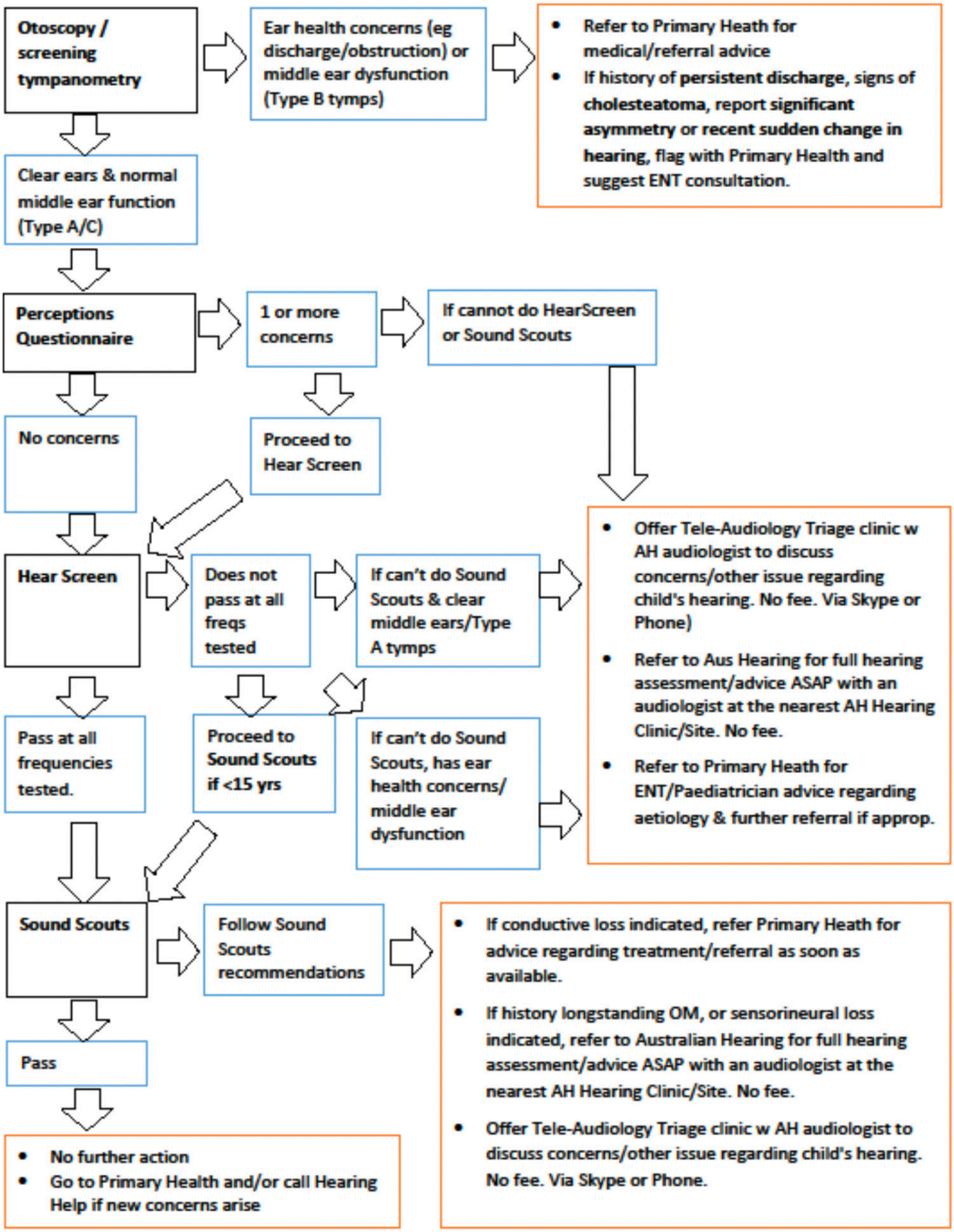
5-12 year olds



Appendix 3. Australian Hearing and RFDS hearing screening clinical pathways, 12–26-year-olds

AH/RFDS Hearing Screening Clinical Pathways

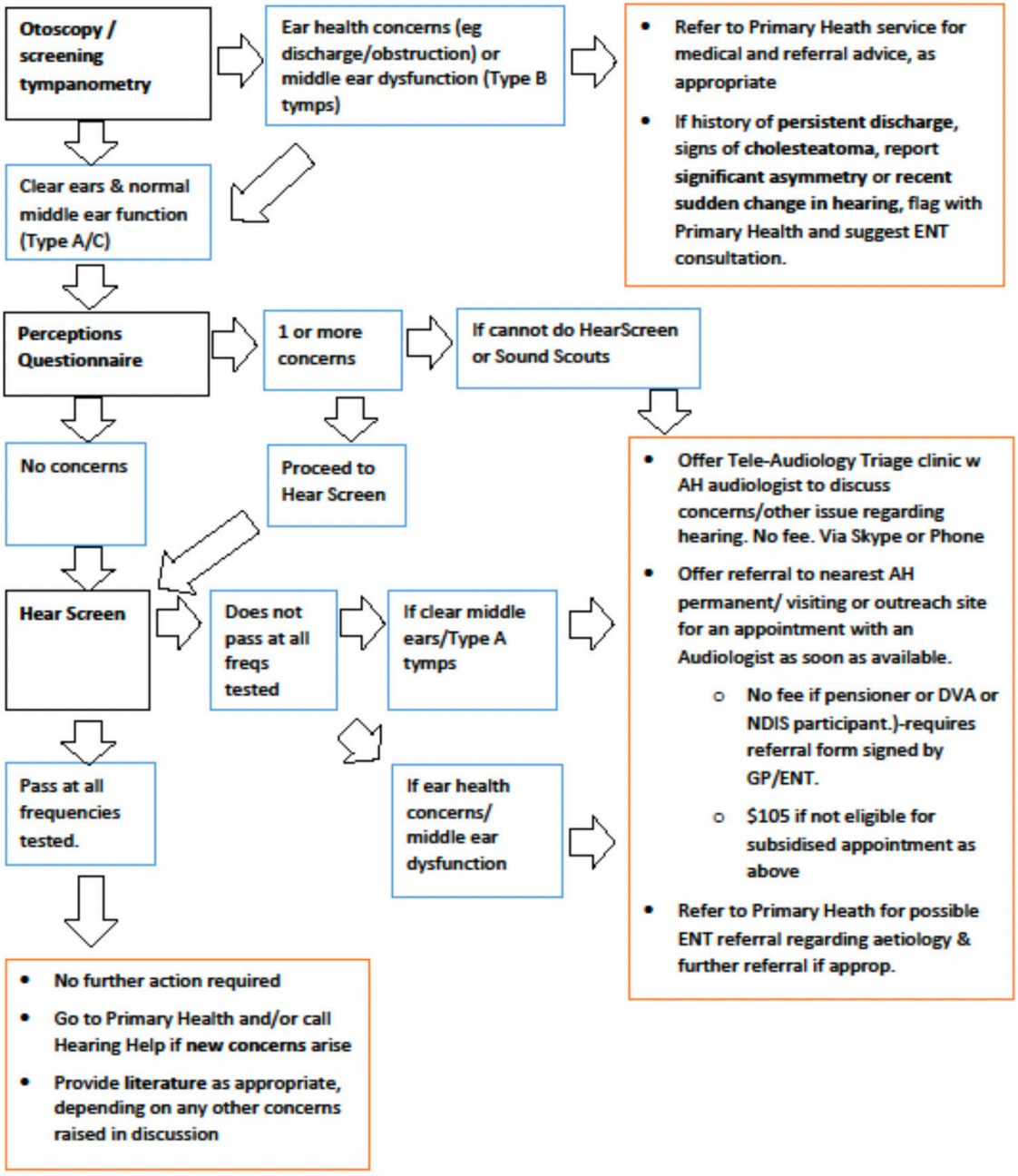
12-26 year olds



Appendix 4. Australian Hearing and RFDS hearing screening clinical pathways, over 26-year-olds

AH/RFDS Hearing Screening Clinical Pathways

Over 26 year olds



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