Audiometry Nurses Association of Australia Inc.

AUDIOMETRY NURSING CLINICAL PRACTICE STANDARDS

2021

AUDIOMETRY NURSING CLINICAL PRACTICE STANDARDS

TABLE OF CONTENTS **PAGE**

SECTION 1: INTRODUCTION

These Clinical Practice Standards are designed for use by nurses who have attained post graduate qualifications in Audiometry Nursing, and whose aim is to improve the health and wellbeing of children and adults who are affected by hearing health issues.

Hearing loss is categorised into two main forms – conductive hearing loss and sensorineural hearing loss.

Sensorineural hearing loss is caused by conditions associated with the inner ear or central auditory pathway and can occur at any age due to a variety of conditions. For example: illness, trauma, age or congenital factors.

According to the international literature, moderate to profound (>40 dB) bilateral permanent childhood hearing impairment (PCHI) occurs in 1.3 per 1,000 babies. Unilateral PCHI of similar severity occurs in 0.6 per 1,000 babies[1]. According to the Australian Bureau of statistics in 2018 there were 315 147 births in Australia[2]. This suggests that, each year in Australia, approximately 409 children are born with bilateral PCHI, and 189 children are born with unilateral moderate to profound PCHI. This is a total of 598 children each year.

All States and Territories in Australia have a Universal Newborn Hearing Screening (UNHS) program. This provides babies with a hearing screen at birth, further referral if required and a diagnosed hearing loss within a few weeks of birth. There is then opportunity for early intervention to assist in the development of speech and language. Many children who pass the UNHS may have identified risk factors for progressive hearing loss and should have their hearing regularly monitored[3].

Conductive hearing loss has a variety of causes and it has been recognised that at least 50% of all children will develop at least one episode of otitis media during their childhood, with many of these children developing chronic hearing problems. There is a significantly greater prevalence of otitis media among indigenous children in Australia[4]. It should be noted that conductive hearing loss is often the result of a disorder of the outer or middle ear. For example: Eustachian tube dysfunction, microtia, otitis media, ossicular disruption, cholesteatoma, etc. Early identification and management of hearing loss in childhood is necessary to enable children to achieve optimum speech and language development, learning and social skills.

It has been acknowledged that Aboriginal and Torres Strait Islander populations are susceptible to an increased incidence of otitis media, therefore reference should be made to the 'Otitis Media Guidelines'[5] and 'Chronic Otitis Media and Hearing Loss Practice'[6] in relation to prevention, assessment and management of this condition.

There are many adults in the community who require hearing assessments due to illness or injury, and who are not eligible for services subsidised by the Australian Government Hearing Services Program[7]. These clients can access hearing services through community health centres or private Audiologists / Audiometrists.

Audiometry Nurses are Registered / Enrolled Nurses who have undertaken post graduate qualifications that enable them to provide comprehensive hearing assessment and management of hearing disorders. They are generally employed within and provide hearing services through community health centres, however may be employed in medical practices or private audiology clinics.[8]

These Clinical Practice Standards are intended for use by Audiometry Nurses to support their clinical practice.

USE OF THE STANDARDS

The standards are intended for use by both novice and expert qualified Audiometry Nurses to complement their knowledge and expertise. Examples of scenarios and clinical pathways are provided for management of a variety of common conditions.

REVISION HISTORY

Clinical Practice Guidelines for Nurse Audiometrists	2004
Clinical Practice Guidelines for Nurse Audiometrists	revised 2007
Audiometry Nursing Clinical Practice Standards	revised 2012
Audiometry Nursing Clinical Practice Standards	revised 2015
Audiometry Nursing Clinical Practice Standards	revised 2021

1a: MAINTENANCE of PROFESSIONAL STANDARDS

Clinical Practice Standards should be maintained by Audiometry Nurses and can be attained by observing the following:

- Current registration with the Nursing Midwifery Board of Australia (Australian Health Practitioners Regulation Authority - AHPRA)[9] as a Registered / Enrolled Nurse, and hold a recognised post graduate qualification in Audiometry Nursing
- Membership of the Audiometry Nurses Association of Australia Inc. (ANAA Inc.), the professional organisation for audiometry nurses[10]
- Conduct regular hearing clinics. A minimum of 8 hours clinical practice in audiometry nursing per month is recommended
- It is recommended that clinicians should schedule approximately 1 hour appointments to complete a full diagnostic hearing assessment including comprehensive history, otoscopy, tympanometry, audiometry, appropriate documentation, cleaning and planning of appropriate management
- Where the clinician has been absent from audiometry nursing practice for more than 12 months, a review of clinical skills in audiometry should be undertaken with a clinical senior (e.g. CNC, CNS, or Clinical Advisor in Audiometry). Ongoing clinical supervision may be required until skill levels meet current standards of professional practice
- Maintain currency of practice by attending the ANAA Inc. annual conference at least every 3 years, and / or other relevant professional development in hearing health. Ensure 20 hours of CPD points accrued annually as part of registration requirements.
- Maintain accreditation as a Clinical Advisor for student Audiometry Nurses by participating in the Clinical Advisor in Audiometry Nursing workshop every 3 years (held in conjunction with the ANAA Inc. annual conference). Ensure recency of practice by performing regular Audiometry clinics, maintaining skills and using evidence based practice. Clinical Advisors in Audiometry

Nursing are recommended but not mandated to complete Cert IV TAE40116 (Training and Assessment) or equivalent

- Practicing audiometry nurses should participate in a clinical review with a clinical senior in audiometry nursing, at least once every three (3) years

1b: INFECTION CONTROL

Local, State and Territory health service policies[11] should be observed in relation to infection control, and manufacturer's equipment guidelines should be observed in relation to cleaning, care and replacement of all re-useable and disposable items.

Otoscope specula are usually single use and therefore disposable. Disposable tympanometer tips are also recommended. If otherwise stated, clean as per manufacturer's guidelines or local policies. Note: where re-usable items are suspected to be contaminated they should be disposed of.

Items such as headphones / headbands, bone conductors and response buttons should be wiped with alcohol free detergent wipes after each client use or as recommended by health service policy and/or manufacturers guidelines.

The 5 moments of hand hygiene are to be performed to minimise the spread of infection between clinician and client.[12]

SECTION 2: HISTORY TAKING

Prior to each assessment a comprehensive client history should be undertaken. Using the approved Audiometry History form[13] as a guide, client history is intended to flag risk factors for hearing loss and should include information on the following:

- Reason for referral
- Presenting issues, including but not limited to: suspicion of hearing loss and duration; fullness; pain; discharge; dizziness; mouth breathing; snoring; asthma; allergies; nasal congestion; excessive headaches; impact of loud noise; tinnitus; exposure to environmental tobacco smoke; ability of child to blow nose, noise exposure, risk factors for progressive hearing loss, pre and post op ENT assessment, ototoxic medication, etc.
- Current health status

History taken at the initial consultation should also include the following information:

For a child:

- Pregnancy, birth and post-natal health information
- Outcome of newborn hearing screening
- Family history of hearing loss

- Speech and language development
- General health and development noting particular risk factors
- History of ear disease
- Behavioural concerns
- Medications past and current
- Infectious diseases and immunisation history
- Previous hearing assessments and outcomes
- Previous Ear Nose and Throat specialist consultations and outcomes
- School performance, learning issues
- Parental/Carer concerns

For an adult:

- Family history of hearing loss or deafness
- General health
- Medications past and present
- History of severe head injuries
    - History of noise exposure including type of noise, type of hearing protection used in the past or currently
    - Previous hearing assessments and outcomes
    - Previous Ear Nose and Throat specialist consultations and outcomes
    - Previously prescribed hearing aids and if worn
    - Noted hearing problems including difficulty hearing the TV, phone, at meetings, in a car, in groups, generally, feeling that people mumble, smoker. Client/carer consent should be obtained for the hearing service to provide copies of the hearing assessment report to relevant agents e.g.: GP, ENT, school, etc. and form signed and dated by the attending clinician.

SECTION 3: OTOSCOPY

PURPOSE:

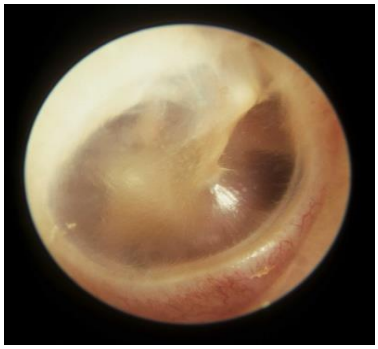
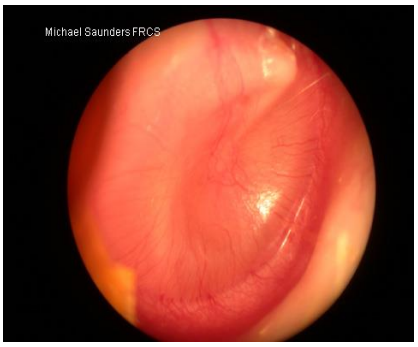
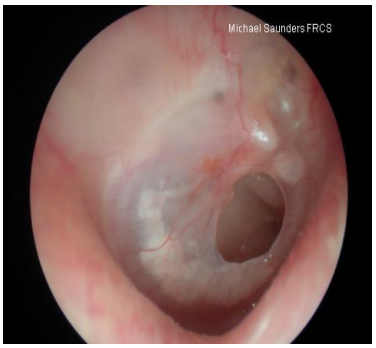
To visualize the integrity of the ear canal and tympanic membrane to assist in the identification of ear disorders and their management. Identification of the landmarks of the normal tympanic membrane is to be attempted. Consideration given to identifying the integrity, colour, presence of discharge, wax, ventilating tube or foreign body.[14] [15] [16]

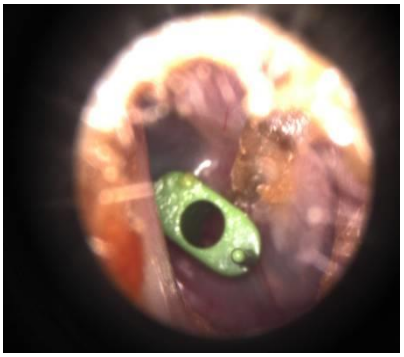
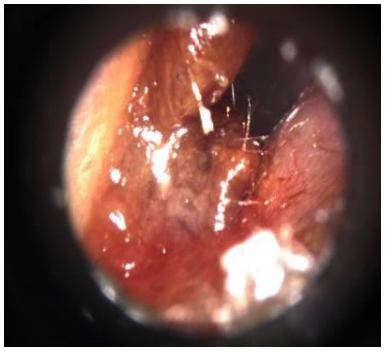
OTOSCOPIC EXAMINATION:

- Explanation of procedure to client / carer in age appropriate manner
- Ensure otoscope light source adequate i.e.: clear, bright light and adequate magnification
- Select appropriate sized speculum
- Note any anomalies of pinna or other craniofacial anomalies
- Hold pinna in a manner that enables the best view of the tympanic membrane and ear canal without causing discomfort
- Rest the side of your hand against client's cheek when introducing the speculum to reduce the risk of trauma should there be sudden head movement
- Check ear canal for wax, foreign body (including grommet) or other abnormalities
- Note colour, integrity and location of landmarks of the tympanic membrane, and any abnormalities such as scarring (tympanosclerosis)
- If discharge / infection present, discard and replace speculum before introducing into opposite ear
- Record findings on approved Audiometry Report Form

OTOSCOPY EXAMPLES

Some examples of more common conditions that may be seen on otoscopy are included below[17]:

 Normal (right) tympanic membrane	 Otitis externa
 Retracted tympanic membrane	 Grommet / ventilating tube in situ
 Acute otitis media. Inflamed, full tympanic membrane	 Dry / safe perforation of tympanic membrane at 4 o'clock

 Foreign body in canal	 Long term grommet
 Cholesteatoma	 Wax in canal
 Pus filled middle ear	 Exostosis

SECTION 4: TYMPANOMETRY

Overview:

Tympanometry is the measurement of middle ear pressure and the compliance and impedance of the tympanic membrane (TM) when variable air pressures are introduced into the ear canal.[18] [19] The inclusion of tympanometry to the hearing assessment protocol compliments the overall objectives of a hearing assessment. (i.e. visual inspection, hearing thresholds, middle ear function and acoustic reflexes).

There is growing evidence that associates a connection between hearing impairment caused by middle ear disease and delays in the development of speech, language and cognitive skills in children.[20] Tympanometry is very useful to assist identification of otitis media with effusion (OME), which has the potential to cause a conductive hearing loss, as well as the detection of other medically related conditions of the middle ear.

Tympanic mobility in children over 6 months of age and adults is measured using a low frequency 226Hz probe tone, and children under 6 months using a high frequency 1000Hz probe tone[21] [22](note that this may vary with the equipment used therefore it is recommended that manufacturers guidelines be followed).

Purpose:

Assess middle ear function to assist in determining status of middle ear. Tympanometry forms one part of a hearing assessment, and should be interpreted in conjunction with otoscopy and audiometry.

Essentially, it is measuring:

- The mobility (compliance) or immobility (impedance) of the tympanic membrane
- The air pressure in the middle ear cavity in relation to the air pressure of the external ear known as 'middle ear pressure' (MEP)
- The amount of air between the probe tip of the tympanometer, and the tympanic membrane, or middle ear cavity. This is known as the 'physical volume' (PV) or 'ear canal volume' (ECV)

Note that different types of tympanometers will have different ways of expressing the above. Refer to the manufacturer's guidelines for interpretation of tympanometry results for each instrument.

Tympanometry should include the measurement of acoustic reflexes (refer to section 4c).

4a: PROCESS

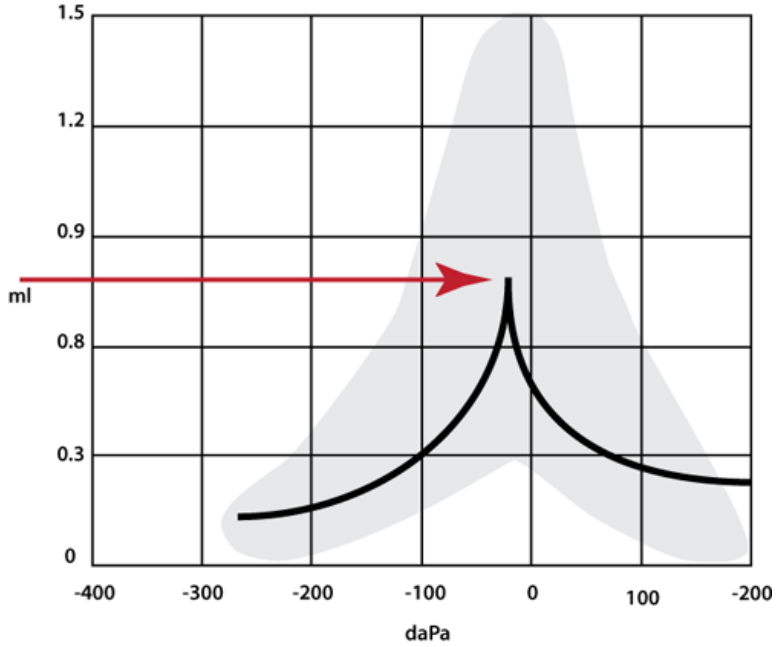
- Complete calibration of tympanometer at beginning of each clinic day as per manufacturers operating manual.
- Explain procedure to client in an age appropriate manner
- Select appropriate sized ear probe tip
- Instruct carer/client that client needs to sit as quietly and as still as possible during this brief procedure
- Position tympanometer probe at entrance to ear canal so it is directed towards the tympanic membrane along the angle of the ear canal. Ensure a seal is obtained
- Complete test (as per operating manual for type of tympanometer in use). Test RIGHT ear first, however if one ear is discharging, test the non-discharging ear first. (Note that a clinical decision should be made as to whether it is medically appropriate to complete tympanometry on a discharging ear)
- Even when the tympanometer has a printer option available, it is useful to plot results onto the tympanogram on audiometry report form. When manually plotting tympanogram onto graph, ensure that the shape of the graph is plotted as close as possible to that recorded on tympanometer and that any variance in the normal range of physical volume (PV), or ear canal volume (ECV) is noted.
- Record results in appropriate section on report form, including acoustic reflexes and note if the reflexes are contralateral or ipsilateral
- Reporting of results should include interpretation of compliance and middle ear pressure. Physical volume does not require comment unless it is outside the normal values (see examples below)

4b: TYMPANOMETRY EXAMPLES: Interpretation and Reporting

Note that normal values may vary slightly depending on the suggested parameters of the individual instrument. The values described in these standards are a guide. When reporting on tympanogram results, it may also be useful to note the **shape** of the tympanogram as well as the actual values.

The following examples are of the three most common variations in tympanometry, however it is important to note other variations.

Example A: NORMAL TYMPANOGRAM (TYPE A)[23]



Normal values[24]:

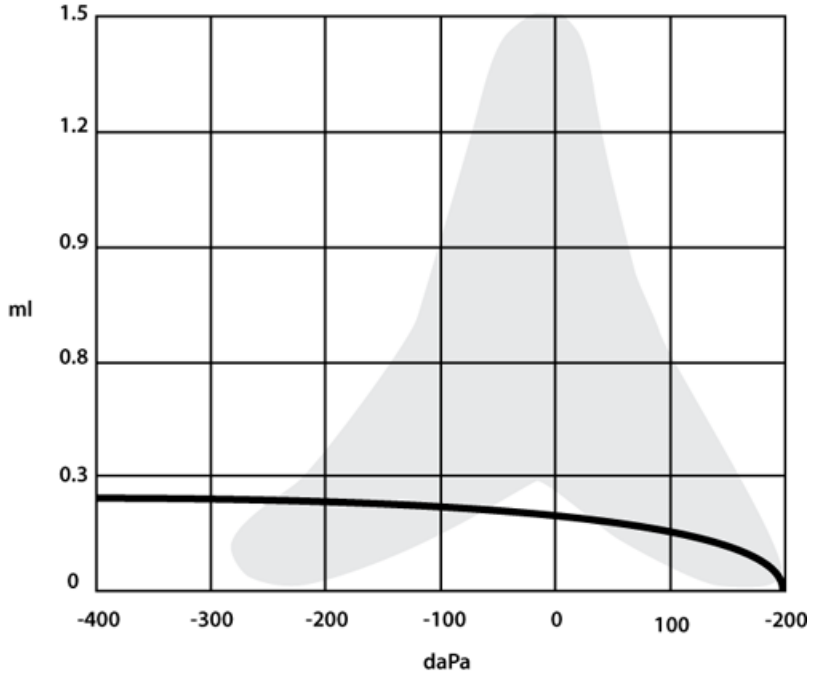
Middle ear pressure (MEP)	+50 daPa to -50 daPa in adults +50 daPa to -200 daPa in children
Physical Volume (PV) or Ear canal volume (ECV)	0.6ml to 1.5mls for adults 0.4ml to 1.0 ml in children
Compliance	0.3 to 1.6 ml adults 0.2 ml lower limit in children > 6 months and <6 years.

Supposition

This is a normal (or type A) tympanogram. It is not expected that there would be any associated middle ear pathology with this. A description of this tympanogram would be as follows:

'Normal compliance and middle ear pressure, shape consistent with normal middle ear function'.

Example B: FLAT TYMPANOGRAM, LOW COMPLIANCE (TYPE B)[25]



Values for type B tympanogram[26]:

Middle ear pressure (MEP):	? or NP
Compliance (Comp):	< 0.2ml
Physical volume (PV) or Ear canal volume (ECV)	Normal when tympanic membrane is intact. Often > 2.5ml if tympanic membrane not intact.

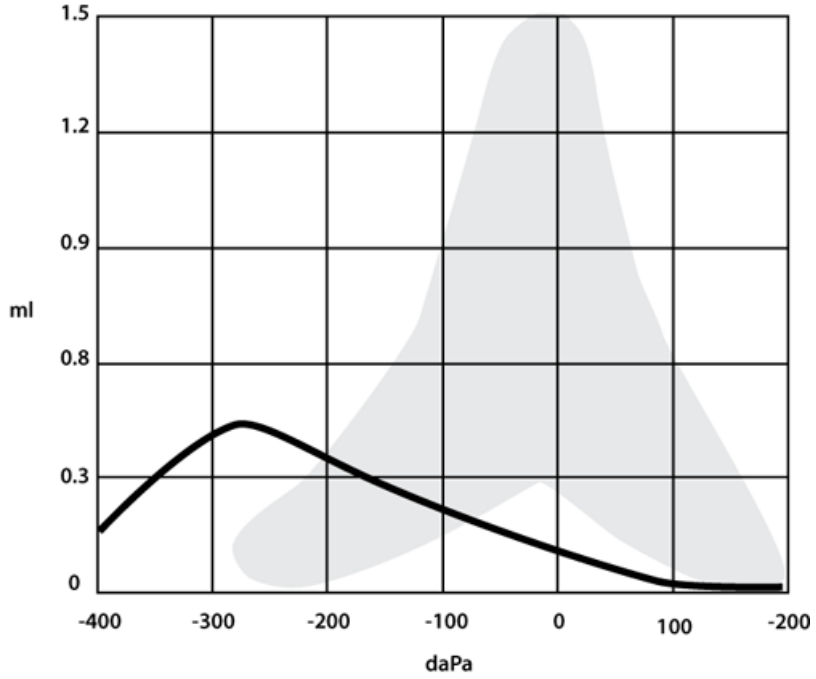
Supposition:

This is a classic 'flat' (or type B) tympanogram. Some pathologies associated with this shape and values may include the following:

Middle ear effusion, thickened tympanic membrane, patent ventilation tube or perforation (if the PV is increased). Note there is no readable peak on this tympanogram, hence the '?' or 'NP'.

Examples of descriptors for this type of tympanogram may be as follows:
'Minimal/reduced/nil compliance, shape consistent with middle ear pathology/effusion'
'Increased physical volume, consistent with patent ventilation tubes/perforation'

EXAMPLE C: INCREASED NEGATIVE MIDDLE EAR PRESSURE (TYPE C)[27]



Values for a type C tympanogram[28].

Middle ear pressure (MEP):	−100 daPa or greater (up to −200 daPa is accepted as normal in young children, depending on the tympanometer used)
Compliance (Comp):	> 0.2ml
Physical volume (PV) or Ear canal volume (ECV)	0.6ml to 1.5mls for adults 0.4ml to 1.0 ml in children

Supposition:

This is a classic type C tympanogram. The peaked negative middle ear pressure is indicative of Eustachian tube dysfunction. Note that a rounded tympanogram with a negative pressure may indicate a higher probability of resolving or evolving effusion.

A typical descriptor of this tympanogram may be:

'Normal compliance with increased negative middle ear pressure; shape consistent with Eustachian tube dysfunction / evolving / resolving middle ear effusion'.

EXAMPLES OF OTHER VARIATIONS IN TYMPANOMETRY RESULTS

RESULT INDICATES:	POSSIBLE DIAGNOSIS:
Increased physical volume	Perforated tympanic membrane, patent grommet / ventilating tube
Increased compliance	Flaccid tympanic membrane; ossicular discontinuity
Low / reduced compliance, normal middle ear pressure	Stiffened tympanic membrane due to scarring, advanced age of client / otosclerosis

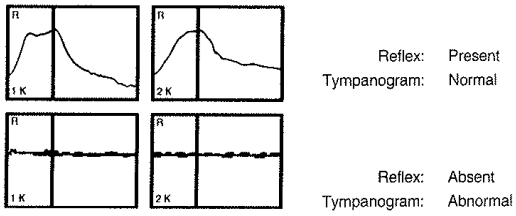
4c: ACOUSTIC REFLEXES

The middle ear has an involuntary reflex in response to loud sounds – this causes a bilateral contraction of the stapedius muscles. This reflex alters the transmission of sound through the ossicular chain, like a protective mechanism for the cochlea. Abnormalities of the Cochlea, 7th or 8th Cranial Nerve, lower brainstem or middle ear pathology can influence the presence of a reflex[29].

Acoustic reflexes (AR) are generally measured with the same immitance instrument immediately after obtaining a tympanogram.

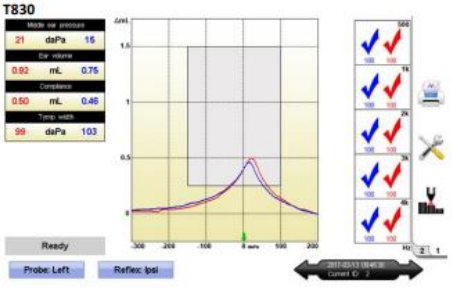
Acoustic reflexes can be measured contralaterally or ipsilaterally. Generally, in audiometry nursing practice, ipsilateral reflex thresholds are measured. This is when the reflex eliciting tone is administered to the same ear where the admittance is being measured. When the reflex eliciting tone is presented to the opposite ear from where admittance is being measured, it is called a 'contralateral' reflex.

Acoustic reflexes should be recorded according to the manufacturer's operating manual for the particular type of tympanometer in use. For example: 'Earscan' tympanometers indicate the **presence or absence** of ipsilateral acoustic reflexes at 105 dB SPL at 1000 Hz and 2000 Hz.



Example 1. *Source: Earscan Acoustic Impedance Microprocessor Operating guide 1993.*

The Earscan provides acoustic reflex screening and indicates presence or absence of reflexes at 1k Hz and 2k Hz only

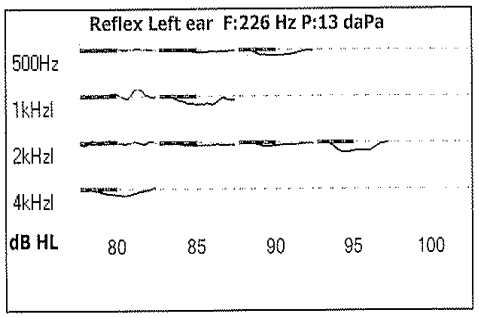


Example 2*: Oscilla T830/T840 guide 2017*

This example indicates the following ipsilateral reflexes:

500 Hz:	Present
1k Hz:	Present
2k Hz:	Present
4k Hz:	Present

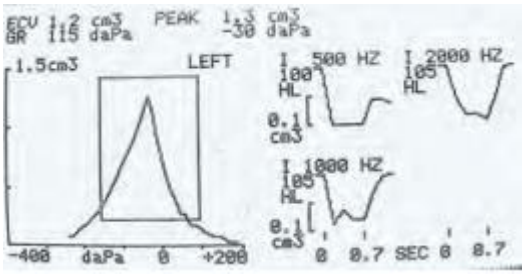
Other tympanometers, (for example: 'Titan', 'GSI') may record acoustic reflexes at 500, 1000, 2000 and 4000 Hz using numerical data and are noted at the hearing level (HL) at which the reflex is elicited.



Example 3: *Source: Titan tympanometer operating guide 2010*

The example on the left indicates that reflexes are elicited as follows:

500 Hz:	90 dB HL
1000Hz:	85 dB HL
2000Hz:	95 dB HL
4000Hz:	80 dB HL



Example 4: *GSI 39 guide 2011*

Reflexes for this machine can be displayed in three formats. This example indicates reflexes are elicited at:

500 Hz:	100dB HL
1000Hz:	105dB HL
2000Hz:	105dB HL

Notation should be made in the tympanometry report regarding the acoustic reflexes. For example: *'acoustic reflexes as noted above' or 'acoustic reflexes not recorded / absent'.*

SECTION 5: OTOACOUSTIC EMMISIONS

Overview:

Otoacoustic Emissions (OAE's) are faint sounds produced by electro mobile motion of the outer hair cells of the cochlear in a healthy ear. These faint sounds travel through the middle ear and tympanic membrane and are picked up via a small microphone inserted in the ear canal[30]. Currently there are two types of evoked OAE's used for clinical assessment. They are transient evoked OAE's (TEOAE's) using an acoustic click, and Distortion product OAE's (DPOAE's), elicited by the simultaneous presentation of two tones[31]. OAE testing may be used in some Audiometry clinics as part of the overall test battery.

The primary purpose of OAE testing is to determine cochlear status, specifically the outer hair cell function. This information can be used to:

- Screen hearing (particularly in neonates, infants, or individuals with developmental disabilities)
- Partially estimate hearing sensitivity within a limited range
- Differentiate between the sensory and neural components of sensorineural hearing loss, and
- Test for functional (feigned) hearing loss (non-organic)[32].

No sedation is required for this test.
Not only is the OAE test used to determine the functionality of the cochlear, it is also valuable in determining peripheral auditory functionality and in the absence of middle ear pathology, the possibility of sensorineural hearing loss.

Emissions are sounds echoed back into the middle ear from the inner ear in vibrational response to receiving a sound. Generally in a hearing loss greater than 25-30dB an emission will not be produced[33].

Procedure

1. Place probe with soft flexible tip in to the ear canal to obtain a seal. Use correct size probe. This microphone produces a stimulus and detects sound waves. Probe cable should not be held as this may increase noise levels during measurement.
2. Test in a quiet environment.
3. Perform Otoacoustic emissions to determine the presence of outer hair cell functioning as per individual equipment instructions.

Obtaining accurate reliable recording is affected by many variables including:-

- inadequate placement of ear probe in canal
- Internal noise emissions from the child, crying and noisy breathing.
- Movement and to a lesser extent external noises.
- Occlusion of the ear canal e.g. Cerumen or debris within the probe assembly.

Interpretation of results

- Absence of an OAE does not necessarily equate to inadequate cochlear function. OAE's should be interpreted within the context of a test battery.

- OAE's can assist in determining if the sensorineural loss is due to a problem in the cochlea or neural pathway.[34]
- The absence of OAE's with normal middle ear function suggests a sensory hearing loss at 30 to 40dB or greater.
- The presence of OAE's can be interpreted as "consistent with functional integrity of the outer hair cell system".[35]
- Your results should always be able to be repeated and come out the same.

A diagnostic test such as DPOAE test might be interpreted as below

- 4/4 bands –normal cochlear outer hair cell function.
- 3/4 bands can also considered a pass in conjunction with middle ear pathology- using clinical judgement in combination with findings being consistent with other assessment findings of tympanometry and audiogram.

Please refer to equipment manual for interpretation of results with your machine.

Recording Results

On Audiometry Report under a title **Otoacoustic Emissions** in form of

√ - Present
X –Absent

Comment under audiogram section

Supposition

If 4/4 bands are PRESENT – ***Otoacoustic emissions were present bilaterally which indicates normal cochlear outer hair cell functioning.***

<4/4 bands are PRESENT with Type B/C tymp – ***Otoacoustic emissions were absent/partially absent which is likely due to middle ear pathology. (There are some/all absent OAEs when OME is present because the middle ear is blocking the transmission of the sounds to the cochlear).***

<4/4 with type A tymp – ***Otoacoustic emissions were absent today which is consistent with abnormal cochlear outer hair cell functioning. (In this scenario it is likely that there are no OAE's because there is a SNHL).***

SECTION 6: PURE TONE AUDIOMETRY

Purpose:

Audiometry is multi-faceted and is undertaken to determine the hearing thresholds of individual ears and the type of hearing loss. It forms a major part of the hearing assessment. In pure tone audiometry the lowest sound pressure levels (thresholds) for different pure tones (frequencies) that a person can *just* hear are determined. The frequencies measured are those between 250 Hz and 8000 Hz – these being the frequencies related to speech sounds from low to high frequency. Thresholds obtained are displayed in a graphical format

Testing is conducted in a quiet environment, preferably a sound treated booth or room[36].

HUGHSON WESTLAKE TECHNIQUE

Audiometry is undertaken using the *Hughson Westlake* technique[37]

- Present a pure tone signal of sufficient volume for the client to hear
- The client is required to use a pre agreed response each time the signal is heard
- When client responds, decrease the signal by 10 dB and re-present signal
- Each time client responds decrease signal in 10 dB steps, re-presenting the signal until the client no longer responds
- When client no longer responds, increase signal intensity by 5 dB steps and re-present signal until a response is indicated
- Decrease the signal in 10 dB steps as above and increase in 5 dB steps as above until 2 out of 3 responses are indicated at the same threshold
- This is determined to be the hearing threshold at that frequency
- Record results using accepted symbols on the audiogram
- If a client indicates that they have tinnitus, use a pulsed tone

ACCEPTED SYMBOLS FOR USE IN AUDIOMETRY NURSING (AUSTRALIA)

Note: ***Symbols endorsed by Audiology Australia are also acceptable.***[38]

O	Right air conduction Unmasked		X	Left air conduction Unmasked
●	Right air conduction Masked		#	Left air conduction Masked
⊓	Bone conduction (either ear) Unmasked		□	Free field response
[	Right bone conduction Masked		]	Left bone conduction Masked
↘	No response Right		↙	No response Left

6a: AIR CONDUCTION AUDIOMETRY

Air conduction audiometry is the measurement of hearing thresholds across the entire auditory pathway. Air conduction is where the sound must travel via the transducer, then as energy through the acoustic pathway via the ear canal, tympanic membrane, ossicular chain and then on through the oval window to the cochlea and acoustic nerve to the brain stem. This involves placing headphones over a person's ears or the insert earphone into the ear canal and introducing a pure tone signal at a volume that should be reasonably audible. The volume of the tone is progressively reduced using the 'Hughson-Westlake' technique.

Process:

- Conduct pre-test check of the audiometer as per manufacturers operating manual
- Explain procedure to client in an age appropriate manner
- Face client to place headphones on their head (red earphone over right ear; blue earphone over left ear) & adjust to ensure speakers are placed over ear canal opening. If using insert headphones ensure the foam cuff is compressed and inserted into the correct canal so that the outer edge of the foam cuff is just within the first bend of the ear canal.
- Commence testing RIGHT ear (or better ear if known) at 1000 Hz
- Then test 2000Hz, 4000Hz, 8000Hz, 500Hz and 250Hz in that order[39]
    - If client is a very young child with limited concentration commence at 1000Hz, then 4000 Hz in each ear. Test remaining frequencies to the limit of their concentration
- Where it is known that a person has been exposed to noise, 1500, 3000 & 6000 Hz must be tested
- Where there is a difference of more than 20dB between two adjacent frequencies, the frequency in between must be tested if available[40]
- Retest 1000Hz. This is only done for the first ear tested.
- Record results using accepted symbols. Join the right ear symbols with a solid line. Join the left ear symbols with a broken line. Do not join symbols if only screened.
  Note: If AC masking is attended at any frequency, the symbols are joined.
- Repeat process in opposite ear.

GRADES OF HEARING IMPAIRMENT: [41]

According to the World Health Organisation hearing loss greater in the better ear than 40dB in adults and 30dB in children is disabling. These grades differ between organisations and countries.
Hearing loss (in the better ear) can be described as:

Normal hearing levels:	0 - 20 dB
Mild hearing loss:	21 - 40 dB
Moderate hearing loss:	41 - 60 dB
Severe hearing loss:	61 - 80 dB
Profound hearing loss:	81 dB +

'Unilateral hearing loss can pose a significant challenge for an individual at any level of asymmetry. It therefore requires suitable attention and intervention based on the difficulty experienced by the person.'[42]

6b: BONE CONDUCTION AUDIOMETRY

Bone conduction is undertaken in conjunction with air conduction audiometry to assist in determining the integrity of the auditory system. This is determined by conduction of sound waves to the inner ear via the mastoid bone, therefore bypassing the middle and outer ear and directly stimulating the cochlea.[43] [44]

The bone conductor / transducer is placed on the bony skull just behind the ear on the mastoid bone (mastoid prominence), and is held in place by a headband over the head. The pure tones are felt as vibrations on the skull and stimulate the inner ear via the mastoid bone.[45] The vibrator is only placed on one side of the skull. Whilst both ears will receive this vibration due to the transmission across the bony skull, the cochlea that is hearing the best will receive the audible tones at the minimum level. The bone conductor can deliver these tones at 250 Hz to 4000 Hz in most audiometers, however some audiometers may deliver the tones at higher ranges. The range is more limited than air conduction due to the distortion at higher frequencies and intensities. Generally, the bone conduction thresholds are less than or equal to the air conduction thresholds in the better ear.

Process:

- Explain procedure to client in an age appropriate manner
- Face the client and place the transducer on the mastoid bone. The vibrator should not touch the auricle, and should be placed under the hair. Ensure the handle does not occlude the outer ear on the opposite side
- Commencing at 1000 Hz using the 'Hughson-Westlake' technique, test all available frequencies. Test 1000 Hz and 4000 Hz for young children and continue to their concentration limits. Testing at low frequencies the stimulus can become vibrotactile. For example at 250Hz the sound may be felt at 25dB, at 500Hz at 55dB and at 1000Hz at 70dB.[46]
- Record results on audiogram using accepted symbols.

6c MASKING

The purpose of masking is to eliminate crossover hearing (otherwise known as interaural attenuation) in order to determine the true threshold of the test ear.[47] [48] Masking can be used for both air conduction and bone conduction audiometry.

Where there is a significant difference between the unmasked bone conduction and the air conduction thresholds, or a significant difference between the air conduction thresholds of each ear, masking must be used to determine the **type** of hearing loss. Masking results will determine whether it is a conductive loss – that is, caused by a disorder of the outer or middle ear; or if it is a sensorineural loss – that is, a hearing loss caused by a disorder of the inner ear or the higher acoustic pathway (retro-cochlea) or a mixed loss – a combination of conductive and sensorineural hearing loss.

AIR CONDUCTION MASKING

Air conduction masking should be undertaken where possible if:

- There is a difference of 40 dB or more between the air conduction thresholds of both ears using supra-aural headphones, or 55dB or more using insert headphones.
- There is a difference of 40 dB or more using supra-aural headphones, or 55dB or more using insert headphones between the poorer air conduction and the unmasked bone conduction thresholds[49] [50]

Process:

- Explain procedure to client in age appropriate manner
- Determine the test ear and frequencies to be masked
- Introduce narrow band masking noise via the headphone into the non-test ear at the unmasked air conduction threshold at that frequency, then add 10dB[51]. This is known as the initial masking level.
- Re-establish the hearing threshold in the test ear commencing at the unmasked level. If no response, increase volume in 5dB increments until client responds
    - When response received, increase masking noise by 10dB and retest
    - Repeat above step x 3
    - The third successive response without increasing the threshold in the test ear indicates the plateau has been obtained
    - Turn masking off and record masked air conduction threshold
    - If NO response received following any increase in masking noise, increase tone in 5dB steps until client indicates they can hear it. Repeat above steps
    - A plateau may not always be obtained due to audiometer output being reached, or because the client finds masking noise uncomfortable. Document findings.
    - Record the results on the audiogram using accepted symbols
- The level at which 3 increases of 10dB of masking does not shift the threshold in the test ear is considered the masked air conduction

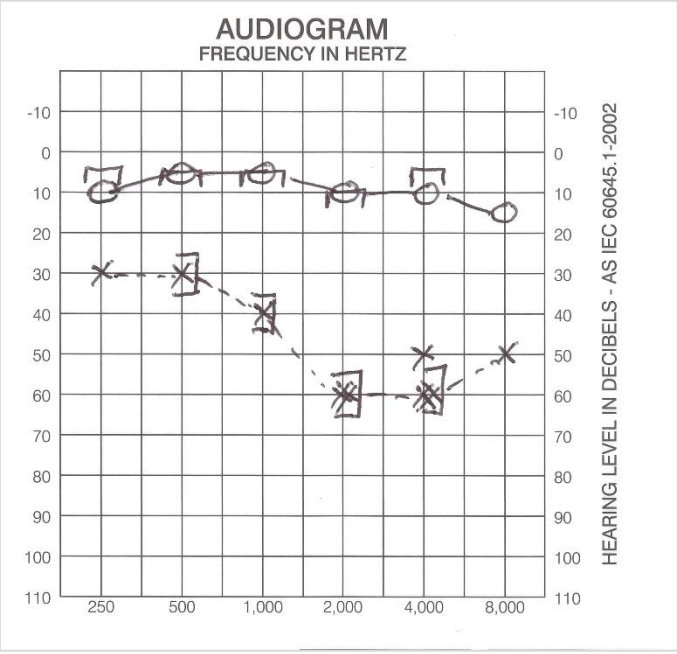
BONE CONDUCTION MASKING

Bone conduction masking should be undertaken where possible if:

- There is a difference of more than 10dB between the unmasked bone conduction threshold and the air conduction thresholds of either ear[52]

Process:

- Explain procedure to the client in an age appropriate manner
- Determine the test ear and frequencies to be masked
- Place bone conductor on mastoid of test ear, taking care not to occlude the non- test ear with the handle of the transducer
- Set bone conduction hearing level at the unmasked bone conduction threshold for that frequency
- Place the insert masker into the ear canal of the non-test ear. Introduce narrow band masking noise into the non-test ear slowly increasing volume until client indicates they can **just** hear it. Add further 10 dB masking noise.
- Re-establish hearing threshold of test ear. If no response increase unmasked tone by 5 dB increments until response indicated
    - Response received → increase masking noise by 10 dB and retest
    - Repeat above x 3
    - The third response is the plateau. Turn masking noise off.
    - Record masked bone conduction result using accepted symbols
    - If NO response indicated, increase tone by 5 dB increments until response indicated. Repeat above.
- The level at which 3 increases of 10dB of masking signal does not shift the threshold in the test ear is the masked bone conduction threshold



Example above of plotted masked audiogram

6d: FREEFIELD SCREENING

It is important to recognise that infants and toddlers have varying ability to respond to sounds, therefore testing techniques must be adjusted according to their developmental age in order to obtain a valid measure of their hearing. Free field screening does not determine hearing thresholds. This screen may determine hearing in at least one ear, however cannot rule out a unilateral hearing loss.[53]

PA5 WITH HEAD TURN RESPONSE (Visual Reinforcement Audiometry)

Purpose:

Visual Reinforcement Audiometry [VRA) is used when children are able to support their own head and rotate it 180 degrees.[54] When they respond to a given sound by turning their head, they are rewarded. This reward may be a puppet, flashing lights or other, dependent on the child and what equipment is available.

Methods:

- VRA booth with puppets
- PA5 (Paediatric audiometer)

This technique is recommended for infants aged approximately 10-24 months corrected age. The aim of VRA is to determine the softest sound down to a minimum of 20 dB, the outer edge of normal, to which the child turns to reliably for 2 out of 3 signals at 1000 and 4000 Hz. [55] [56] Attempt to screen at 500Hz & 2000Hz if child's concentration allows.

Catch trial should always be used at some stage during screening. A catch trial involves using the same process, except without audible signal.

Test Environment[57]:

Room should be of adequate size to accommodate parent(s), child and two testers comfortably. The British Society of Audiology recommend minimum floor dimensions of 6mX4m. Adequate ventilation, minimal distraction, dimmable lights.

Process:

- Observe child's ability to turn head 180 degrees
- Explain procedure to parent / carer in an appropriate manner
- Place child in high chair / child's chair or on parent/carer's lap as appropriate
- Distractor to sit in front of the child with a few non audible toys to direct child's attention to the front during screening. The distractor would ideally be a second Audiometry nurse, but a parent can be taught to do this role if need be.
- Instruct distracter to maintain child's attention without audible sound and not to cue child when the tone is presented
- If using the PA5, the screener sits behind child with PA5 holding it 50 cm behind child's head and outside child's peripheral vision
- Condition child to activity:

    - Screener presents either a warble or narrow band tone for 3-5 seconds at sufficient volume to attract child's attention. For example 60dB at 1000 Hz
    - When child turns toward signal a visual reinforcement is offered. For example: flash lights on PA5, display illuminated puppets, etc.
- Once the screener has determined child has been conditioned, commence screening by introducing tone at 1000 Hz at 40 dB, decreasing by 10 dB after each response and visual reinforcement. Attempt to gain responses at 20 dB
- Record result on audiogram using accepted symbols ☐ for free field screening and indicate the type of noise used as a stimulus *e.g.: 'narrow band and warble tones used'*
- The PA5 can be positioned behind either ear, however it is important to inform carer/parent that the individual ears of the child are not being tested

A guide for infant responses to free field screening is provided below[58]:

- 9 – 13 months: baby directly locates a sound source 25-35 dB SPL to the side and below
- 13-16 months: toddler localises directly sound signals of 25-30 dB to the side and below; indirectly above
- 16-21 months: toddler localises directly sound signals of 25-30dB on the side, below and above
- 21-24 months: child locates directly a sound signal of 25 dB at all angles

Note that when using a PA5 (paediatric screening audiometer), the decibel levels vary in 10dB increments. The table above may be used as a guide.

PA5 requiring PLAY RESPONSE:

Anticipated responses should be appropriate to the developmental / cognitive age of the client. The PA5 with play response can be used with children as young as 2 years of age or for older children / adults with developmental or cognitive delay.

Process:

- Ensure play responses are pre-determined and age / developmentally appropriate. For example, instruct and demonstrate to the child / client that you want them to place a toy into a bucket, clap, etc. when they hear the noise
- Screener to sit opposite child with PA5 facing the child and held at a distance of 50cm
- Present sufficiently loud signal (e.g.: 60dB @1k Hz) for 3-5 seconds to attract child's attention. Child is expected to respond within 5 seconds from onset of signal
- Repeat until child is conditioned to respond
    - If using PA5, engage child in activity as appropriate for age by encouraging him / her to *'blow out lights'* or '*touch lights to make them go out'*, saying '*good job!*' or other appropriate encouragement
- Commence screening at 1K and 4K Hz decreasing volume until the child no longer responds to the signal
- Aim for a response x 2 at 20 dB
- Catch trial should always be used at some stage during screening. A catch trial involves using the same process, except without audible signal

Ideas for engaging the child/client in the process:

- A useful idea is to give each frequency the name of an animal e.g.: 500Hz a frog, 4000Hz a bird, etc.
- A method that has been successfully used is to have the child place a toy/peg etc. on the face of the PA5 and when the child hears the signal, they place the toy/peg into a container – this method is useful to connect the signal with the action for the child. This may be particularly useful if you are able to progress to using a PA5 with an earphone

6e: PA5 requiring play response – USING EARPHONE

If PA5 free field screening has been successful, the child / client may then be able to progress to screening using the PA5 with earphone. This would then determine the hearing in individual ears rather than free field screening where a unilateral hearing loss cannot be ruled out.

Note that once the earphone is connected to the jack on the PA5, the tones become **pure-tone** rather than warble, narrow band or white noise.

Process:

- Ensure play responses are pre-determined and age / developmentally appropriate (as above)
- Plug earphone into the jack on the PA5. Distance from the child / client is not relevant as the child / client will hear the tones via the earphone
- Hold earphone over test ear and present signal as described above until valid responses obtained at frequencies tested
- Repeat for other ear
- Record valid responses on the audiogram using accepted symbols
- Note that this is a *screen only*. The **O** symbol (right ear) and **X** symbol (left ear) should be plotted but not joined on the graph

SECTION 7: NEWBORN HEARING SCREENING

Universal newborn hearing screening (UNHS) programs have been introduced throughout Australia and many other countries. Research has shown that in Australia, approximately one infant in every 1000 live births will be born with a significant hearing loss – defined as a hearing loss greater than 40dB in the better ear.[59] Universal newborn hearing screening programs aim to detect this hearing deficit, and offer families early diagnosis and appropriate intervention which leads to significantly improved health, education and social outcomes.[60]

Infants who do not pass the UNHS are referred to diagnostic audiology where anomalies in the function of the auditory pathway are detected or diagnosed. It is important to note that this screening does not prevent progressive hearing loss, nor does it detect or prevent a mild hearing loss or conductive hearing loss.[61] [62] UNHS is a non-invasive screening test that takes just minutes to complete, using computerised technology.

Infants that pass their UNHS but are identified at that time with one of more risk factors for progressive hearing loss should have their hearing monitored[63] as per their State or Territory's protocol/guidelines.

The newborn hearing screening program is known by various names. For example: 'SWIS-H' (State Wide Infant Screening - Hearing) in NSW, 'Healthy Hearing' program in Queensland, etc.

The following are the screening methods used within Australia:

- Automated Auditory Brainstem Response (AABR)
- Oto-Acoustic Emissions (OAE)

Information related to newborn hearing screening programs can be found by contacting the Health Department in your State or Territory for more information, and the Clinical Practice Guidelines and Policies relevant to each program. Some useful links:

Australasian Newborn Hearing Screening Committee http://www.newbornhearingscreening.com.au/newborn-hearing-screening-programs/

NSW: http://www1.health.nsw.gov.au/pds/ActivePDSDocuments/GL2010_002.pdf

QLD: https://www.childrens.health.qld.gov.au/chq/our-services/community-health-services/healthy-hearing-program/screening/

VIC: https://www.rch.org.au/vihsp/

SA: http://www.cyh.com/SubContent.aspx?p=420

WA: http://cahs.health.wa.gov.au/services/newborn_hearing/index.htm

TAS: http://www.dhhs.tas.gov.au/service_information/services_files/RHH/treatments_and_services/statewide_audiology_service

ACT: https://health.act.gov.au/services-and-programs/women-youth-and-children/children-and-youth/childrens-hearing-service-chs

SECTION 8: CLINICAL PATHWAYS

It is important to note that these pathways are a guide only, and management of all clients must be considered on an individual basis

8a: RECOMMENDED CLINICAL PATHWAYS: INFANTS and CHILDREN

INITIAL ASSESSMENT	ACTION	REVIEW FINDINGS	ACTION	SECOND REVIEW
Normal otoscopy; Normal hearing; Normal middle ear function (MEF) *(Note: It is preferable to use high frequency tympanometry for children <6 months)*	No further action; review if ongoing concern			
	If risk factor/s for progressive hearing loss* State/Local Health Service Policy/Protocol should be followed	Initial hearing assessment at 10-12 months corrected age	*(* Infants with diagnosed CMV & UNHS pass require 6 monthly hearing monitoring up to age 4yrs)*	Review at age 3-4yrs when headphones can be reliably used
Hearing loss identified; normal MEF & normal otoscopy	Refer to Audiologist / Hearing Australia Refer GP/ENT Refer to Itinerant Support Teacher -Hearing (IST-H)			
Normal hearing; Eustachian tube dysfunction (ETD)	Eustachian Tube (ET) patency exercises; Review if continued parental/GP concern	Normal hearing MEF abnormal Otoscopy abnormal	Refer GP/ENT Review 6-8 weeks or on request	
Hearing loss with middle ear pathology (MEP) *(Note: masking should be attempted where appropriate to determine type of hearing loss)*	ET patency exercises; Review 6-8 weeks	Normal hearing Normal MEF	No further action	
		Normal hearing with MEP	Refer GP/ENT	Review on request
		Hearing loss with MEP	Refer GP/ENT Refer to IST-Hearing	Review on request Persistent OME &/or long wait for grommets refer to Hearing Australia
		Hearing loss; normal MEF	Refer GP/ENT, Hearing Australia / Audiologist & IST-Hearing	Review on request

8b: RECOMMENDED CLINICAL PATHWAY - ADULTS

Clients of all ages present with a variety of symptoms / history. Some examples may include:

INDICATION	ACTION & REFERRAL
Sudden hearing loss or sudden onset of tinnitus	Immediate referral to GP/ENT & priority for audiometry assessment
Family history of hearing loss	Monitor (on individual basis) Refer to GP for ENT if changes noted
Tympanometry - reduced compliance but still in normal range; Audiometry - low frequency conductive hearing loss and depressed 2K bone conduction (Carhart's notch)	Possible otosclerosis Refer to GP for ENT referral
Tympanometry - normal middle ear function Audiogram – hearing loss greater in higher frequencies	Probable presbycusis (age related hearing loss) Refer to Australian Government Hearing Services Program (if eligible) or private audiologist for hearing aid assessment Provide information re Assistive Listening Devices and support agencies
Asymmetrical hearing loss on any frequencies with or without tinnitus	Refer to GP for ENT opinion to rule out retro-cochlea pathology
Tinnitus	Information re tinnitus causes and management Refer to GP for investigation, ENT referral
Dizziness, nausea, vomiting, balance disorder, tinnitus	Suspect Méniére's Disease, Benign positional vertigo (BPV) Refer to GP for investigation, ENT referral

SECTION 9: OCCUPATIONAL HEARING SCREENING

Occupational screening requires a different approach to diagnostic hearing assessment. It is useful to remember that this is a screen only. Refer to the **A/NZS 1269** 'Occupational Noise Management Part 4: Auditory Assessment'[64] for details relating to technique, reference and monitoring audiometry, interpretation of results and management / referral procedures. These standards are updated periodically.

The *Hearing Conservation Audiometry Report Form is* suggested for use in Occupational Screening programs (see appendix 3). Client history, results, management and consent should be documented on this form.

Clients undergoing **reference** audiometry need to be 'noise free' for at least 16 hours prior to testing, whilst clients requiring **monitoring** audiometry should be tested well into a work shift.

- Complete information about past ear disease, any family history of deafness and current/past tinnitus and record in appropriate area on form
- Complete otoscopy and record findings
- Use the Ascending Hughson Westlake Technique (as per A/NZ standard 1269) commencing with right ear
- Test air conduction thresholds of 500Hz,1000Hz, 1500Hz, 2000Hz, 3000Hz, 4000Hz, 6000Hz and 8000Hz
- Record all results directly onto report form using accepted symbols, except 3000Hz, 4000Hz and 6000Hz – record these in boxes A, C & E for right ear
- Test left ear as above and record results of 3, 4 & 6K in boxes A, C & E for left ear
- Remove headphones for a minute or two and then reposition
- Retest right ear at 3000Hz, 4000Hz and 6000Hz and record results in boxes B, D & F for right ear (below the first test results)
- Retest left ear as above and record in boxes B, D & F for left ear
- Add the results of individual ear results of both 3000Hz (A & B) divide by 2 and record in 'average box'. Repeat for 4000Hz (C&D) and 6000Hz (E & F)
- Plot this 'average' result onto audiogram form
- Add up the results of A B C D E & F of the right ear, divide by 6 and record result in box provided on form. Note that the average of 3K, 4K and 6K of the 2 tests gives an overall decibel loss of those combined frequencies – it is ***not*** a percentage of hearing loss
- Repeat for the left ear

- If the test is ***monitoring*** audiometry and the results show any of the following differences from the ***reference*** audiogram, the client is to be advised to undergo further testing on another day after being free from noise for 16 hours:

    - A shift in average threshold at 3K, 4K and 6K ≥ 5dB
    - A shift in mean threshold ≥ 10dB at 3K and 4K **or**
    - A change in mean threshold ≥ 15dB at 6K **or**
    - A threshold shift ≥ 15dB at 500Hz, 1K 1.5K or 2K **or**
    - A threshold shift ≥ 20dB at 8k

- Where a threshold shift is confirmed, the client is to be referred for a medical opinion
- Write the report, print name and designation and sign the form
- Provide the client with a copy
- Documentation maintained as per local service policy/protocol

NOISE INJURY PREVENTION AND MANAGEMENT

An essential component of any Occupational Hearing Screening program is noise injury prevention and management.

The following issues should be discussed:

- client awareness of noise exposure
- length and degree of noise exposure that causes damage to hearing
- client understanding of hearing protection
- appropriate type of hearing protection for client needs
- essentials of comfortable hearing protection
- dispelling myths re use of hearing protection
- impact of leisure noise and personal noise exposure as well as occupational noise exposure

SECTION 10: REPORT WRITING

Report writing is an important and integral part of nursing practice. Audiometry reports not only provide documented evidence of client assessment, but also become part of a client's Health Care Record. The NSW Registered nurses standards for practice indicates that documentation provides evidence of decision making and of the care planned, as well as evidence of critical thinking and professional judgment.[65]

History and report forms relevant to your State or Territory or those endorsed by your service should be used. Local service policies regarding documentation should be observed.
Basic principles of report writing and documentation:

- Written reports should be accurate, legible and relevant
- Otoscopy – report on what you can see
- Tympanometry – ensure reference is made to compliance, middle ear pressure and physical volume (where relevant). Physical volume is relevant where it is excessive and confirms a perforation, patent ventilation tube, or reduced physical volume such as a wax filled ear canal or foreign body. Reference should be made to shape of the tympanogram where this is significant (for example: '*low rounded shape consistent with evolving/resolving middle ear pathology')*
- Reference should be made to acoustic reflex responses
- Audiogram report should indicate type and degree of hearing loss. Use of the term 'normal hearing levels' is preferable to the term WNL (within normal limits)
- Action / management plan: document appropriate management and referral or review process
- If results are the same for both ears use of the word 'bilateral' is acceptable, however where results are different report on results individually. Include the degree (mild, moderate, severe, profound), frequencies affected (low, mid or high), and type (conductive, sensorineural, mixed)

SECTION 11: PROFESSIONAL STANDARDS

Nurses and midwives must be registered with the Nursing and Midwifery Board of Australia (NMBA), and meet the NMBA's professional standards in order to practice in Australia.
Professional standards define the practice and behavior of nurses and midwives and include:

- Codes of conduct,
- Standards for practice, and
- Codes of ethics.

https://www.nursingmidwiferyboard.gov.au/Codes-Guidelines-Statements/Professional-standards.aspx

SECTION 12: CLINICAL COMPETENCIES/PRACTICE STANDARDS FOR AUDIOMETRY NURSES

The ANAA Inc. has developed a set of clinical skills which should be achieved and maintained in order to practice as an Audiometry Nurse. (Appendix 4)

SECTION 13: HEARING SERVICES CLINICAL PRACTICE REVIEW

As below:

HEARING SERVICES: CLINICAL PRACTICE REVIEW

Name: **……**……

Site: **……..**……..

Date of review: **……..**……

PURPOSE:

A clinical practice review should be undertaken between a clinical senior in audiometry nursing (e.g.: CNC, CNS or Clinical Advisor in Audiometry) with the clinician to determine that a best practice approach to the provision of a high quality hearing health service is achieved. Clinical practice review should be completed at least once every 3 years or more often if required.

GUIDELINES:

- The environment for testing meets the ANSI/ASA S3.1 or ISO 8253 for maximum acceptable background noise levels for testing with and without headphones e.g. sound field or bone conduction
- The clinic has the essential equipment necessary for conducting hearing assessments including an otoscope, tympanometer with acoustic reflex facility, audiometer with air, bone and masking options, and a paediatric screening audiometer
- The equipment is calibrated annually and is maintained in excellent working order
- Booths are inspected at least 3 yearly by an appropriate technician.
- The length of appointment time is appropriate for a diagnostic assessment (e.g. one hour)
- Relevant State and Territory health department and local health service infection control and work, health and safety guidelines are followed
- A reporting mechanism is in place for statistical data collection
- The audiometry nurse maintains professional standards as per professional organisation guidelines

WERE ANY POINTS RAISED AT PREVIOUS CLINICAL REVIEW? IF SO HAVE THEY BEEN ADDRESSES? IF NOT, WHY?

……

……

……

……

……

CLINICAL ASSESSMENT: To be completed by clinician

- How often do you conduct audiometry clinics? Are you happy with this, or would you like
- to discuss changes? (recommended minimum 8 hours per month)

  ……

- What is the usual waiting time for a hearing appointment?

  ……

- Describe the process at this facility for scheduling appointments:

  ……

- Is the time allocated to complete each appointment adequate?

  ……

- Describe how non attendees are followed up

  ……

- Does the testing environment meet the relevant A/NZ Standard?

  Yes □ No □

  Comment: ……

- Are there Safe Operating Procedures for each piece of equipment?

  Yes □ No □

  Comment: ……

- Does the testing environment meet Workplace Health and Safety Standards

  Yes □ No □

  Comment:……

- Is there a copy of the current Audiometry Nursing Clinical Practice Standards for the hearing service available?

  Yes □ No □

  Comment: ……..

- Is there a copy of the current Clinical Competencies for Audiometry Nurses available?

  Yes □ No □

  Comment : ……..

- Do you have adequate tools of trade available?

  Yes □ No □

  Comment : ……..

- Is the equipment checked and calibrated as per operator manual prior to each clinic

  Yes □ No □

  Comment: ……..

<u>ASSESSMENT SKILLS to be completed by assessor</u>

History taking and communication skills

Comments: ……

……

……..

Otoscopy

Comments: ……..

……..

……..

Tympanometry

Comments: ……..

……..

……..

Air and bone conduction audiometry

Comments: ……

……

……

Air and bone conduction masking

Comments: ……

……

……

Free field / PA5 screening

Comments: ……

……

……

Audiometry report form including appropriate report writing

Comments: ……

……

……

Interpreting and explanation of results to the client/carer

Comments: ……

……

……

Handouts for clients and other resources

Comments: ……

……

……

Clinical notes / data collection

Comments: ……

……

……

CLINICIAN'S COMMENTS:

Quality or health promotion activities undertaken in the past 3 years

……

……

……

Professional development activities related to audiometry nursing in the past 3 years

……

……

……

What area of your audiometry nursing practice do you feel is your strongest area?

……

……

……

Are there any areas you feel you can improve on or benefit from further knowledge?

……

……

……

Have you considered how could this be achieved? How?

……

……

……

Other comments?

……

……

……

……

FUTURE NEEDS OF THE SERVICE

List what you see as being essential for the continued quality and growth of the hearing service. For example environment, resources, educational needs, professional support.

……

……

……

……

Signature: …… Print name: ……..

Date: …….. Designation: ……..

Assessors Comments:

……

……

……

……

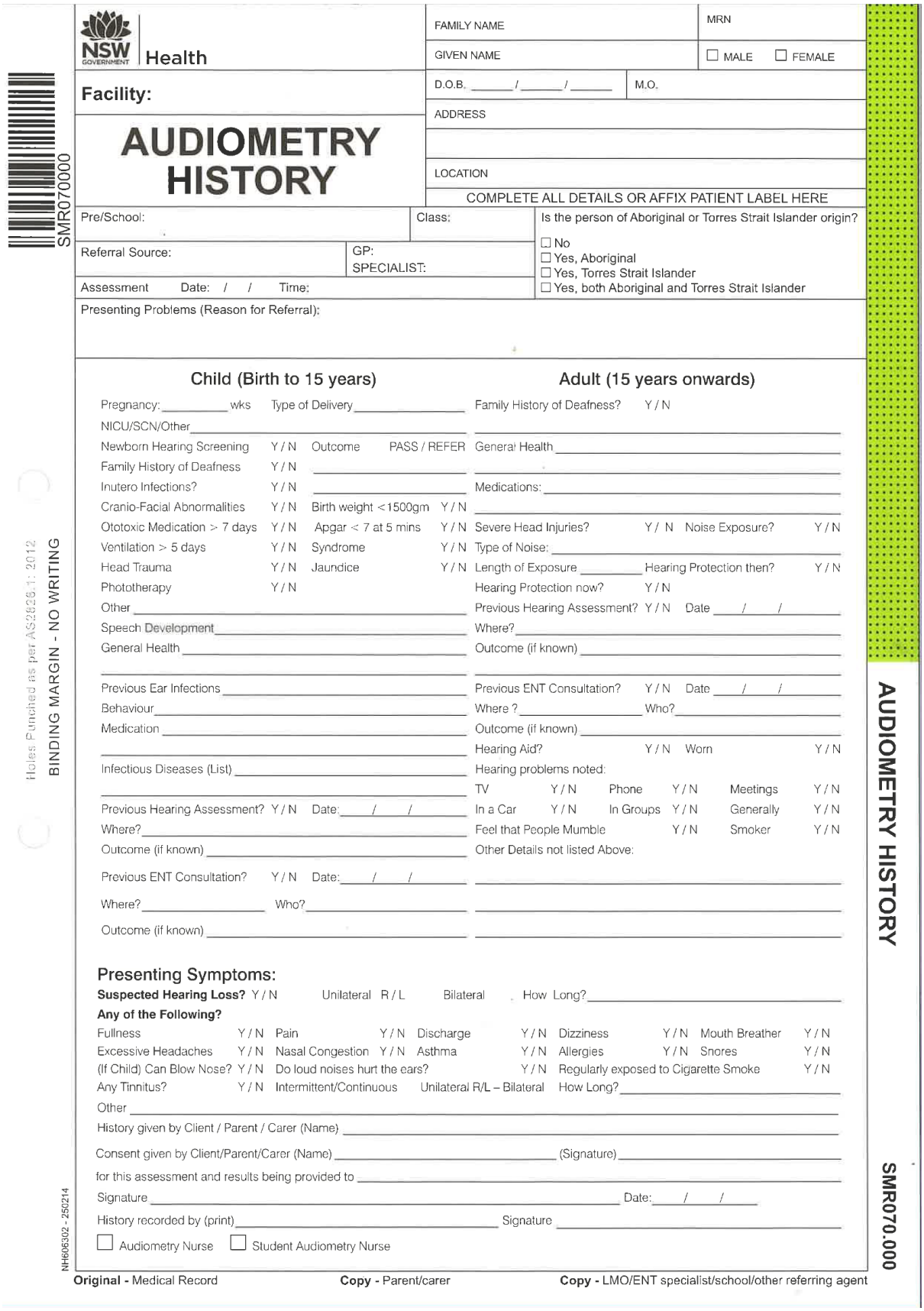
Signature: …… Print name: ……..

Date: …….. Designation: ……..

APPENDICES

1. NSW Health Audiometry History form (example only)
2. NSW Health Audiometry Report form (example only)
3. Occupational Hearing Screening Report form (example only)
4. ANAA Inc. Clinical Competencies for Audiometry Nurses

APPENDIX 1:



NSW GOVERNMENT Health

Facility:

AUDIOMETRY HISTORY

SMR070000

FAMILY NAME | MRN

GIVEN NAME | ☐ MALE ☐ FEMALE

D.O.B. ____/____/____ | M.O.

ADDRESS

LOCATION

COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE

Pre/School: | Class:

Is the person of Aboriginal or Torres Strait Islander origin?
☐ No
☐ Yes, Aboriginal
☐ Yes, Torres Strait Islander
☐ Yes, both Aboriginal and Torres Strait Islander

Referral Source: | GP: SPECIALIST:

Assessment Date: / / Time:

Presenting Problems (Reason for Referral):

Child (Birth to 15 years)

Pregnancy: ____ wks Type of Delivery ____
NICU/SCN/Other ____
Newborn Hearing Screening Y / N Outcome PASS / REFER
Family History of Deafness Y / N
Inutero Infections? Y / N
Cranio-Facial Abnormalities Y / N Birth weight <1500gm Y / N
Ototoxic Medication > 7 days Y / N Apgar < 7 at 5 mins Y / N
Ventilation > 5 days Y / N Syndrome Y / N
Head Trauma Y / N Jaundice Y / N
Phototherapy Y / N
Other ____
Speech Development ____
General Health ____
Previous Ear Infections ____
Behaviour ____
Medication ____
Infectious Diseases (List) ____
Previous Hearing Assessment? Y / N Date: ____/____/____
Where? ____
Outcome (if known) ____
Previous ENT Consultation? Y / N Date: ____/____/____
Where? ____ Who? ____
Outcome (if known) ____

Adult (15 years onwards)

Family History of Deafness? Y / N
General Health ____
Medications: ____
Severe Head Injuries? Y / N Noise Exposure? Y / N
Type of Noise: ____
Length of Exposure ____ Hearing Protection then? Y / N
Hearing Protection now? Y / N
Previous Hearing Assessment? Y / N Date ____/____/____
Where? ____
Outcome (if known) ____
Previous ENT Consultation? Y / N Date ____/____/____
Where ? ____ Who? ____
Outcome (if known) ____
Hearing Aid? Y / N Worn Y / N
Hearing problems noted:
TV Y / N Phone Y / N Meetings Y / N
In a Car Y / N In Groups Y / N Generally Y / N
Feel that People Mumble Y / N Smoker Y / N
Other Details not listed Above:

Presenting Symptoms:

Suspected Hearing Loss? Y / N Unilateral R / L Bilateral How Long? ____

Any of the Following?

Fullness Y / N Pain Y / N Discharge Y / N Dizziness Y / N Mouth Breather Y / N
Excessive Headaches Y / N Nasal Congestion Y / N Asthma Y / N Allergies Y / N Snores Y / N
(If Child) Can Blow Nose? Y / N Do loud noises hurt the ears? Y / N Regularly exposed to Cigarette Smoke Y / N
Any Tinnitus? Y / N Intermittent/Continuous Unilateral R/L – Bilateral How Long? ____
Other ____
History given by Client / Parent / Carer (Name) ____
Consent given by Client/Parent/Carer (Name) ____ (Signature) ____
for this assessment and results being provided to ____
Signature ____ Date: ____/____/____
History recorded by (print) ____ Signature ____
☐ Audiometry Nurse ☐ Student Audiometry Nurse

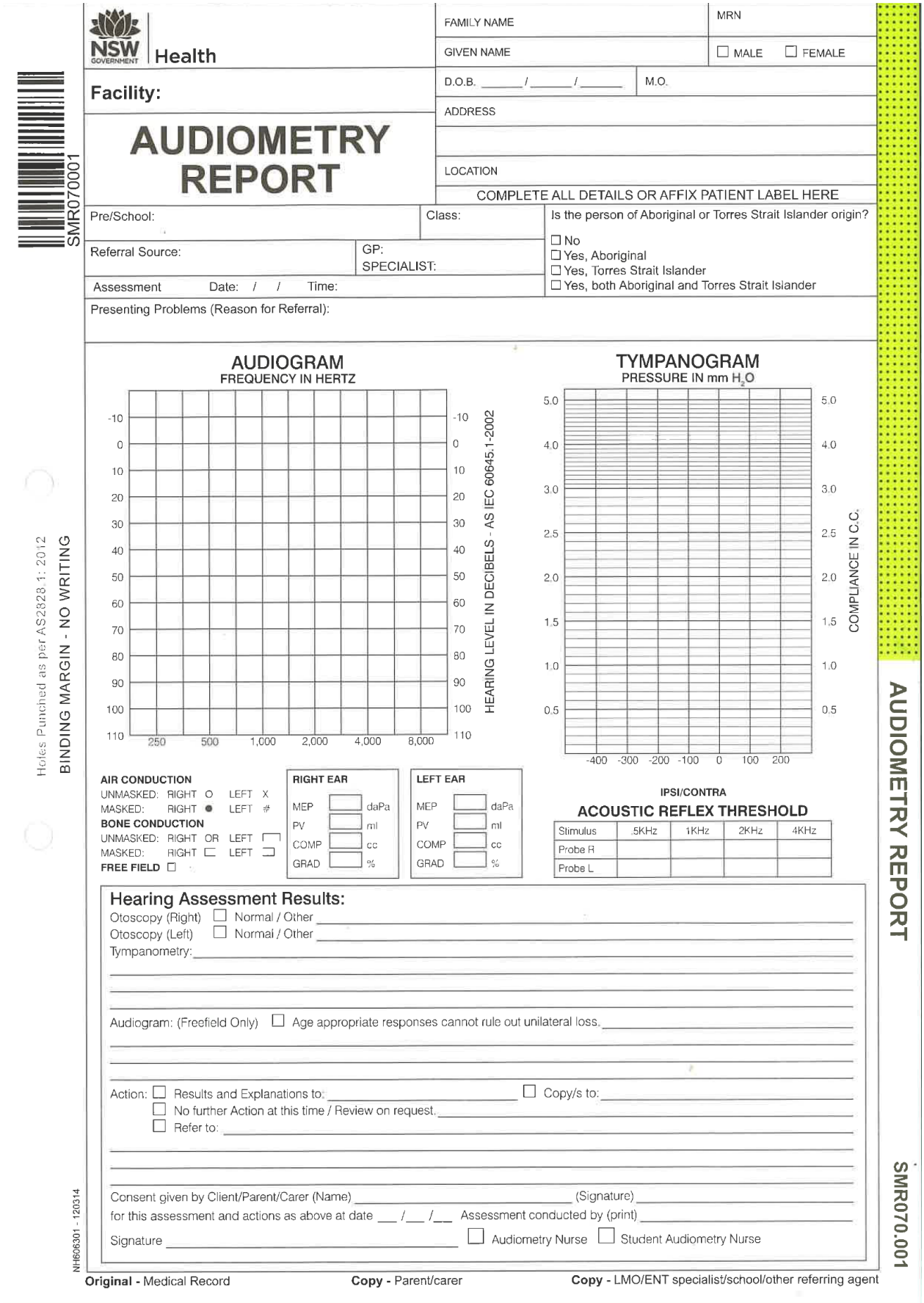
NH606302 - 250214

Original - Medical Record **Copy** - Parent/carer **Copy** - LMO/ENT specialist/school/other referring agent

Holes Punched as per AS2828.1: 2012
BINDING MARGIN - NO WRITING

AUDIOMETRY HISTORY
SMR070.000

APPENDIX 2



NSW GOVERNMENT Health

Facility:

AUDIOMETRY REPORT

FAMILY NAME | MRN

GIVEN NAME | ☐ MALE ☐ FEMALE

D.O.B. ____/____/____ | M.O.

ADDRESS

LOCATION

COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE

Pre/School: | Class:

Referral Source: | GP: SPECIALIST:

Assessment Date: / / Time:

Is the person of Aboriginal or Torres Strait Islander origin?
☐ No
☐ Yes, Aboriginal
☐ Yes, Torres Strait Islander
☐ Yes, both Aboriginal and Torres Strait Islander

Presenting Problems (Reason for Referral):

AUDIOGRAM
FREQUENCY IN HERTZ

-10, 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110

250 500 1,000 2,000 4,000 8,000

HEARING LEVEL IN DECIBELS - AS IEC 60645.1-2002

TYMPANOGRAM
PRESSURE IN mm H_2O

5.0, 4.0, 3.0, 2.5, 2.0, 1.5, 1.0, 0.5

-400 -300 -200 -100 0 100 200

COMPLIANCE IN C.C.

AIR CONDUCTION
UNMASKED: RIGHT O LEFT X
MASKED: RIGHT ● LEFT #
BONE CONDUCTION
UNMASKED: RIGHT OR LEFT
MASKED: RIGHT LEFT
FREE FIELD ☐

RIGHT EAR			LEFT EAR		
MEP		daPa	MEP		daPa
PV		ml	PV		ml
COMP		cc	COMP		cc
GRAD		%	GRAD		%

IPSI/CONTRA
ACOUSTIC REFLEX THRESHOLD

Stimulus	.5KHz	1KHz	2KHz	4KHz
Probe R				
Probe L				

Hearing Assessment Results:

Otoscopy (Right) ☐ Normal / Other _____
Otoscopy (Left) ☐ Normal / Other _____
Tympanometry: _____

Audiogram: (Freefield Only) ☐ Age appropriate responses cannot rule out unilateral loss. _____

Action: ☐ Results and Explanations to: _____ ☐ Copy/s to: _____
☐ No further Action at this time / Review on request. _____
☐ Refer to: _____

Consent given by Client/Parent/Carer (Name) _____ (Signature) _____
for this assessment and actions as above at date ___ /___ /___ Assessment conducted by (print) _____
Signature _____ ☐ Audiometry Nurse ☐ Student Audiometry Nurse

Original - Medical Record **Copy** - Parent/carer **Copy** - LMO/ENT specialist/school/other referring agent

SMR070001

Holes Punched as per AS2828.1: 2012

BINDING MARGIN - NO WRITING

AUDIOMETRY REPORT

SMR070.001

NH606301 - 120314

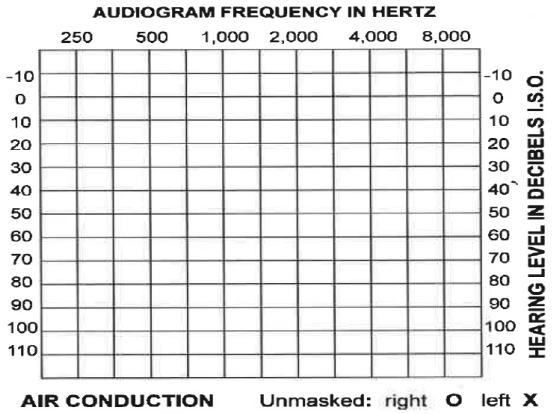
APPENDIX 3:

HEARING CONSERVATION AUDIOMETRY REPORT FORM

Surname:	MRN:
Address:	
Date of Birth:	MO:
Aboriginal ☐ Torres Strait Islander ☐	
Both Aboriginal & Torres Strait Islander ☐ Neither ☐	

AUSTRALIAN / NEW ZEALAND STANDARD 1269:4:2014

Name:		M/F	Site:	
Referral Source /Employer:		Reference/Monitoring Audiometry		
Date:	Time:	Years of current employment:		
Hearing Protectors Worn: ☐ Nil	☐ Plugs	☐ Earmuffs	☐ Either	☐ Both
Use of Hearing Protection: ☐ Often	☐ Seldom	☐ Never	☐ Not Necessary	
Noise Exposure History:				
Noise Exposure over past 16 hours:				
Audiometer:		Date of Calibration		



	3000Hz	4000Hz	6000Hz	(A to F) ÷ 6
Right 1 Right 2	A B	C D	E F	 dB
Average	[ ] (A+B)÷2	[ ] (C+D)÷2	[ ] (E+F)÷2	
Left 1 Left 2	A B	C D	E F	 dB
Average	[ ] (A+B)÷2	[ ] (C+D) ÷2	[ ] (E+F)÷2	

Audiometric Interpretation:

Otoscopy (Right) ☐ Normal / Other _____

Otoscopy (Left) ☐ Normal / Other _____

History of ear problems: _____ Tinnitus: Yes / No Intermittent / Continuous How Long?

Audiogram: _____

_____

_____

_____

Threshold shift since last screening on _____ Yes / No

If yes, which frequency/s _____ Right and or Left Ear/s

Referred: Yes / No To Whom: _____

☐ Results explained to Client ☐ Hearing conservation education given to Client

Action Plan: _____

_____

_____

_____

Client Agrees / Disagrees to the release of audiometric results to _____

Client Signature _____ Date: _____

Tester: _____ Signature: _____ Designation: _____

Australian Nurse Audiometry Association: Reviewed March 2020

This page has been intentionally left blank

APPENDIX 4:

CLINICAL COMPETENCIES

for

AUDIOMETRY NURSES

Name: ……...

Site: ……..…..

Date: ……..

These competencies may be assessed in conjunction with the ANAA Inc. Clinical Practice Review *(ANAA Inc. Clinical Practice Standards 2021)*

CLINICAL COMPETENCIES for AUDIOMETRY NURSES

The professional organisation for audiometry nurses, the ***Audiometry Nurses Association of Australia Inc****,* has developed a set of seven (7) Clinical Competencies which must be achieved by students in audiometry nursing, and maintained by practicing audiometry nurses. These competencies should be used in conjunction with the ***ANAA Inc Clinical Practice Standards for Audiometry Nurses (2021.).***

The clinical competencies include the following categories:

1: practices effective communication
2: provides comprehensive hearing assessments
3: record, interpret, report and explanation of results to client / carer
4: understanding of newborn hearing screening programs
5: case management in consultation with client / others
6: maintenance of equipment and environment
7: professional and clinical issues

Competency 1: Practices effective communication

Criteria	Competent Y/N	Date
Establishes and maintains rapport with client / carer		
Uses age / developmentally appropriate language		
Observation of client / family throughout assessment		
Shares all relevant information with client / carer		
Obtains informed consent		
Provides appropriate explanation of procedures and results		
Uses culturally appropriate language and approach		
Seeks peer support / supervision for complex situations		

Competency 2: Provides comprehensive hearing assessments

Criteria	Competent Y/N	Date
Conducts comprehensive history taking / interview – child		
Conducts comprehensive history taking / interview – adult		
Otoscopy - function and safe use / technique		
Otoscopy - accurate description of observations		
Tympanometry - function and safe use / technique		
Tympanometry - interpretation and description of results		
Tympanometry - identifies and records presence / absence of acoustic reflexes and understands their relevance		
Pure tone audiometry (air conduction) – Hughson Westlake technique		
Pure tone audiometry (air conduction) – plotting of results		
Pure tone audiometry (bone conduction) – Hughson Westlake technique		
Pure tone audiometry (bone conduction) – plotting of results		
Masking (air conduction) – rules of masking		
Masking (air conduction) – technique		
Masking (air conduction) – plotting of results		
Masking (bone conduction) – rules of masking		
Masking (bone conduction) – technique		
Masking (bone conduction) – plotting of results		
Free field screening – VRA / PA5 technique		
Free field screening – VRA / PA5 plotting of results		
Hearing screening using PA5 with earphone		
Manages challenging behaviours		
Uses developmentally appropriate testing / screening techniques		
Demonstrates Audiometric Weber – use and limitations		
Demonstrates knowledge of occupational screening standards and procedures		

Competency 3: Record, interpret, report and explanation of results to client / carer

Criteria	Competent Y/N	Date
Use of appropriate clinical forms for hearing clinic		
Accurate plotting and recording of results		
Use of appropriate symbols		
Accurate interpretation of all findings including masking		
Written report using appropriate terminology which reflects results		
Appropriate explanation of results to client / carer - culturally acceptable		

Competency 4: Understanding of newborn hearing screening programs

Criteria	Competent Y/N	Date
Explains the difference between AABR and OAE		
Observes newborn hearing screening		
Demonstrates knowledge of risk factors associated with progressive sensorineural hearing loss		
Demonstrates knowledge of follow up process for infants and children with risk factors for progressive hearing loss		

Competency 5: Case management in consultation with client / others

Criteria	Competent Y/N	Date
Recalls client for review if appropriate		
Refer client to other agencies / disciplines / organisations as appropriate		
Provides client / carer with appropriate hearing health resources		
Advocates on behalf of client		
Uses other strategies to optimise client outcomes		

Competency 6: Maintenance of equipment and environment

Criteria	Competent Y/N	Date
Equipment check prior to commencing clinic		
Annual calibration requirements		
Use and limitations of all equipment		
Knowledge and understanding of relevant standards for audiometric testing environment and equipment calibration		
Troubleshooting / problem solving		

Competency 7: Professional and clinical issues

Criteria	Competent Y/N	Date
Adherence to local and State workplace health and safety policies		
Adherence to relevant infection control policies		
Ethical and legal considerations in all aspects of client care		
Adherence to all relevant local policies and procedures		
Practices in accordance with recommended professional and national nursing standards including audiometry nursing clinical practice standards and competencies		

Clinician's name: …….. Designation: ……..

Signature: ……

Date: ……

Assessor's name: ……Designation: ……..

Signature: ……

Date: ……

Further information relating to these clinical competencies should be directed to the executive committee of the Audiometry Nurses Association of Australia Inc.

This page has been intentionally left blank

REFERENCES

Acknowledgements and appreciation is extended to all the Audiometry Nurses who offered their valuable time and expertise in their specialty for input into developing and reviewing these practice standards.

[1] Medical Services Advisory Committee (MSAC). (2007) *Universal neonatal hearing screening: assessment report*. Canberra, Commonwealth of Australia. https://www.adelaide.edu.au/ahta/pubs/reportsmonographs/Neonatal_Hearing_Screening_report_updated_2007_final.pdf

[2] Australian Bureau if statistics (ABS). (2018). *Births, Australia*.www.abs.gov.au/AUSSTATS/abs@.nsf/mf/3301.0

[3] Joint Committee on Infants Hearing. (2007). Year 2007 Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention, *Pediatrics, Vol 120* (1), October 2007, 898-921. https://pediatrics.aappublications.org/content/120/4/898

[4] Gunasakera, H., O'Connor,T.E., Vijayasekaran, S. and Del Mar, C.B. (2009) Primary Care Management of otitis media among Australian Children. *Medical Journal of Australia*, 191(9), 55-59.

[5] Australian Government Department Health. (2017). Otitis Media Guidelines for Aboriginal and Torres Strait Islander Children. https://otitismediaguidelines.com/#/start-main

[6] Audiology Australia. (2012). *Chronic Otitis Media and Hearing Loss Practice* https://audiology.asn.au/Tenant/C0000013/Position%20Papers/Member%20Resources/COMHELP_final.pdf

[7] Australian Government Department of Health, Hearing Services Program. http://www.hearingservices.gov.au

[8] Audiometry Nurses Association of Australia Inc. (ANAA Inc.) http://www.anaa.asn.au

[9] Australian Health Practitioners Registration Agency http://www.ahpra.gov.au

[10] Audiometry Nurses Association of Australia Inc. (ANAA Inc.) http:// www.anaa.asn.au

[11] Local, State and Territory Infection control guidelines accessed as per local service policies

[12] Australian Commission on Safety and Quality on Healthcare. (2019). National Hand Hygeine Initiative : 5 moments For Hand Hygeine. www.safetyandquality.gov.au/our-work/infection-prevention-and-control/national-hand-hygiene-initiative-nhhi/what-hand-hygiene/5-moments-hand-hygiene

[13] NSW Health Audiometry History form (see appendices' 1)

[14] Wormald, P.J. & Browning, G.G. (1996). *Otoscopy – a structured approach*. Arnold, London.

[15] Black, B. (ud). *An introduction to ear disease.* Smith Kline Beecham (Aus.) Pty Ltd

[16] Northern, J.L. and Downs, M.P. (2014). *Hearing in Children* (6th ed.). Lippincott, Williams & Wilkins, Philadelphia.

[17] Saunders, Michael. MD. FRCS. www.entbristol.co.uk (Acknowledgement and appreciation for use of otoscopy tutorial)

[18] Kramer, S. & Brown, D. (2018), *Audiology Science to Practice*. (3rd ed.). Plural Publishing, San Diego CA.

[19] Martin F.N. & Clark J.D.(2014). *Introduction to Audiology (*12th ed.). Allyn and Bacon, Boston.

[20] Yoshinaga-Itano C., Sedey A.L., Coulter D.K. and Mehl A.L. (2008). Language of early and later identified children with hearing loss. *Pediatrics,* Nov, *102*(5), 1161-1171.

[21] Purdy S.C. and Williams M.J.(2000), High frequency tympanometry: a valid and reliable immitance test protocol for young infants? *The New Zealand Audiological Society Bulletin, 10*(3), 9-10,12-21,24.

[22] Kramer, S. & Brown, D.(2018). *Audiology Science to Practice*, (3rd ed.). Chapter 10, Plural Publishing, San Diego CA.

[23] American Speech-Language-Hearing Association (ASHA). (n.d). *Hearing Loss-Beyond early childhood*. https://www.asha.org/PRPSpecificTopic.aspx?folderid=8589935335&section=Assessment

[24] British Society of Audiology.(2013). *Recommended procedure – Tympanometry*. http://www.thebsa.org.uk/wp-content/uploads/2014/04/BSA_RP_Tymp_Final_21Aug13_Final.pdf

[25] American Speech-Language-Hearing Association (ASHA).(n.d). *Hearing Loss-Beyond early childhood.* https://www.asha.org/PRPSpecificTopic.aspx?folderid=8589935335&section=Assessment

[26] British Society of Audiology.(2013). *Recommended procedure – Tympanometry*. http://www.thebsa.org.uk/wp-content/uploads/2014/04/BSA_RP_Tymp_Final_21Aug13_Final.pdf

[27] American Speech-Language-Hearing Association (ASHA). (n.d.). *Hearing Loss-Beyond early childhood.*. https://www.asha.org/PRPSpecificTopic.aspx?folderid=8589935335&section=Assessment

[28] British Society of Audiology.(2013). *Recommended procedure – Tympanometry*. http://www.thebsa.org.uk/wp-content/uploads/2014/04/BSA_RP_Tymp_Final_21Aug13_Final.pdf

[29] Kramer,S. & Brown, D. (2018). *Audiology Science to Practice*. (3rd ed.).Plural Publishing. San Diego CA.

[30] Smith,R. & Gooi, A. (2019). *Hearing Loss in Children: Screening and evaluation*. Up to Date. https://www.uptodate.com.acs.hcn.com.au/contents/hearing-loss-in-children-screening-and-evaluation?search=Degrees%20of%20Hearing%20Loss&source=search_result&selectedTitle=3~150&usage_type=default&display_rank=3

[31] Cain, SE., Gomes, T., Leisner, D., Lenzen, N., Rall, E., Schicke, E., and Uhler, K. (2020). Clinical Guidance Document: Assessment of Hearing in Infants and Young Children. *American Academy of Audiology* https://www.audiology.org/sites/default/files/publications/resources/Clin%20Guid%20Doc_Assess_Hear_Infants_Children_1.23.20.pdf

[32] Campbell, K. (2018). Otoacoustic Emissions. *Medscape*. https://emedicine.medscape.com/article/835943-overview#a6

[33] Cain, SE., Gomes, T., Leisner, D., Lenzen, N., Rall, E., Schicke, E. and Uhler, K. (2020) Clinical Guidance Document: Assessment of Hearing in Infants and Young Children. *American Academy of Audiology* https://www.audiology.org/sites/default/files/publications/resources/Clin%20Guid%20Doc_Assess_Hear_Infants_Children_1.23.20.pdf

[34] Kramer,S., Brown, D., (2018). *Audiology Science to Practice*. (3rd ed.). Plural Publishing. San Diego CA.

[35] Cain, SE., Gomes, T., Leisner, D., Lenzen, N., Rall, E., Schicke, E. and Uhler., K. (2020). Clinical Guidance Document: Assessment of Hearing in Infants and Young Children. *American Academy of Audiology* https://www.audiology.org/sites/default/files/publications/resources/Clin%20Guid%20Doc_Assess_Hear_Infants_Children_1.23.20.pdf

[36] Australian Standards *ISO 8253.2-2009 Acoustics – Audiometric test methods*

[37] Kramer, S. & Brown, D.(2018). *Audiology Science to Practice*. (3rd ed.). Plural Publishing. San Diego CA.

[38] Audiology Australia. (2013). *Professional Practice Standards Part B Clinical Standards.* https://audiology.asn.au/Tenant/C0000013/Position%20Papers/Member%20Resources/Clinical%20Standards%20partb%20-%20whole%20document%20July13%201.pdf

[39] British Society of Audiology. (2018). *Recommended Procedure: Pure-tone air-conduction and bone-conduction threshold audiometry with and without masking*. Bathgate, UK. https://www.thebsa.org.uk/wp-content/uploads/2018/11/Recommended-Procedure-Pure-Tone-Audiometry-August-2018-FINAL.pdf

[40] Kramer, S. & Brown, D., (2018). *Audiology Science to Practice*. (3rd ed.). Plural Publishing, San Diego, CA

[41] The Australian Government. (2013). *National Framework for Neonatal Hearing Screening. Department of Health*. https://www1.health.gov.au/internet/main/publishing.nsf/Content/neonatal-hearing-screening

[42] World Health Organization (WHO). 2021. World report on Hearing. https://www.who.int/publications/i/item/world-report-on-hearing

[43] Dirks, D.D. (2014). Bone conduction threshold testing. In J. Katz (Ed) (7th ed.). *Handbook of Clinical Audiology*. Lippincott Williams & Wilkins, Baltimore.

[44] Martin, F.N. and Clark, J.G., (2014). *Introduction to Audiology. (12th* ed.). Allyn and Bacon, Boston.

[45] Kramer, S. & Brown, D., (2018). *Audiology Science to Practice*. (3rd ed.). Plural Publishing, San Diego, CA.

[46] British Society of Audiology. (2018). *Recommended Procedure: Pure-tone air-conduction and bone-conduction threshold audiometry with and without masking*. British society of Audiology, Bathgate UK. https://www.thebsa.org.uk/wp-content/uploads/2018/11/Recommended-Procedure-Pure-Tone-Audiometry-August-2018-FINAL.pdf

[47] Bess, F.H. & Hume, L.E., (2008). *Audiology – the fundamentals.* (4th ed.), Lippincott Williams, Philadelphia.

[48] Goldstein B.A. & Newman C.W.(2014). Clinical masking: a decision making process. In J.Katz (Ed), *Handbook of Clinical Audiology,* (7th ed). Lippincott Williams & Wilkins, Baltimore.

[49] British Society of Audiology. (2018). *Recommended Procedure: Pure-tone air-conduction and bone-conduction threshold audiometry with and without masking*. British society of Audiology, Bathgate UK. https://www.thebsa.org.uk/wp-content/uploads/2018/11/Recommended-Procedure-Pure-Tone-Audiometry-August-2018-FINAL.pdf

[50] Kramer, S. & Brown, D., (2018). *Audiology Science to Practice.* (3rd ed.). Plural Publishing, San Diego, CA.

[51] Kramer, S. & Brown, D. (2018). *Audiology Science to Practice. (*3rd ed.), Plural Publishing, San Diego, CA.

[52] Kramer, S. & Brown, D. (2018). *Audiology Science to Practice. (*3rd ed.). Plural Publishing, San Diego, CA.

[53] Northern, J.L. and Downs M.P. (2002). *Hearing in Children*. (5th ed). Lippincott Williams & Wilkins, Philadelphia.

[54] Martin, F.N. & Clark, J.D. (2014). *Introduction to Audiology* (12th ed.). Allyn and Bacon, Boston.

[55] Northern, J.L. and Downs, M.P. (2002). *Hearing in Children*. (5th ed.). Lippincott Williams & Wilkins, Philadelphia.

[56] Kramer, S. & Brown, D.(2018). *Audiology Science to Practice. (*3rd ed.). Plural Publishing, San Diego, CA.

[57] British Society of Audiology. (2014). *Recommended Procedure: Visual Reinforcement Audiology*. British society of Audiology https://www.thebsa.org.uk/resources/visual-reinforcement-audiometry-infants/

[58] Northern, J.L. and Downs, M.P. (2002). *Hearing in Children*. (5th ed). Lippincott Williams & Wilkins, Philadelphia.

[59] Mehl, A.L. and Thomson, M.A. (2002). The Colorado Newborn Hearing Screening Project, 1992–1999: On the Threshold of Effective Population-Based Universal Newborn Hearing Screening, *Pediatrics, 109*(1),1-8

[60] Joint Committee on Infants Hearing. (2007).Position Statement: Principles and Guidelines for Early Hearing Detection and Intervention. *Pediatrics*, 120(1), 898-921.

[61] Allen,D., Harlor, B. Jr. & Bower,C. (2009). Clinical Report- Hearing assessment in infants and children: recommendations beyond neonatal screening. *Paediatrics*. 124(4):1252-1263

[62] Hutt, N. & Rhodes, C. (2008). Post natal hearing loss in universal newborn hearing screening communities: current limitations and future directions. *Journal of Paediatrics and Child Health*. 44 (3), 87-91.

[63] Nance, W.E, Lim, B.G and Dodson, K.M, 2006, Importance of congenital cytomegalovirus infections as a cause for pre-lingual hearing loss. *Journal of Clinical Virology*, 35(2), 221–225.

[64] Australia/New Zealand Standards (2014). *1269:2014 Occupational Noise Management Part 4: Auditory Assessment.*

[65] Nursing and Midwifery Board of Australia (NMBA).(2016). *Registered Nurse Standards for Practice.* https://www.nursingmidwiferyboard.gov.au/codes-guidelines-statements/professional-standards.aspx