

CICADA AUSTRALIA INC.

**HEARING LOSS
and
HEARING SOLUTIONS**

A GUIDE

CONTENTS:

INTRODUCTION

1. PERCEPTIONS OF HEARING LOSS AND BARRIERS TO HEARING SOLUTIONS

2. HOW NATURAL HEARING WORKS

3. HEARING TESTS AND AUDIOGRAMS

4. TYPES OF HEARING LOSS WITH EXAMPLE AUDIOGRAMS

5. SOLUTION OPTIONS - LIMITATION AND PREVENTION

6. SOLUTION OPTIONS - CATEGORIES OF HEARING AIDS

7. SOLUTION OPTIONS - CATEGORIES OF IMPLANTABLE DEVICES

8. SOLUTION OPTIONS - MATCHING WITH HEARING LOSS TYPES

9. HEARING AIDS AND IMPLANTABLE DEVICES - COMMON FEATURES

10. CONCLUSION: DO SOMETHING ABOUT IT, BE IN GOOD COMPANY

A GUIDE to HEARING LOSS and HEARING SOLUTIONS

INTRODUCTION

WHY THIS GUIDE?

About one-third of Australian adults have some degree of hearing loss. That is about 3.5 million, of which some 2.5 million should have some form of hearing assistance but do not use it or have not tried any. Proportions are similar in other developed countries. Many people do not recognise their problem, others are in denial and some fear a stigma associated with a visible hearing solution. Myths include beliefs that hearing aids don't work, that cochlear implants are only for children, and that hearing devices make one look older or handicapped.

This CICADA Guide therefore starts by summarising the numerous perceptions and misconceptions about hearing loss and the barriers to wider use of hearing solutions. The subsequent sections deal with what is involved in understanding hearing loss and potential solutions.

WHAT IS CICADA?

CICADA is a charity, originally established in 1984 as the Cochlear Implant Club and Advisory Association. CICADA now supports implant recipients and hearing-impaired Australians generally. As an independent, non-profit organisation CICADA Australia Inc. offers unbiased guidance through the difficult and emotional process of choosing and using hearing technology.

Overall, CICADA aims to keep up to date with developments in hearing technology through:

- Social events
- Guest speakers
- Technology expos
- National magazine (now the responsibility of the Tangelo group)
- State newsletters
- Interactive website
- Providing support from its members who have experience of all types of hearing aids and implantable devices.

WHO IS THIS GUIDE FOR?

Those who are hearing-impaired, their families and friends, and for medical, audiological and other professionals in the hearing health field.

We hope this Guide will help address the lack of awareness of the wide range of solutions available and the types and degrees of hearing loss that they apply to.

ACKNOWLEDGMENTS:

CICADA Australia Inc. would like to acknowledge the following people for their contributions to this Guide:

- **NEVILLE LOCKHART - CONTENT AND EDITING:**

As a toddler in Scotland after the war, Neville's hereditary deafness was quantified as total in the left ear and about 70% in the right ear. With hearing aids, years of speech therapy and continuous support from family, teachers and classmates, he progressed well at normal schools. In mid-teens there was a sudden loss of residual hearing along with tinnitus. Neville had to rely on lip-reading through the rest of school and at Strathclyde University. He undertook extensive library work to compensate for what he missed aurally, ending up with B. Sc in Chemistry followed by Ph. D in the solid state physics area, in both cases with the university medal and prize for top graduate. A teaching fellowship at the University of Nottingham followed, including research on electrical processes in biological materials.

Neville came to Australia in 1974 to join the Commonwealth Scientific and Industrial Research Organisation (CSIRO). He progressed to the senior research levels through the different fields of textiles, environment, coal and minerals that reflected changing government R&D needs. He then moved into management of R&D and technology. He became strategy and business development manager for the Division of Energy Technology and pulled together the Flagship Program "Energy Transformed" to address efficiency and greenhouse issues in the electricity generation, transport and energy end-user sectors. Neville was fortunate that facsimile machines, followed by mobile phone texting and emails, and then personal assistants helped him cope with the increasing communication requirements. He took early retirement in 2002 because of political and relocation issues, not deafness-related.

After "retirement" Neville recalled visiting Prof Graeme Clark in 1983 and being advised he "heard" extremely well and it would be better to come back in 15-20 years when the cochlear implant was hopefully much better developed. After bringing himself up to date, including attending CICADA functions and talking to many implant recipients, and with the support of Judy and the children and grandchildren, Neville proceeded with the then newest cochlear implant (Freedom) in 2005 through SCIC and Prof Bill Gibson.

What a noisy world! But after 6 months he was achieving over 90% in sentence recognition tests in quiet without lip-reading, well above expectations for someone totally deaf for over 40 years. While he still has difficulties in noise and with the phone, the implant has been a great success, both socially and in work for CICADA. Neville was a committee member for 9 years. He became editor of the national newsletter (6 pages and 2000 circulation) and helped develop this into the 28 page glossy CICADA magazine with 20,000 circulation, filling a huge gap for the hearing-impaired and professionals in the hearing sector. The magazine was handed over in 2012 to the Tangelo Group to further develop and expand as Hearing HQ magazine; Neville is a member of the Editorial Advisory Board. He also helped with the revamp of the CICADA members newsletter Buzz and with material for the CICADA website.

Neville's technological management background in identifying unmet needs, along with his science communication experience, led him to attempt this CICADA Guide to Hearing Loss and Hearing Solutions. Neville welcomes the launch of this updated Guide on the CICADA website, which has been upgraded and further developed with Pat as webweaver.

- **PATRICIA MITCHELL – LAYOUT, DESIGN AND GRAPHICS:**

Pat is also CICADA Australia Inc. volunteer webweaver. She was formerly a website designer and computer support staff member at La Trobe University IT Division, following many years in the private sector. She has created websites on deafness, photography and healthy eating, Pat has been hearing-impaired for nearly 70 years, profoundly so for the last 20 years. She received her first cochlear implant in February 2014 and the second in February 2016. You can read more of Pat's story through this link: [What Price Hearing?](#)

- **MARGARET ANDERSON:**

A former audiologist and clinical development manager, Margaret retired in 2011 after 33 years with Australian Hearing. She has written and delivered many learning programs, is responsible for countless information brochures and articles related to hearing loss, plus tucked in six years in publications and PR into her career. She now freelances as a Learning, Design and development consultant to the hearing industry from her tree change 50 acres at Crookwell, NSW.

- **MARIE-LOUISE (MUIR) HEKEL:**

A thirst for excellence in communication, expression and understanding led her to Master degrees at Columbia University in Speech Pathology and Audiology. Ten years in hospital diagnostic and clinical casework angered her enough to push boundaries, create hearing aid legislation in New York, teach undergraduates and establish a private practice. After twenty-six years in the Australian hearing aid industry, education and a Collins Street practice

specializing in “Auditory Re-Awakening”, she retired with her husband on 5 acres. Marie-Louise enjoys creative arts, sport, cooking and the friendship of many past clients.

- **ROBERTA MARINO:**

Roberta has 20 years experience as an audiologist with expertise in hearing aids, cochlear implants and other hearing implantable solutions. She is currently Senior Audiologist at Specialist Hearing Services and at Fiona Stanley Hospital, Perth and is Adjunct Research Fellow at the University of West Australia. She has presented at various national and international conferences and published papers in peer-reviewed international journals relating to cochlear and middle ear implants.

MARGARET, MARIE-LOUISE AND ROBERTA - all professional audiologists (retired and practising) - refereed the drafts and made valuable corrections and improvements. Some of their experiences and insights have been incorporated as breakout boxes in appropriate parts of the text.

1. PERCEPTIONS OF HEARING LOSS AND BARRIERS TO HEARING SOLUTIONS

Only a small proportion of those who need or would benefit from a hearing solution actually have one or have even tried one.

The barriers and perceptions are many:

- (I) Lack of Awareness
- (II) Denial
- (III) Unrecognised Impacts of Hearing Loss
- (IV) Misbeliefs and Unrecognised Value of Solutions
- (V) Poor Medical Guidance, Commercial/Vested Interests
- (VI) Stigma and Public Attitudes
- (VII) Cosmetics
- (VIII) Cost
- (IX) Inadequate Information
- (X) Fragmented Support Groups

(I) Lack of Awareness:

Many people are still unaware or apathetic about damage to hearing through exposure to excessive or prolonged noise or that the damage is cumulative and permanent.

Many people are not aware they have a hearing loss, even when it is more than a mild loss, especially when the onset is gradual and the person and their family/friends adapt to it often without realising they are adapting.

Indifference to noise exposure and apathy are applicable to lots of people, with or without a hearing loss:

Do YOU find it hard to....

- Follow conversations?
- Understand family & friends?
- Notice soft sounds?
- Separate voices from background noise?
- Hear on the phone/mobile?

If you said yes to any of these questions, it may mean there is some hearing impairment. Hearing checks are widely available, including free telephone and website tests that one can carry out oneself. Follow up quantification by professionals is covered in Section 3 of this Guide.

The most common reason for people getting their first hearing aid is that their 'hearing got worse' and they are experiencing increasing communication problems and embarrassments.

At the other extreme, people have been motivated to seek a hearing solution after losing contracts or jobs due to misunderstandings. It is important to identify hearing loss earlier and not delay a solution.

AUDIOLOGIST COMMENT 1

IF ONLY

If all individuals, from childhood to adulthood, would have REGULAR threshold testing - i.e. every 2 years for a child, every 3 years for a student, and every 5 years for an adult, - AND if all doctors, especially GPs, would understand and explain the social and psychological consequences of hearing loss on both the individual and their associates, much of the apathy and misconceptions could be eliminated.

AUDIOLOGIST COMMENT 2

AH-HA MOMENTS

One of the most dramatic "Ah-Ha" moments in my client's lives (or the parents of hearing-impaired children) happens when I demonstrate the difference between listening to familiar, recorded music or speech or environmental noises, VIA SPEAKERS - FIRST with their natural hearing AND THEN with instruments set to correct adjustment for the loss. HEARING THE DIFFERENCE ALLOWS BELIEVING, - and with today's digital technology, this is easy and inexpensive.

AUDIOLOGIST COMMENT 3

ASK for a PROFESSIONAL DEMO

of listening to the radio, or their loved one's voice, or a favourite recording, or recorded environmental sounds while wearing/using a hearing aid set to the correct prescription for someone's hearing loss IS NOT UNREASONABLE AND HIGHLY DESIRABLE.

(II) Denial:

Facing up to a loss of ability in an area of our lives can be difficult, and hearing loss is no exception.

Among the justifications:

- “I don’t have a problem” (though it is obvious to others),
- “my hearing loss not severe enough”,
- “my loss too mild”,
- “I hear well in most situations”,
- “my hearing loss is not disruptive to my life”,
- “hearing aids are a hassle”,
- “other people mumble”.

There are many reasons why people won’t deal with fading hearing. Some people, struggling to admit there is a problem, may not want to confront their advancing age, or are afraid of how they will manage or afford a hearing aid. Some genuinely don’t realise there is an issue as their hearing is fading so gradually they haven’t noticed it. In fact, in most cases it is someone else who notices the hearing loss, not the person with the impairment.

(III) Unrecognised Impacts of Hearing Loss:

The Australian Hearing CRC and Access Economics have estimated the costs of untreated hearing loss at \$11.75billion annually, including 160,000 who would otherwise be employed and off welfare, and that costs to business are \$1880 per employee per year. US studies estimate reduced earnings potential of \$30,000pa for impaired employees. Importantly, in recent years hearing loss has been linked to Alzheimers and dementia. The greater the degree of (untreated) loss the greater the risk, while if hearing solutions are used the incidence falls to the same level as for the general population in the same age group. The link is not necessarily causative, but may be partly or wholly due to social isolation and lack of stimulation as a result of untreated hearing loss.

AUDIOLOGIST COMMENT 4**DISCRIMINATION in PRACTICE**

No matter if legislation exists which states that one cannot discriminate against the “disabled”, if an individual cannot hear subtle or soft information, cannot come across as being ‘an active, attentive, interested individual’ in the customer’s needs, they will not be hired or promoted. Simple!

Untreated hearing loss causes great problems in many relationships. “He won’t get a hearing aid.” “She won’t stop talking from another room”. Tension all round. Too often it is another family member who begs the hearing-impaired person to get an aid. “I had to force him to get hearing aids” is a common scenario in affected families. Audiologists often say “however hard it is for you, it’s harder for your family”. Most hearing aid wearers and recipients of implantable devices, agree with this, at least in hindsight.

(IV) Misbeliefs, Fear and Unrecognised Value of Solutions:

Common misbeliefs are that hearing aids don’t work, are not good enough or have too many problems; these are not true certainly for modern technology. Another myth is that cochlear implants are only for children, or even that cochlear implants come from dead people or organ donors. Fear of surgery, necessary for all implantable devices, is also a barrier for some people, as is the fear “what if it does not work”. This is despite the relatively minor nature of most modern implant surgery and the low incidence of complications. In addition, success rates are extremely high while many patients with profound hearing loss can rationalise any fears of failure in that they are no worse off!

Surveys of hearing aid wearers and implant recipients repeatedly demonstrate high levels of satisfaction with their devices. Objective assessment, unbiased advice and auditory rehabilitation to maximise the benefits are all important, along with realistic expectations.

For example, hearing aids won’t cut out all unwanted noise, and cochlear implants do not restore hearing to normal. Nevertheless, nearly all hearing impairment has one or more solution options. For older children and adults who have had no hearing since birth, implants can at least help with environmental sounds and with lip reading, such that with prior counselling even signing deaf recipients can benefit.

(V) Poor Medical Guidance, Commercial/Vested Interests:

Many General Practitioners, specialists in Gerontology, even some specialists in Ear, Nose and Throat are not aware of some of the above factors, nor of the wide range of hearing solutions available and who would benefit from them. Worse, some give incorrect information such as telling a patient:

- “you still have good hearing in one ear”,
- “you can converse in quiet”,
- “you’re fine, you understand me face-to-face in my rooms”,
- “your hearing loss is normal for your age”,
- “nothing can be done for nerve deafness” etc.

Hearing impairment can be misinterpreted as senility, while children can be misdiagnosed as slow, intellectually impaired, attention deficit etc when these symptoms may be a consequence of hearing loss.

Another factor can be hearing aid clinics which offer a limited range of hearing aids and/or may be tied to one manufacturer, and have commercial/ vested interests in selling a solution that is not fitted properly or not the most appropriate device. To keep this in perspective, modern surveys also demonstrate high levels of satisfaction with professional services in this field. Dissatisfaction is greater with cut-price, one-fits-all approaches and on-line purchases.

(VI) Stigma and Public Attitudes:

Some people reject hearing solutions because they believe it makes others feel they are less competent, unattractive, older, handicapped etc. This may be exacerbated by modern society being perceived as oriented towards youth, attractiveness, communication, and consumerism. But it is not hearing solutions that make one look older or incompetent, it is attitude, personality and other factors besides biological age.

It is the misinterpretation of conversations, need for repetition/clarification and withdrawing from social interactions that is more often the cause of a stigma. In a surprising twist, hearing technologies are now often thought to be MP3 players and hands-free phone devices, making users of hearing aids look very technology savvy.

AUDIOLOGIST COMMENT 5

INTIMACY

Often overlooked even by many professionals is to discuss with 'youthful - no matter what chronological age' clients the improvement in "INTIMACY". Sounds of intimacy, whether physically sexual or tenderness in words, are lost when the partner must raise their voice. It's wonderful with the use of amplification to catch those murmured "sweet nothings" again.

(VII) Cosmetics:

Cosmetic issues are no longer a barrier. Since the 1990s completely-in-the canal (CIC) devices provided virtual "invisibility". And if one needed a more powerful or suitable device, the in-the-canal (ITC) aids were only slightly larger. Public figures have commented along the lines that "people still think that you have to wear a huge contraption but, in fact, they can be colour

matched to your hair and are very discreet”. The argument goes ‘Let’s face it, you associate hearing loss with getting old and boring. But who says you can’t be sexy and wear hearing aids?’

In Australia, the last five years has seen a shift away from custom moulded ‘in-the-ear’ products back toward behind-the-ear hearing aids (BTE). Ironically, a behind-the-ear instrument can be more cosmetically appealing than an in-the-ear device as current designs render them small and light, less visible, and physically more comfortable for the wearer. For many hearing-impaired clients, a custom-made ear mould is no longer required. Some hearing instruments communicate sound to the ear via a visually-transparent capillary tube or wire, connected to a miniature loudspeaker suspended in the open ear canal.

Advanced feedback cancellation technology has allowed the current generation of hearing instruments to use a more comfortable open ear fitting without any whistling. This design means that the ear is not blocked with a mould enabling it to breathe and does not impair the natural acoustics of the ear. Attractiveness is being addressed with professional fashion designers dealing with product imagery, and the cosmetic appeal of hearing aids has soared. Bone-anchored hearing aids are much less visible than conventional bone conduction hearing aids. Cochlear implants and other implantable devices may be more apparent, but can also be nearly invisible for females and others with longer hair.

(VIII) Cost:

Costs, and government plus private insurance rebates, vary from country to country. In Australia, privately-purchased devices (excluding internet sales) range from \$1500 for a basic hearing aid to \$12,000 for a pair of premium aids. There are usually many services included in the cost of hearing aids, such as hearing tests, expert assessment, initial fitting, follow up adjustments, cleaning and warranty. Also while the overall cost of hearing aids (and implants) have remained steady, the technology and sophistication at these same cost levels are much enhanced. A top-of-the-line aid a few years ago would be considered basic now. Cochlear implants with wireless accessories can range up to \$30,000 for a pair, plus surgical and rehabilitation costs.

Health insurance is available at reasonable cost to the general population. Most insurers provide at least partial reimbursement for hearing solutions, including any necessary upgrades and replacements at intervals of several years. The Australian government provides fully subsidised hearing aids and services for children and young adults up to 26 years and for pensioners and war veterans. The majority of cochlear implants are supplied with little or no cost to the recipient, due to health insurance and other funding sources. The surgical component is covered by Medicare and private insurance.

A consequence of the cost issue is the recent expansion of over-the-counter, on-line and mail order hearing aids. These can be OK but buyer beware! Readers are referred to a large survey by the Better Hearing Institute comparing satisfaction levels for those who had minimal services with those who had professional service protocols:



(IX) Inadequate Information:

There is plenty of information from manufacturers and clinics and on the internet. But that information is dispersed, often overlaid with marketing hype, and it is difficult and time-consuming to understand in any systematic way.

The wide variety of hearing aids across different manufacturers may not be categorised according to the specific types and degrees of hearing loss that particular styles and models apply to. Implantable devices are much less well known, yet the types and applications are expanding, while comparative information is hard to find.

Furthermore, hearing aids and implantable devices are not compared, certainly not in any systematic way, despite the increasing areas of overlap and integration.

CICADA hopes this guide and website information is a significant step towards overcoming this problem.

(X) Fragmented Support Groups:

There are numerous support groups for the hearing-impaired (as well as for the signing Deaf community) and many websites and other on-line resources. In Australia, the major and longest-established is Better Hearing Australia while the peak government body is Deafness Forum. Many others have narrower or more specific aims, such as Aussie Deaf Kids, Parents of Deaf Children and Hear for You (aimed at teenagers and young adults).

The key social and economic issue is that some 2.5 million Australians should have a hearing solution but do not. Statistics are similar in other countries. The Better Hearing Institute notes that more than 22 million people in the USA need but have not tried hearing solutions. Action on Hearing Loss (formerly RNID) estimates this figure at about 4 million for the UK.

Hence CICADA's thrust for the last three years:

Helping hearing-impaired Australians achieve the optimum, tailor-made solution to improve their hearing.

This guide and website information is a key step towards this end.

AUDIOLOGIST COMMENT 6**DEAF vs HEARING IMPAIRED**

Of all the terms related to hearing, the term DEAF should only be used to denote true deafness, that is the absence of all hearing. The comparison is that someone who is BLIND, CANNOT BENEFIT FROM SPECTACLES/GLASSES. Those who wear glasses need correction with lenses. A majority of hearing LOSS OR IMPAIRMENT, is just that - an impairment - and can benefit from correction through a variety of instruments.

Sections 2 to 10 which follow, deal with what is involved in understanding hearing problems and investigating potential solutions. Many other topics that are relevant or interesting to hearing-impaired people are not included in order to maintain this focus and keep the Guide a reasonable length.

'Assistive Listening Devices' (ALDs) have developed in parallel with the revolution in consumer electronics – the digital, miniaturisation and wireless trends that have advanced audiovisual and music devices, mobile phones, computers

and so on. These are not covered in the Guide except for Bluetooth wireless accessories that are specifically built in to, or associated with, digital hearing aids and implants.

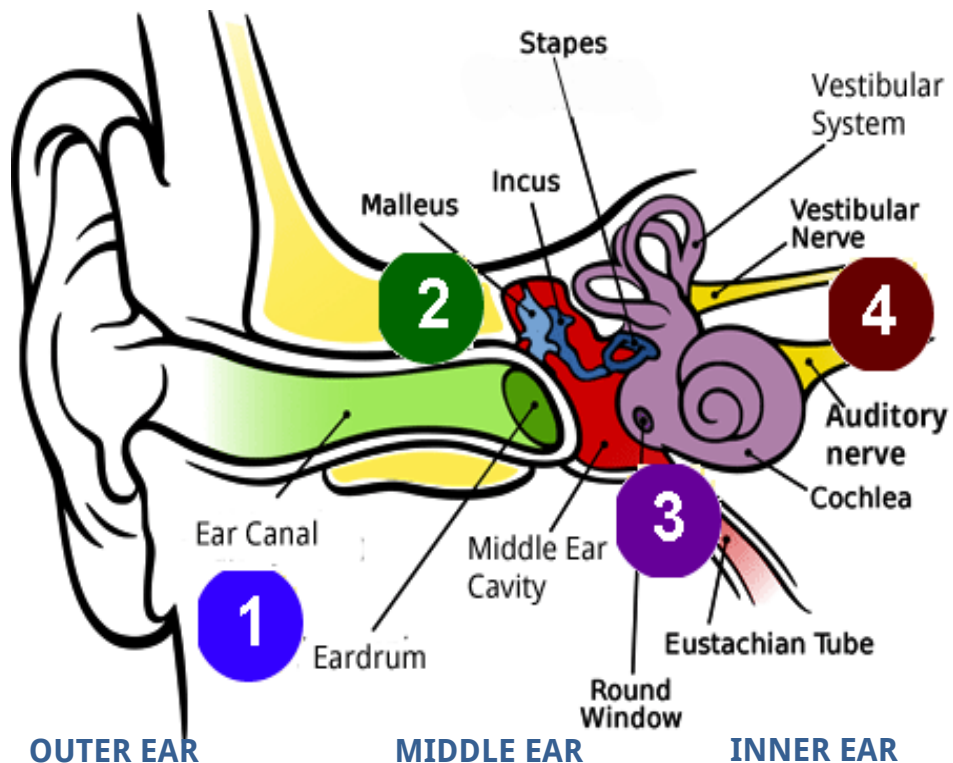
The purpose of ALDs is improved understanding especially in noisy environments, with speakers some distance away, when many people are talking, and in using telephones or enjoying TV programs without background noise. Some ALDs, and also the latest developments in smart phones and their software applications, can in fact be substitutes for people who have mild to moderate hearing loss but are reluctant to use hearing aids.

Many hearing-impaired people have outstanding achievements in business, academia, sport or other areas, in some cases while they were deaf and before they received hearing aids or implants. Such personal stories of the famous and not-so-famous are numerous and inspiring, but they too are only summarised briefly in Section 10.

Conditions commonly associated with hearing loss such as Tinnitus and Meniere's Disease are mentioned only briefly, as are the specialised medical descriptions of hearing disorders and the exciting research or likely future developments. Interested readers are referred to the CICADA national magazine 2009-2012 issues, the contents of which are posted on the [CICADA website](#), and to its successor HQ magazine and website www.hearinghq.com.au.

2. HOW NATURAL HEARING WORKS

Sound enters our ear and sound waves funnel down the ear canal to the eardrum.



1 This is the outer ear.

2 The middle ear begins at the eardrum. Sound waves make the tympanic membrane vibrate like a drum (hence the term “eardrum”). Beyond the eardrum is an air-filled space containing three middle ear bones, the smallest bones in the body. These carry the vibrations to the inner ear.

3 The sound vibrations transfer to fluids in the cochlea, a snail-shaped structure containing “hair cells”. Fluid movement causes these tiny hair cells to bend. Hair cells at one end of the cochlea send low pitch sound information and hair cells at the other end send high pitch sound information.

4 The movement of the hair cells creates electro-chemical signals that are picked up by the auditory nerve. The auditory nerve sends signals to the brain where they are interpreted as sounds and given meaning.

The inner ear actually comprises two functionally separate sections:

The vestibular or balance part and the cochlea, which is the hearing part. The former helps us sense acceleration/deceleration in all directions, head position in relation to gravity, and to maintain sharp visual focus as we walk, run, ride, chew etc. Balance disorders, head noises (tinnitus) and hearing impairment are sometimes linked, such that some clinics deal with tinnitus, Meniere's disease and hearing loss in a holistic approach. Tinnitus does not cause hearing loss but is a common symptom, while the progression of Meniere's disease is usually accompanied by increasing hearing loss. Both tinnitus and Meniere's can be helped by hearing aids and implantable devices, but this Guide focuses on the hearing loss aspects.

3. HEARING TESTS and AUDIOGRAMS

The first step is recognising some of the tell-tale signs which can include:

- mishearing words or asking people to repeat what they say
- finding them hard to understand when not facing you
- feeling people mumble or do not speak clearly
- greater difficulty in following conversations in noisy environments
- ringing, buzzing or other noises in the ears
- poorer understanding of, and/or a need to turn up the volume on the telephone, radio or TV
- problems identifying the direction sounds are coming from
- distortion of speech and music.

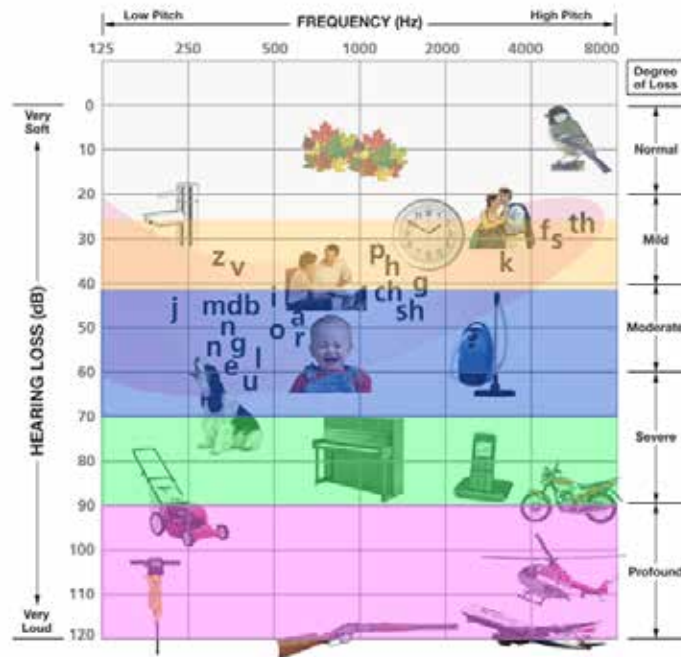
Simple hearing tests such as telephone checks offered by Australian Hearing are useful. Note that very few GPs routinely carry out hearing tests, and hearing problems are rarely recognised in the quiet one-to-one environment of a doctor's surgery!

The second step is to have a specialist (ENT, audiologist or audiometrist) quantify and classify the hearing loss. This starts with a case history – details of general health and specifics about the hearing loss. Next, a visual inspection of the ear canal and eardrum is performed with an otoscope (ear light) to check for any blockages or abnormalities in the outer ear. Then hearing is tested in a quiet room or sound-treated booth by presenting a series of tones through earphones to each ear.

The softest levels of each tone one can hear (the thresholds of hearing), across the frequency range in Hertz (Hz) units from 250Hz (very low pitch) to 8000Hz (very high pitch), are recorded on a graph.

This Graph is called an **audiogram**. On the decibel (dB) scale, 0dB represents extremely soft and 120dB extremely loud. The severity of hearing loss is described in terms of degree of disability or impact on everyday life. A mild hearing loss would cause mild problems, a severe hearing loss would cause severe disruption to communication and lifestyle. The chart below illustrates the various degrees of loss.

Normal hearing (Grey)
-10dB to +20dB;
Mild Loss (Orange)
20dB to 40dB;
Moderate Loss (Light Blue)
40 to 55dB;
Moderately Severe
(Dark Blue) 55 to
70dB;
Severe (Green)
70 to 90dB;
Profound (Pink)
90 to 120dB

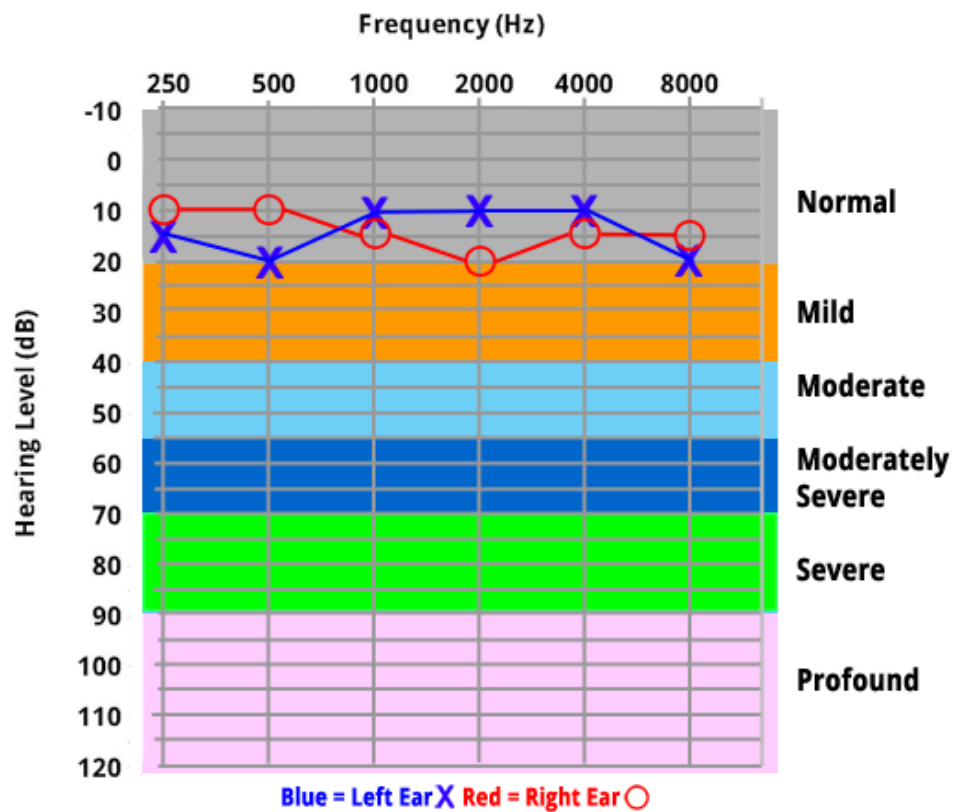
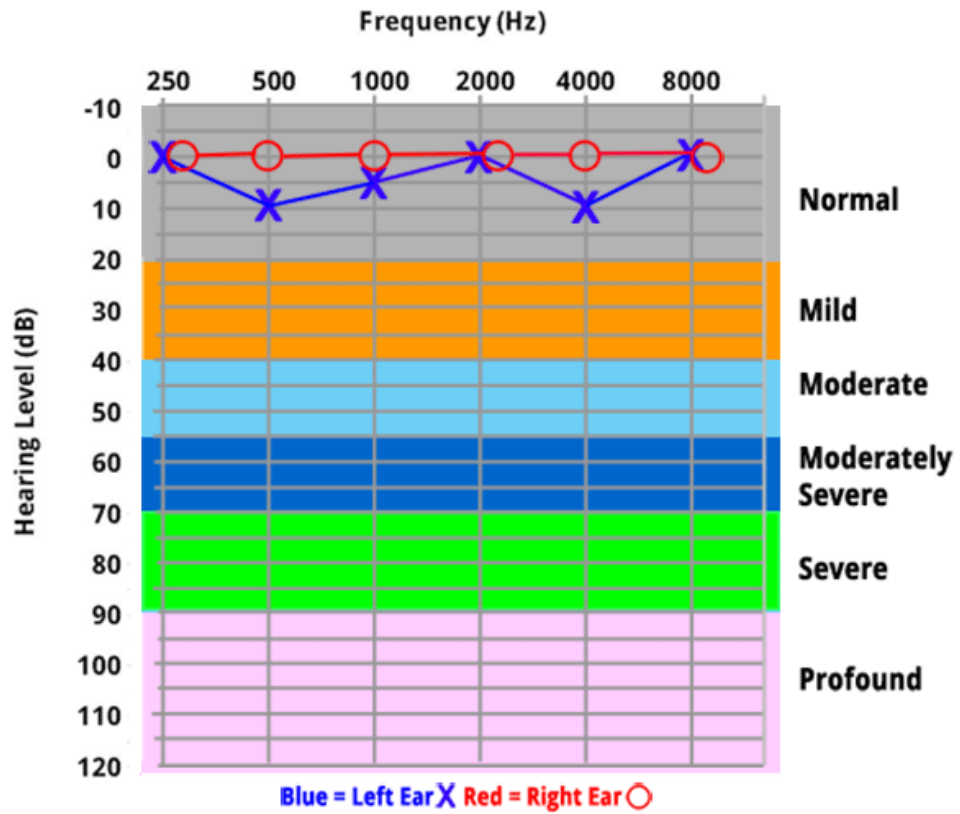


The hearing test using earphones is referred to as air conduction. When this test reveals a hearing loss, it is supplemented with bone conduction testing. A small vibrator is placed on the mastoid bone directly behind the ear and sound is transmitted through the bones of the skull directly to the inner ear, bypassing the outer and middle ear.

On the audiogram, air conduction hearing thresholds (softest sounds heard) are shown as O for the right ear and as X for the left ear. The bone conduction hearing thresholds are represented by < and > respectively.

Examples of **normal hearing** audiograms are shown below.

There is commonly some variation for individual people across the frequency range and between their right and left ears. 0dB is considered to be the average normal hearing for a 21 year old. This means some people can hear at much quieter levels down to -20dB while others whose hearing ranges to +20dB are also considered normal hearing.



AUDIOLOGIST COMMENT 7

NORMAL HEARING does NOT mean NO HEARING LOSS

If you have grown up with better than average hearing say 0dB, and are a healthy individual most of your life, and you begin to have trouble understanding (as opposed to hearing) certain speakers well, and you get tested - YOUR HEARING WILL BE CLASSIFIED NORMAL IF 20dB IS THE SOFTEST LEVEL YOU CAN HEAR ACROSS THE FREQUENCIES TESTED.

Unfortunately, you may have lost 20dB of your hearing and this means a significant loss of perception and your brain struggles to follow what you had no trouble with years before. THIS IS WHY SOME CHILDREN AND ADULTS CAN AND DO STRUGGLE WITH 20dB HEARING ACROSS THE ENTIRE FREQUENCY RANGE.

Audiograms representative of various degrees of hearing loss follow in Section 4. The difference or the lack of any difference between the air conduction (X and O) lines and the bone conduction (> and <) lines determines the nature of the hearing loss.

Hearing tests may extend further to:

- assessing ability to understand words or sentences, (before and after scores are a routine measure of the success of hearing aids or implants)
- tympanometry for the middle ear function and acoustic reflex for neural pathway
- otoacoustic emission testing which assesses the functioning of the inner ear
- auditory brainstem testing (ABR)

ABR is the foundation for universal newborn hearing screening (UNHS) by which nearly all babies in Australia and most other developed countries are checked for hearing loss soon after birth.

AUDIOLOGIST COMMENT 8

HEARING CHECKS FOR CHILDREN

The time to have a hearing test is age 2 or 3 to set a baseline and testing should be as regular as eyesight tests.

Why - a mild or even worse hearing loss can be hard to pick up if a young child is bright or particularly alert. Some children are misjudged as slow learners, troublemakers, or learning-impaired. Some end up language-delayed and functionally-impaired because their loss was not identified.

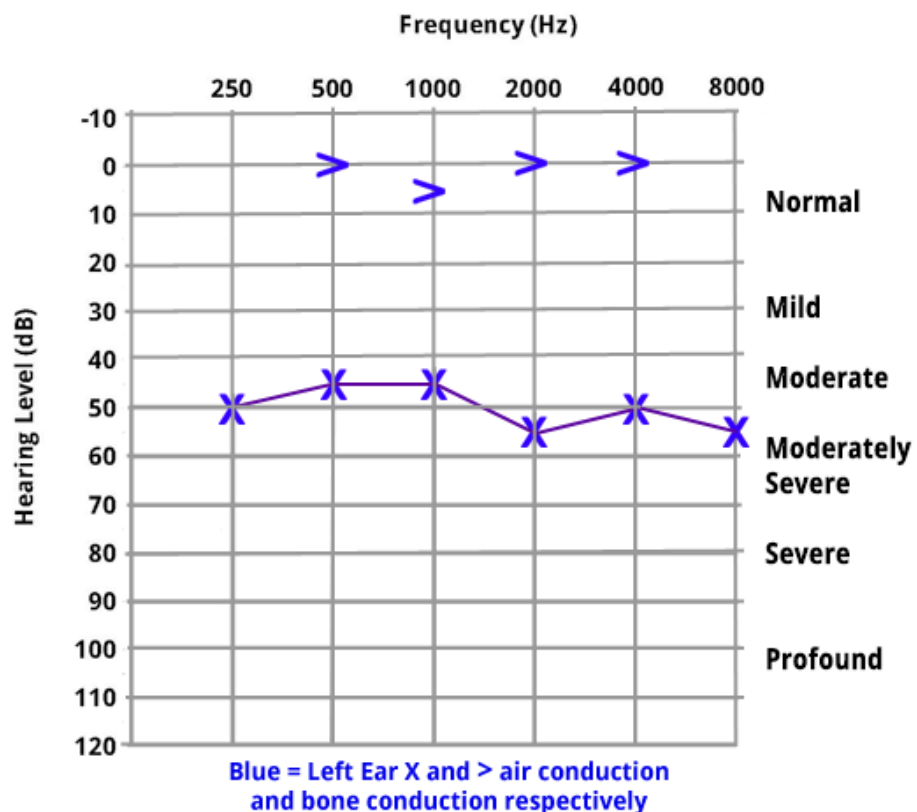
Ear examination - If possible, seek out a professional who can make a photo of your ear canal and your ear drum on both ears. This equipment, called a Video-Otoscope, allows you to see what the examiner is seeing and has been around since the early 1990's. Being able to see your own ear canal and ear drum, especially when you may use a hearing aid, is of vital importance. The other reasons for doing this is to show the health and condition of the outer ear and ear drum so to coordinate health records. This equipment also helps show and explain how the tip of any conventional hearing devices can get blocked with dirt, dust, dry skin, wax or fluids.

4. TYPES of HEARING LOSS with EXAMPLE AUDIOGRAMS:

- (I) Conductive Hearing Loss
- (II) Sensorineural Hearing Loss
- (III) High Frequency Sensorineural Hearing Loss
- (IV) Low Frequency Sensorineural Hearing Loss
- (V) Mixed Hearing Loss, Combinations
- (VI) Neural Hearing Loss

(I) Conductive Hearing Loss

The key feature is a bone conduction audiogram showing hearing in the normal range while the earphone (air conduction) test shows significant loss, as illustrated by the example audiogram below. The gap means that the hearing nerve function is better than the mechanical hearing. Conductive hearing loss is caused by a problem in the outer and/or middle ear that blocks sounds getting to the inner ear.



Common causes (from Healthy Hearing 2017) are:

Outer ear

- * A narrowing of the ear canal (stenosis)
- * Wax impaction
- * Bone-like protrusions that can develop inside the ear canal and cause potential blockages
- * Otitis externa (also known as swimmer's ear)
- * Obstructions caused by foreign bodies inserted into the ear

Middle ear

- * A breach in the tympanic membrane caused by injury, ear infections or extreme and rapid air pressure changes
- * A thickening of the tympanic membrane (tympanosclerosis)
- * Otitis media or a buildup of fluid in the middle ear
- * Blockages in the eustachian tube, which connects the middle ear to the back of the nose and throat
- * Otosclerosis, a rare medical condition that causes the middle ear bones to freeze up
- * Abnormal growths or tumors that form within the middle ear
- * Ossicular chain discontinuity, or a break in the connection between the bones of the middle ear, caused by injury or heavy trauma

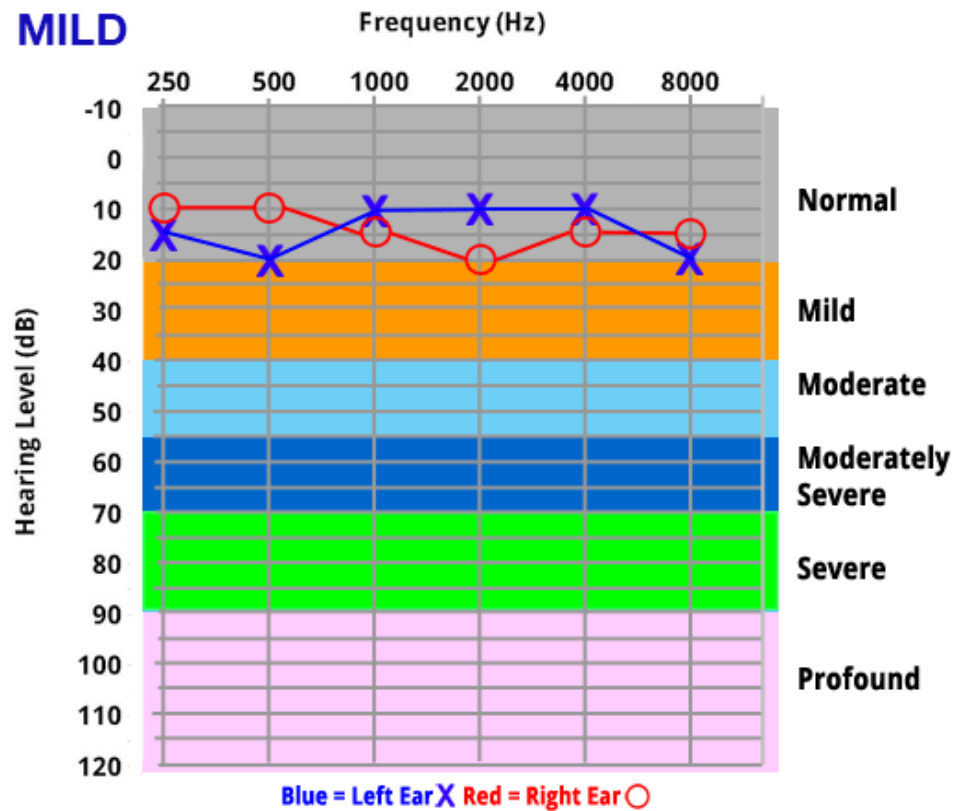
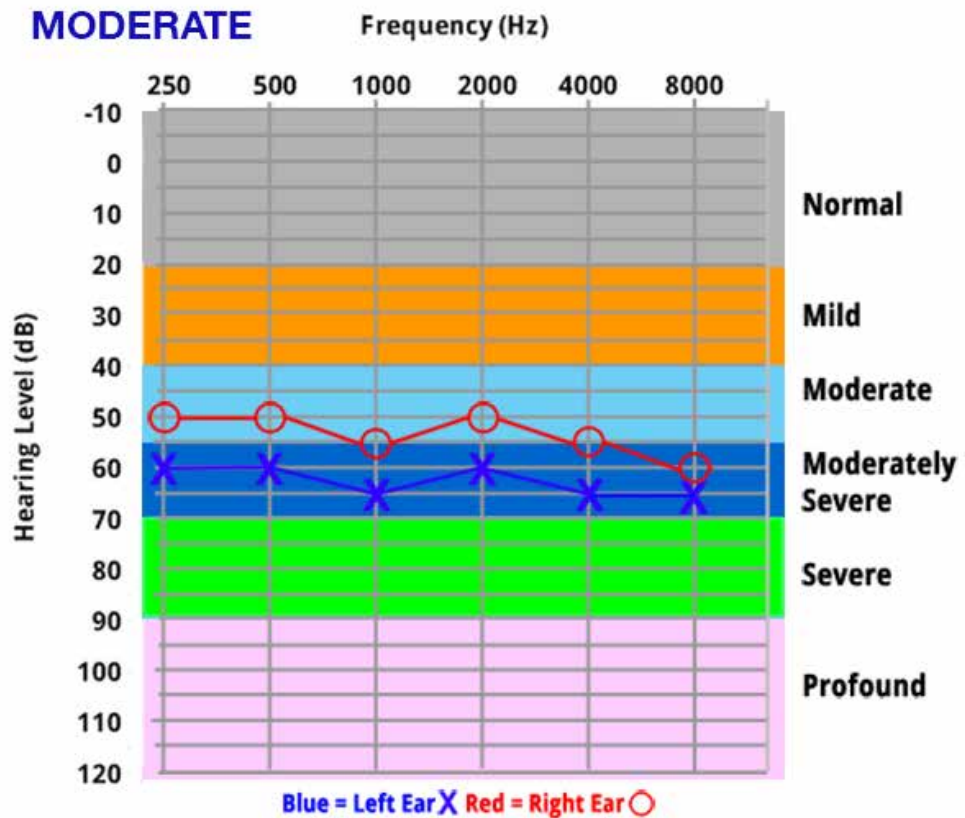
Approximately 10% of all hearing losses are conductive, which can range from mild to moderate in severity. Conductive hearing loss can often be medically or surgically treated, and in many cases, hearing can be restored or greatly improved.

(II) Sensorineural Hearing Loss

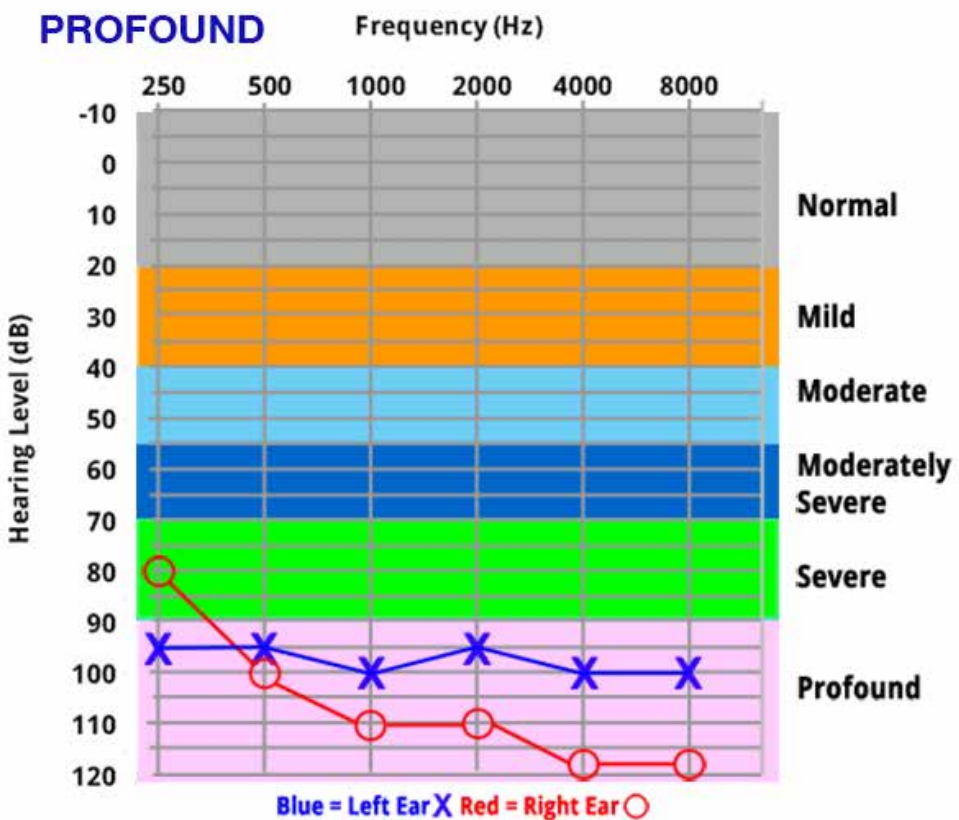
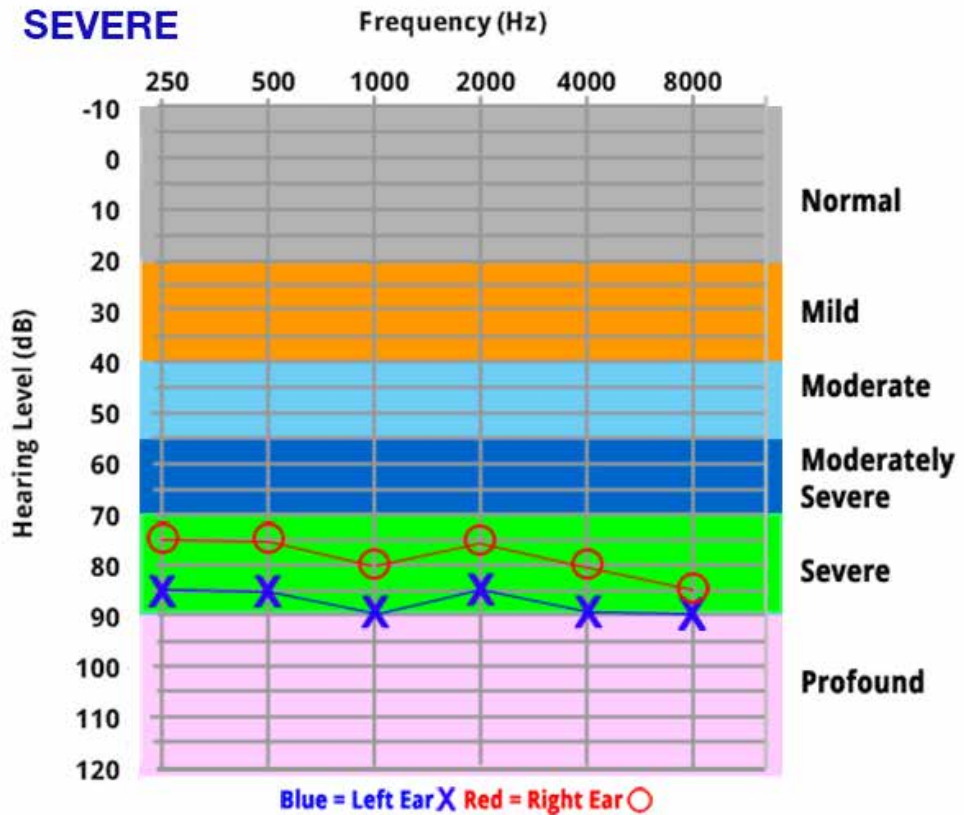
This is the most common type, applying to about 90% of all people with hearing impairment. The losses with the earphone and bone conduction tests are the same. If a child is born with sensorineural hearing loss, it is most likely due to a genetic syndrome or an infection passed from mother to fetus inside the womb, such as toxoplasmosis, rubella or herpes. When sensorineural hearing loss develops later in life, it can be caused by a wide variety of triggers, including:

- * Deterioration caused by age (presbycusis)
- * Blood vessel diseases
- * Auto-immune diseases
- * Infections such as meningitis, mumps, scarlet fever and measles
- * Traumatic injuries
- * Noise exposure over extended periods of time
- * Menieres disease
- * Acoustic neuroma or other cancerous growths in the inner ear
- * A side effect through the use of certain medicines

The hearing loss can be mild, moderate, severe or profound illustrated in the audiograms below.

MILD**MODERATE**

Severe loss equates to not hearing conversational speech, hearing only shouting and loud noises like traffic. Profound loss means only very loud noises like pneumatic drills or planes taking off can be heard (or felt).

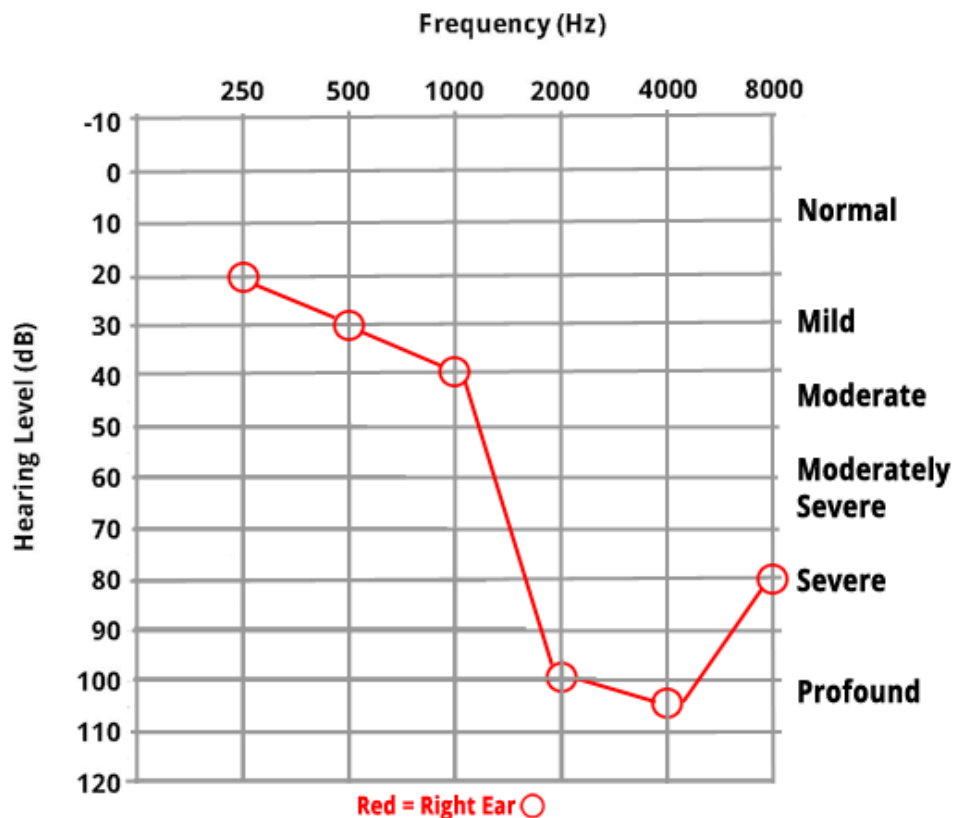


Sensorineural loss is a malfunction of the inner ear. The cause may be genetic, aging, exposure to excessive noise, viral infections, metabolic disturbances, medications, or accident/injury, or a combination. In many cases the cause is unknown, termed idiopathic. Sensorineural loss can be of any degree, is usually irreversible, permanent and not medically or surgically treatable. However future prospects include gene therapy and regeneration via stem cells, along with drugs that can prevent or aid recovery from instances of noise-induced hearing loss such as from loud concerts. Hearing aids and/or implantable devices are appropriate in nearly all cases.

(III) High Frequency Sensorineural Hearing Loss

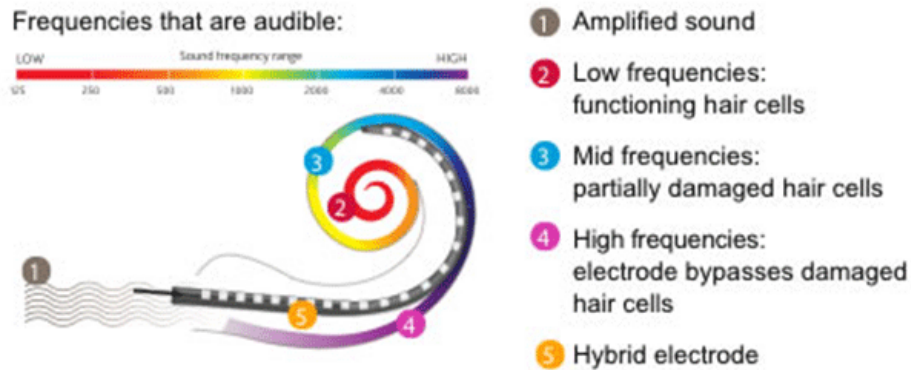
Most audiograms are not fairly flat like the examples above. They can be sloping down or up, or even U-shaped. One subcategory of sensorineural hearing loss is high frequency or “ski-slope” hearing loss; it is classified separately here because a recent device to address this loss has been a special combined hearing aid/cochlear implant.

A typical “ski-slope” audiogram, for an individual with a variable hearing loss that becomes profound at high frequencies, is shown below.



Many words begin and end with high frequency sounds, With high frequency hearing loss, words seem to merge together and become indistinguishable, The cause is illustrated by the cochlea diagram below.

Cause of ski-slope hearing loss:

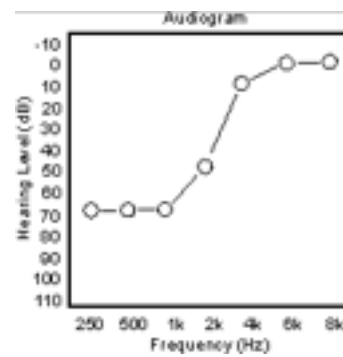
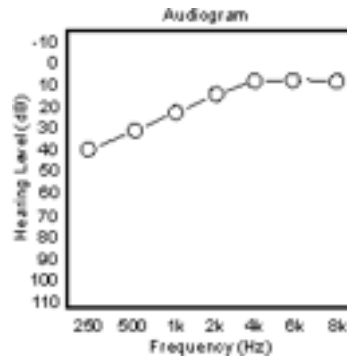


Low frequency sounds stimulate hair cells deep within the cochlea, whilst high frequencies stimulate those that are close to the entrance. The pitch most easily damaged by loud noises is ~4000Hz because of its proximity to the most intense vibrations. If high frequency hair cells are damaged and non- functioning, the brain will miss out on the high frequency elements of the sound. Sound without high frequency hearing has been described as like life without all its colours.

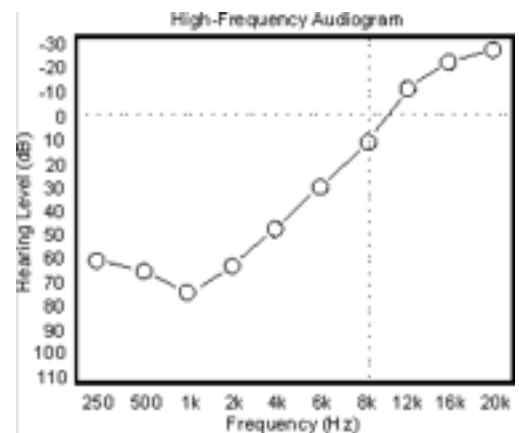
(IV) Low Frequency Sensorineural Hearing Loss

Much less common is reverse-slope hearing loss where the audiogram slopes up to the right. Some people can have hearing loss so severe they can't hear thunder rumbling overhead or a car motor running right beside them; yet, at the same time, have hearing so acute they can hear a pin drop, or a whisper from across a large room. The most common name is actually reverse-slope (or reverse curve) hearing loss.

Below left to right are example audiograms - mild/moderate to good; moderate/severe to good; and severe to amazingly acute!



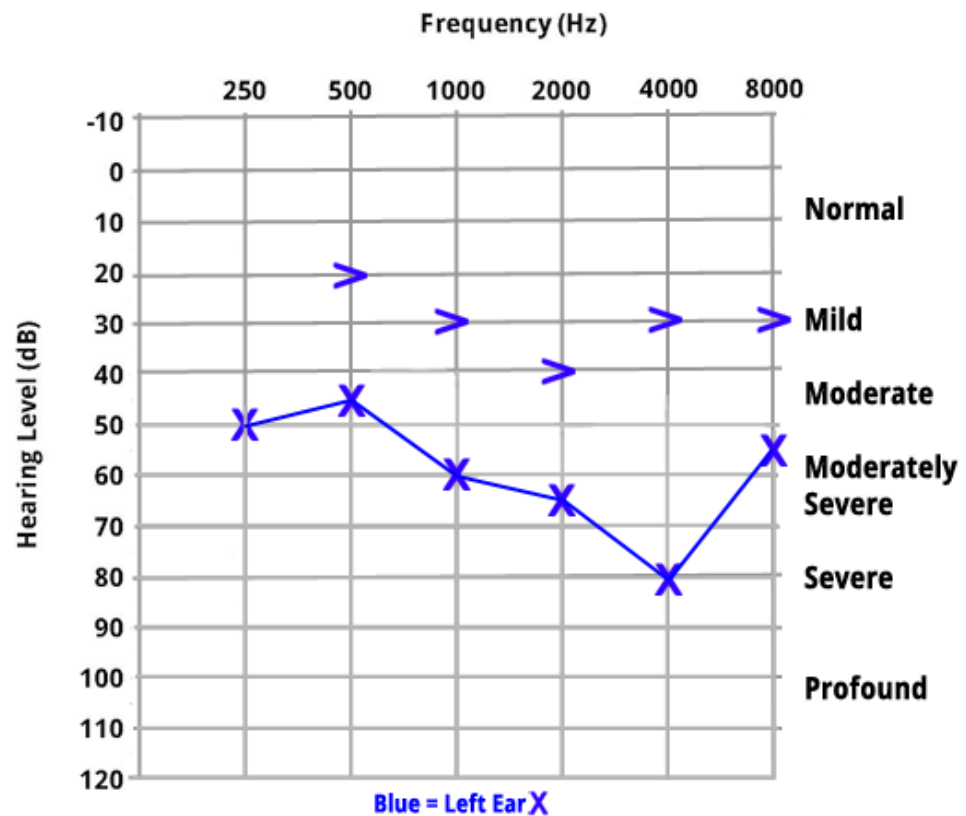
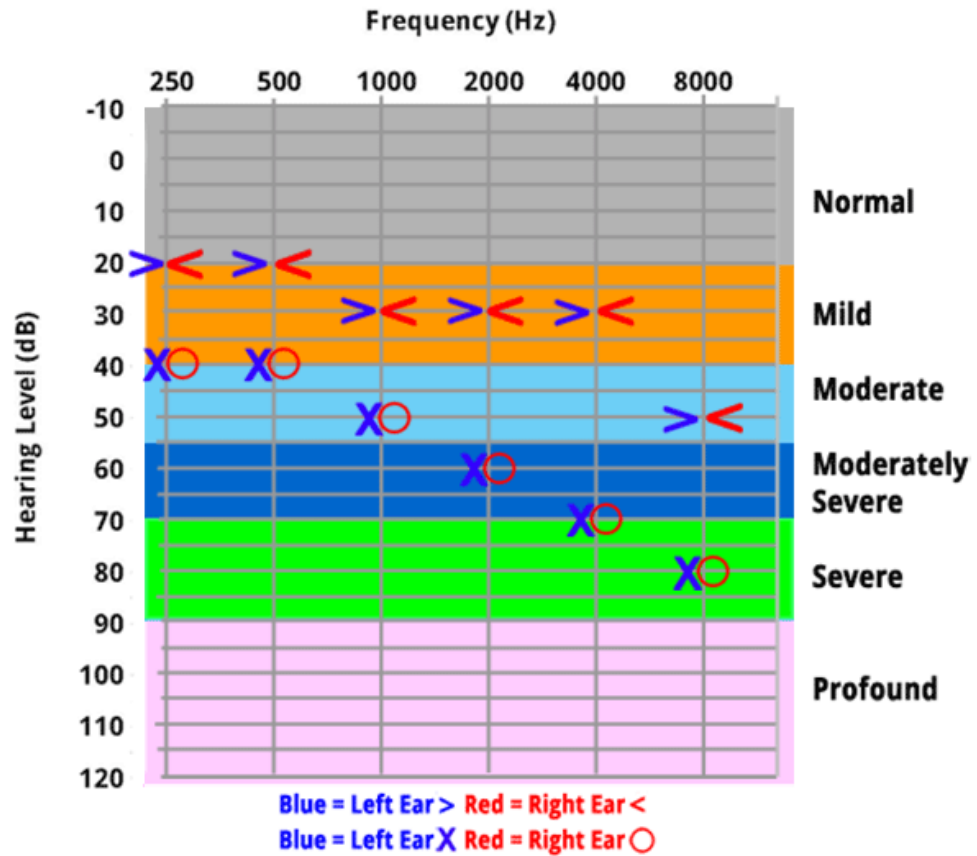
The last (right) belongs to the author (Dr Neil Bauman) of “The Bizarre World of Reverse-Slope Hearing Loss”, Centre for Hearing Loss Help, Jan 2015. He had amazingly acute hearing (-30dB) at 20kHz, where people with “perfect” hearing cannot hear at all. Reverse slope hearing loss is rare, particularly extreme cases like Bauman. The causes are mainly genetic or Menieres disease.



(V) Mixed Hearing Loss, Combinations

Sound can be blocked in multiple places along its path. When a hearing loss occurs from conditions in the outer and/or middle ear as well as the inner ear, this is known as mixed hearing loss. An example of mixed hearing loss may be someone with inner ear hair cell damage due to aging who at the same time has infected fluid in the middle ear due to an upper respiratory infection. The example audiograms below show two of the many variations that are seen.

There are also numerous **combinations** of mixed hearing loss - right only, left only and bilateral (both ears) mixed losses. (And of course right, left and bilateral conductive; right, left and bilateral sensorineural).



(VI) Neural Hearing Loss

This is another particular type of sensorineural hearing loss which is very rare. Sound enters the outer and middle ears and is processed correctly by the inner ear, but the auditory nerve is not able to transmit the nerve impulses to the brain. One cause is acoustic neuroma, a benign tumor that grows on the vestibular (balance) nerve and then presses against the auditory nerve. Ways of testing for neural hearing loss are the acoustic reflex, auditory brainstem response and MRI scans. Neural hearing loss usually results in a greater loss of speech discrimination than occurs with sensory hearing loss.

Because damaged nerve fibers aren't able to repair or regenerate themselves like some other parts of the body can, this type of hearing damage is currently permanent. Gene therapy and stem cells may however have long-term promise in this regard.

Recently-recognised conditions CAPD (Central Auditory Processing Disorder) and ANSD (Auditory Neuropathy Spectrum Disorder) also seem to derive from problems in the neural pathway, but not as defined or as severe as acoustic neuromas. CAPD is an umbrella term for a variety of disorders that result in a breakdown in the hearing process. The brain cannot fully understand the information contained in sound, although the ability to hear and conventional hearing tests may well be "normal". Because the auditory signal is distorted in some way, the biggest problems experienced by individuals with CAPD is difficulty listening in background noise, and working out what direction certain sounds are coming from. CAPD is said to affect about two to five percent of children.

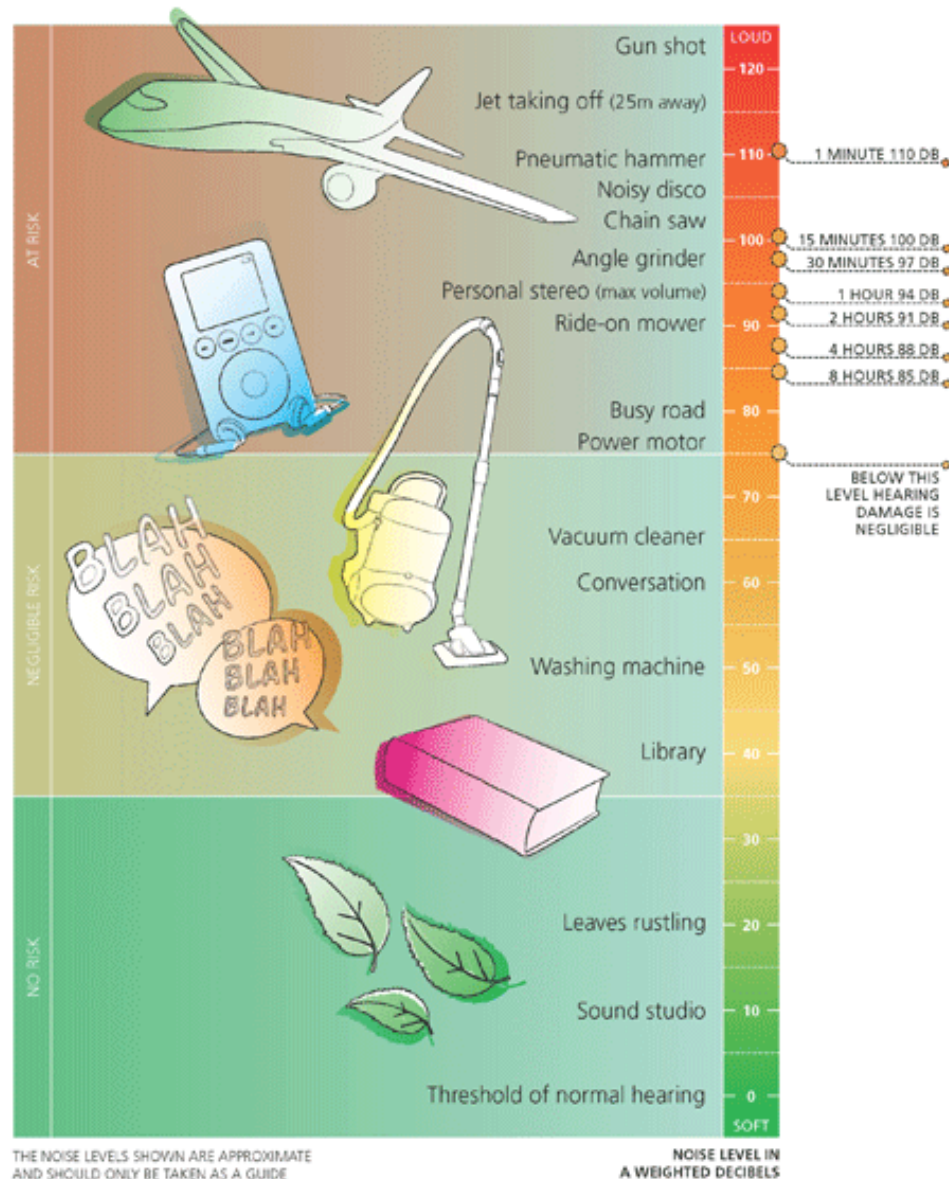
ANSD involves nerve dysfunction, commonly disruption of the timing of the electrical impulses. This results in distortion of sound and listeners often report that they "can hear but can't understand what is being said to them". Again listening in background noise is particularly affected. Localisation skills, the ability to judge where sounds are coming from, may also be affected. The most common form of AN is present from birth and occurs as a result of trauma. Babies with breathing problems and/or severe jaundice are particularly at risk. Progressive forms of AN also exist, often related to generalised neurologic diseases.

Diagnosing AN can initially be challenging, as people with the condition can have perfectly normal detection of sound. Tests that measure the function of the nerve and auditory pathways are required. These assessments are carried out routinely in babies, as part of Universal Newborn Hearing Screening programs, but are not standard in adult hearing tests.

5. SOLUTION OPTIONS - LIMITATION and PREVENTION

The most preventable hearing damage is noise-induced hearing loss. Not unlike sun exposure, sunburn and skin cancer, exposure to loud and/or prolonged noise damages hearing and leads to cumulative and permanent degrees of hearing loss, as illustrated below:

MANY DAILY ACTIVITIES CAN BE CARRIED OUT WITHOUT CAUSING ANY DAMAGE TO YOUR HEARING, BUT EXPOSURE TO NOISE DURING OTHER ACTIVITIES STARTS CAUSING DAMAGE AFTER A LIMITED AMOUNT OF TIME.



Source: Australian Hearing

Many Australians are regularly exposed to high levels of noise in nightclubs, pubs, music concerts and personal stereos.

The initial 'solution' to hearing loss is **Prevention and Limitation**. If you need to raise your voice or shout in order to be understood in background noise, then that noise is too loud. If you are listening to an audio device with personal earphones and do not hear people speaking, then that music is too loud. If your ears "ring" after being in noise, then that noise was damaging. Babies are very vulnerable; some baby toys can create extremely loud noises and this problem should not be overlooked or underestimated.

The prevention and limitation solution has the mnemonic **CAT** – **C**over your ears, **A**void the noise or **T**urn it down. If you attend discos, pop concerts, car or motorbike races or fireworks displays, take correctly-fitting earplugs. Wear them when using or being close to mowers, blowers, mulchers, chainsaws, grinders, pneumatic hammers etc. Electronic hearing protection devices are available with Noise Reduction Ratios from 20 to 32dB. With peak clipping technology, when an unsafe sound is detected, the unit clips the sound. Compression technology takes an unsafe sound and reduces it to a safe level.

AUDIOLOGIST COMMENT 9

EAR PLUGS

Many types are available from soft, coated foam for long hours of use to musicians custom made to allow quiet sounds in while dampening only loud music. EAR PLUGS MUST BE FITTED CORRECTLY TO BE EFFECTIVE

PEOPLE MUST BE NOT ONLY SHOWN HOW TO INSERT THEM, BUT BE OBSERVED TO INSERT THEM INTO THEIR OWN EARS CORRECTLY. This also means the users must understand how to maintain clean ear canals so as not to push in clumps of wax. Also it is important to know when to wear plugs and when to use muffs.

6. SOLUTION OPTIONS - CATEGORIES of HEARING AIDS

- (I) Behind the Ear (BTE)
- (II) In the Ear (ITE) to Completely In the Canal (CIC)
- (III) Receiver in the Ear (RITE)
- (IV) Contra-lateral Routing of Sound (CROS)
- (V) Spectacle Style
- (VI) Bone Conduction Types

(I) Behind the Ear (BTE)

The first category (BTE) is the most common style fitted today and is generally the most powerful, with a larger battery, more robust construction, easier to use controls, and ideal for children. There are two sub-categories:

BTE with moulded earpiece:

- Suitable for mild to severe hearing losses of all types. It has the greatest potential fitting range of all types of hearing aids
- All electronic components are contained in a hard plastic case worn behind the ear and connected to a custom-made ear mould that fits snugly into the ear
- Has the potential to carry the greatest range of features, including Telecoil for direct audio input, volume control, and larger battery size for longer life
- Can be best option when wearer has some eyesight or dexterity considerations and for young children and frail elderly where others make the adjustments.

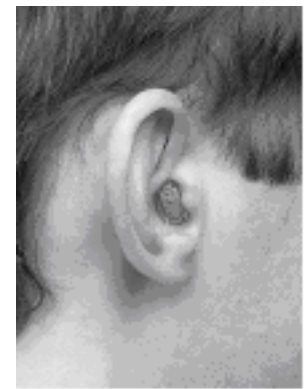
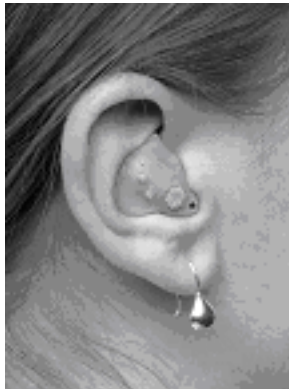


BTE open fit (also called mini BTE or on-the-ear aids):

- Suitable for mild to moderately severe, high frequency hearing loss
- Small aid that sits behind the ear
- Thin tube inserted into the ear canal, attached to a soft unifit dome or to a custom-made open style earpiece.
- Capability can extend to correcting severe losses using acoustic feedback filters

**(II) Custom in the ear (ITE), in the canal (ITC), and completely in the canal (CIC)**

Small to very small one-piece hearing aids for mild to moderately severe hearing loss. The hearing aid is built into a custom-made earpiece, making them relatively discreet to nearly invisible. Usually easy to insert and no bearing on wearing glasses, hats, etc.



ITEs can include volume and other controls, so may be suitable for some with moderately severe hearing loss. CICs are not suitable for those with small ear canals, and the very small battery requires good eyesight and manual dexterity. CICs can in certain cases be fitted for a severe loss.

AUDIOLOGIST COMMENT 10

AUDIO LINKING

Digital hearing instruments can be linked to Bluetooth devices, I-phones, radios and TVs usually through the use of a remote control.

Active, tech-savvy people, even those with severe losses, can achieve an amazing degree of hearing and understanding, even if listening through a stethoscope.



There are in-between variations offered by some manufacturers. Another development is “extended wear” hearing aids that are placed by an audiologist deep in the ear canal millimetres from the ear drum. They are worn continually up to several months at a time then replaced with a new device. Their softer material fits the curves of the ear, protects against moisture and earwax and they can be worn while exercising, showering etc - so are very useful for active individuals.

(III) Receiver in the Ear (RITE)

RITE hearing aids are another recent innovation, in effect a combination of the other two types - some of the electronics sit behind the ear, and some are inside the ear. A thin wire inserts into the ear canal to a receiver/speaker that sits inside the canal. This mini-BTE category includes the smallest external hearing aids. They may be more discreet than BTE types, but still offer sophisticated sound processing technology and ability to link to other devices.

Appropriate for mild to severe hearing loss, ideally for mild to moderate loss.



(IV) Contralateral Routing of Sound/Signal (CROS)

“Contralateral” is just a fancy word that means “on the other side.” A CROS hearing aid takes the sound arriving on one side of the head and feeds it into the opposite ear. CROS hearing aids can work for people who are deaf in one ear and have normal or near normal hearing in the other ear. The person wears what looks like two hearing aids in one of two styles—either BTE or a larger ITE type.



The device worn on the deaf ear is just a microphone (to pick up sounds on the deaf side) and a transmitter which sends these sounds to the device worn on the good ear. The device amplifies the sounds it receives from the deaf side, and then feeds these sounds into the good ear. Since the person has normal or near normal hearing, the sound doesn't have to be amplified much. Because the normal ear can

hear the difference between amplified sound (from the other side) and what is coming in naturally from that side, users can USUALLY have better sound localisation because the brain hears the difference and timing. CROS ear moulds are of an open fit design so they don't block the sounds the good ear hears naturally.

Bi-CROS hearing aids are for people who are deaf in one ear with a mild to moderate loss in the other ear. The device on the good ear is then a “regular” hearing aid, as well as an amplifier of sounds from the deaf ear, and it involves a custom made ear mould. CROS or Bi-CROS aids are a good solution for single-sided deafness especially where sounds typically come from the deaf side. For example, a car driver with a deaf left ear can hear passengers much better.

Recent advances in digital and wireless technology have improved CROS and Bi-CROS devices and eliminated the annoying wire that connected the two sides. Indeed it can be said that modern technology has effectively eliminated the CROS through simply programming a hearing aid to be able to communicate with its “pair” that sits on the opposite side of the head. Wireless technology has progressed to a point where not only is control information being routed from one ear to the other, but the entire audio spectrum. One can program a hearing aid to have this full-spectrum wireless capability and the other to receive this wireless information.

In a CROS fitting, one would use software to turn off the hearing aid receiver in the “unaidable” ear and implement wireless communication to the other ear where the microphone has been disabled. In a BiCROS fitting, both microphones would be left on. No longer are specially designed hearing aid shells and receivers required for a CROS/BiCROS fitting. Some manufacturers now sell a CROS or BiCROS “hearing aid” as two separate hearing aids that, depending on the software settings, can be either two functional hearing aids in a binaural fitting or alternatively set up as a CROS or BiCROS fitting.

Many hearing-impaired people with one ear worse than the other dislike CROS aids, possibly because one must put a device in the ‘good’ ear. An alternative solution for single-sided deafness is bone-anchored hearing aid (Baha) or direct bone conduction device, while cochlear implants have recently been shown to be effective.

(V) Spectacle Style

This category is still available from some suppliers. Its popularity has declined due to improved technologies in BTE and other styles. Various models are suited for hearing loss types from mild to severe. These are for users who prefer a hearing aid to be an integrated component of their eyeglasses. The earmould attaches to the



arm of the spectacles. Models which use bone vibration have no ear mould and are for conductive hearing loss.

(VI) Bone Conduction Types

This category is specifically to overcome conductive hearing loss. Spectacle-style bone conduction aids circumvent body-worn aids and thus give wearers, especially women, freedom to wear nice clothes without a need to hide wires, if the spectacle is supported with a hair/head band. The amplified sound is delivered to a vibrator which transmits the sound as vibrations through the bones in the skull, generally through the mastoid bone behind the ear. The sound thus bypasses any problem in the outer or middle ear.

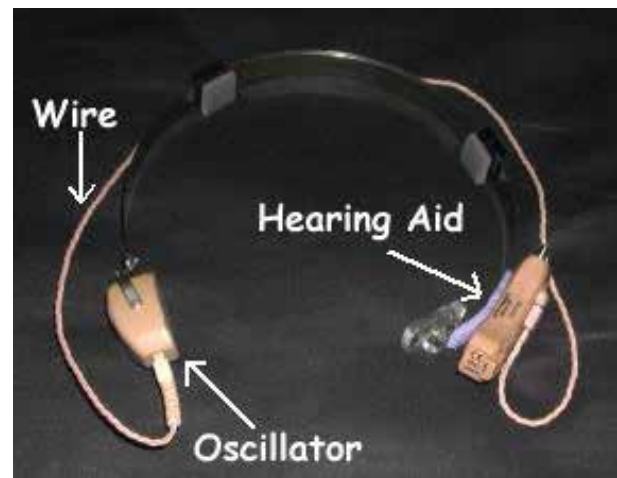
The output of bone conduction hearing aids is restricted compared to the air conduction hearing aids, particularly the more powerful BTE category. They are for mild to moderately severe hearing loss.

Bone conduction aids work best when there is good cochlear function (sensorineural hearing) in both ears. Bone conduction aids are also part of the solutions to mixed hearing losses, though these are more complex when each ear has different degrees of sensorineural loss.

Bone conduction aids are contact devices using a spring headband, neck collar or strapping that holds the vibrator in position on the bone; the sound amplifier component is on the other side (or even possibly on the same side) of the head. These aids are less comfortable to wear and in some cases continuous pressure on the skin can cause irritation or even ulceration.

Sometimes the hearing aid, cable and vibrator can be placed inside a baseball cap (or integrated into spectacles) to improve the appearance, or placed in a soft headband for better retention on small children.

It is a solution option for people with middle ear disorders, including those with chronic ear discharge, and those (especially children) with very small ears and ear canals not suited to an earmould. Another use is for those with Atresia – lack of cartilaginous structure of the outer ears. Indigenous Australians, especially children, suffer from high rates of middle ear disease, and this style of hearing aid is often most appropriate for them.



Again many people do not like the bone conduction devices. Perhaps for this reason a removable dental insert has recently become available in some countries. This Soundbite achieves bone conduction of sound through the teeth and jaw bones - see illustration at right. It works together with a small BTE microphone and transmitter.



There is still debate among audiologists and ENTs as to whether this device is indeed effective and/or easy to wear.

Bone-anchored implants are another option (next Section). Another possibility can be high power conventional (air conduction) hearing aids. Significantly more power is required to bypass the damaged outer and/or middle ear.

7. SOLUTION OPTIONS - CATEGORIES of IMPLANTABLE DEVICES

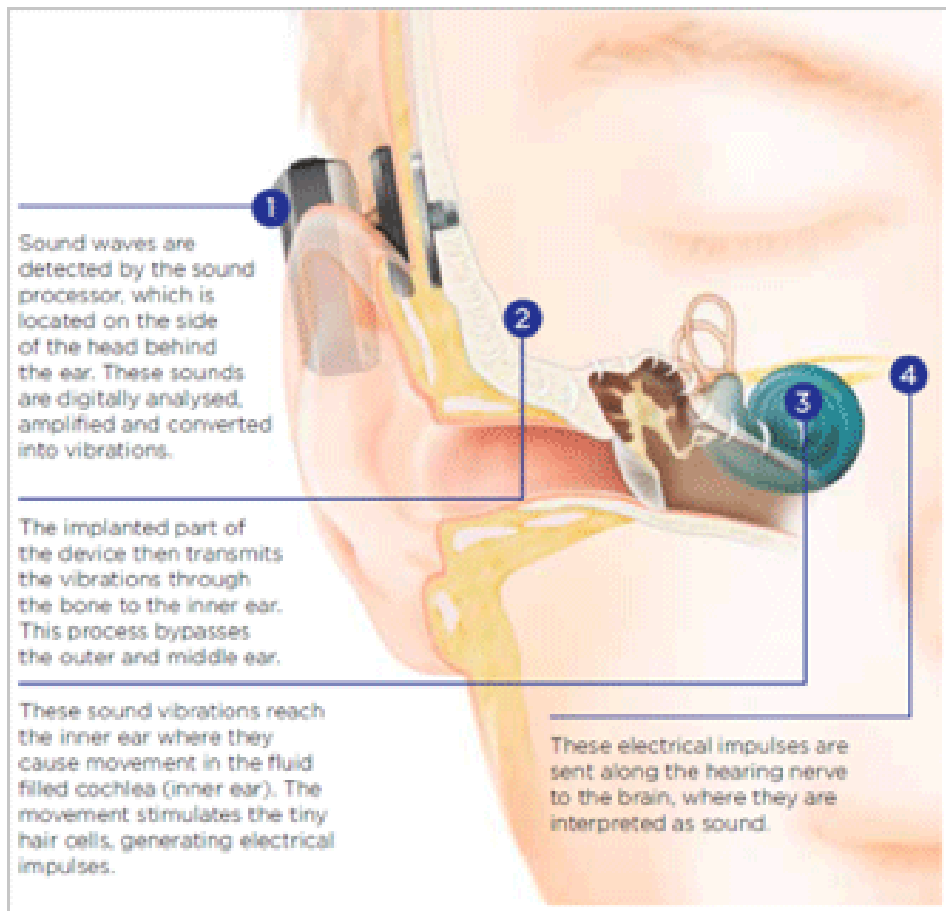
- (I) Bone-Anchored Devices
- (II) Middle Ear Implants
- (III) Cochlear Implants (CIs)
- (IV) Hybrid Cochlear Implant/Hearing Aid (ElectroAcoustic Device)
- (V) Auditory Brainstem Implant

Hearing implants are an area of considerable research and development. There is less consistent and very little comparative information about hearing implants, so this Guide covers the above categories in more depth than it covers the categories of hearing aids.

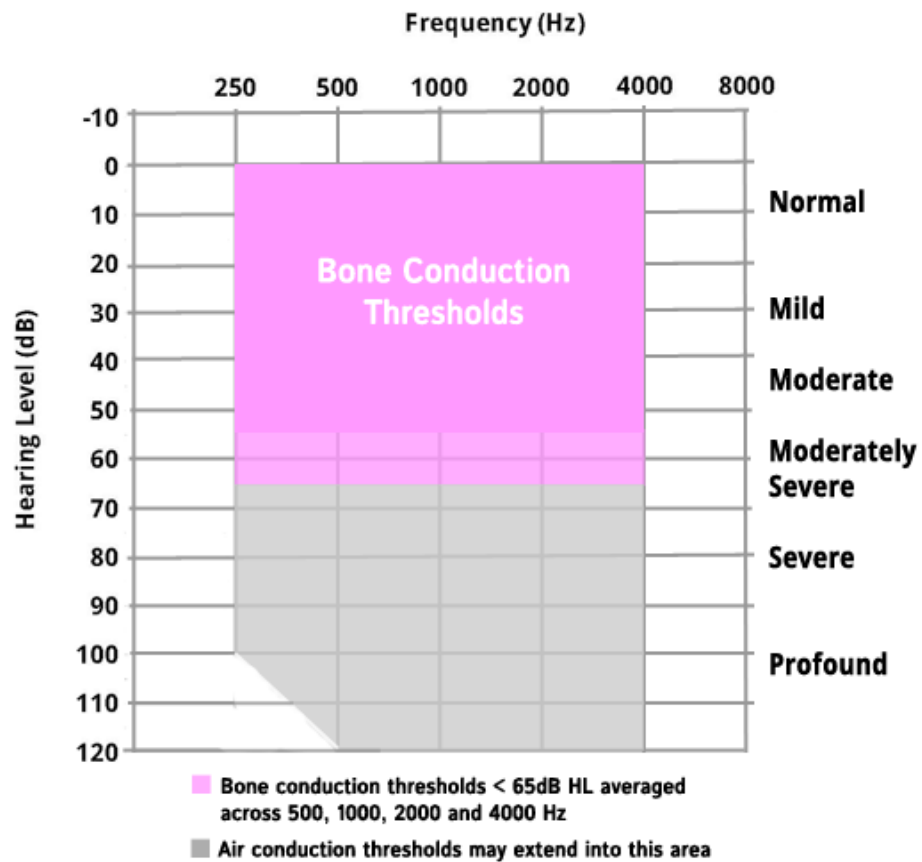
(I) Bone Anchored Devices

Like bone conduction hearing aids covered in the preceding section, these devices bypass impairments in the outer and middle ear via sound vibrations conveyed through the bones of the skull to the inner ear. They too address unilateral/bilateral conductive and mixed hearing loss, mild to moderately severe, arising from outer ear malformations, infections and discharges. The advantages over the conventional bone conduction hearing aids include improved appearance and comfort, and ability to assist conductive losses even when higher degrees of sensorineural loss are also present.

Recipients have reported improved clarity of hearing in both quiet and noisy situations. They are also useful for people with good hearing on one side and none on the other (single-sided deafness or SSD) and are thus an implanted version of the CROS hearing aid.

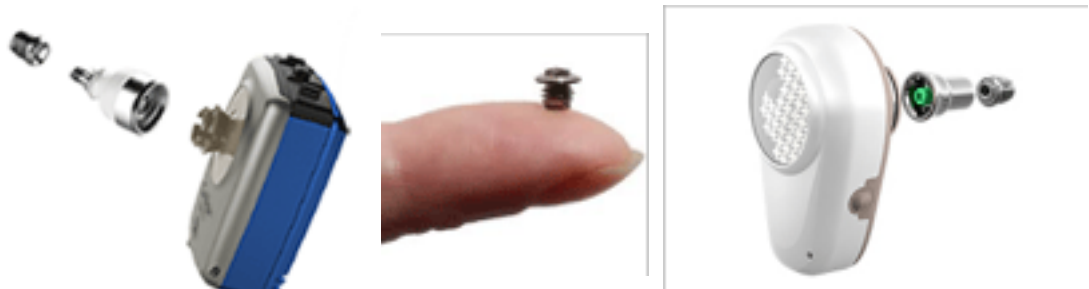


The above diagram and text are self-explanatory. For single-sided deafness, the bone-anchored device is placed behind the 'non-hearing ear'. Soundwaves picked up by the processor are transferred through the bones of the skull, to the hearing ear. This allows the detection of sounds coming from the 'non-hearing side.'



For conductive hearing losses, bone anchored devices are applicable within the coloured region, while for single sided sensorineural deafness the devices extend to profound hearing loss.

There are currently several bone-anchored devices available in Australia. One type is “percutaneous”, where a titanium screw (below, middle) is placed in the mastoid bone with a skin-penetrating abutment. Once this has settled (osseointegration), an external sound transducer is attached to the abutment. The Cochlear Baha Connect (left) and the Oticon Ponto (right) are shown below:



A more recent type is “transcutaneous”, meaning there is no skin-penetrating abutment, rather the external transducer is held by magnetic attraction to the implant under the skin. The vibrations are transmitted through the soft tissue, as illustrated below left, exemplified by the Cochlear Baha Attract (middle) and the Medtronic Sophono Alpha (right)



The transcutaneous type have obvious cosmetic advantages with no metal poking out through the skin behind the ear and even lower risk of infection, though performance may be dampened relative to percutaneous devices. Readers should note that the term Baha is often used to mean Bone-Anchored Hearing Aids generally and historically reflects the brand name of the Cochlear implanted device.

The Medel Bonebridge is a different transcutaneous device where the transducer (below, left) is also implanted, allowing for a smaller external processor (below, right).



Theoretically, this approach should reduce the dampening effect of the other transcutaneous devices. On the other hand the larger size of the implant component (left) requires adequate thickness of mastoid bone and may have higher risks of minor adverse effects - pain, tinnitus, skin infection.

(II) Middle Ear Implants

These comprise a sound processor and an implanted vibrational device with electrical lead to a very small transducer that is attached to the middle ear structures by surgical techniques called Vibroplasty. In a similar way to bone conduction hearing aids, sound causes vibration, in this case to one of the ossicles, such that normal movement of these tiny bones is restored or amplified, and sound is then transmitted naturally to the inner ear.

While there are no speakers or ear moulds, the surgery and implant system is more complex and expensive than hearing aids, so is not usually the first choice of recipients. They may not be able to use hearing aids for medical reasons or are dissatisfied with them e.g:

- cannot tolerate ear moulds or other foreign bodies in the ear canal
- chronic ear canal inflammations or eczemas
- narrow, collapsed or closed ear canals, or malformed ears.
- want a free ear canal for personal or professional reasons, e.g. musicians, singers or physicians who wish to hear harmonics free and undistorted by the occlusion effect.
- rely on good perception of high frequency sounds

A middle ear implant system is an alternative to conventional hearing aids. It is suitable for people with mild to moderately severe hearing losses whether conductive, sensorineural or mixed. For conductive or mixed loss, it is also an alternative to bone-anchored devices.

They are still uncommon but a number of partly or totally implantable systems are available overseas.

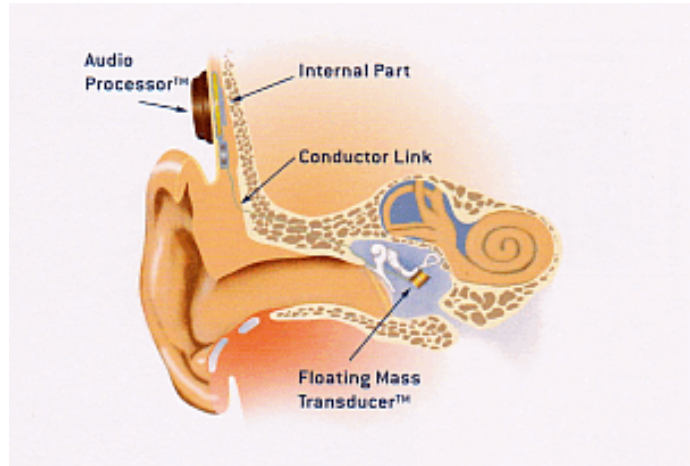
The Medel Vibrant Soundbridge is the longest established (20 years) and was recently approved for use with children three years and older; its placement is independent of skull growth.



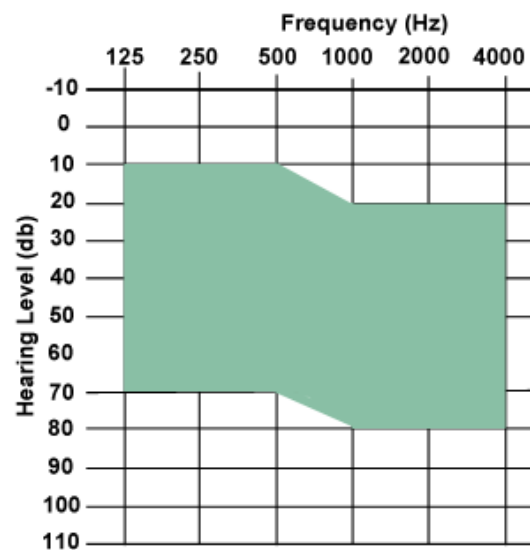
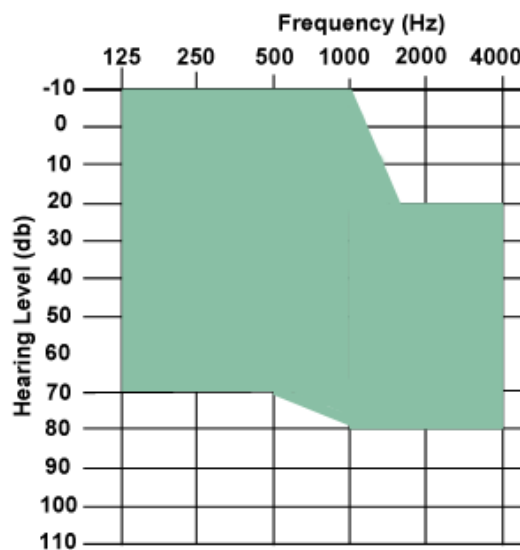
The audio processor (picture above left) is attached to the head with a magnet and can be worn discreetly under the hair. It comprises the battery, microphone and electronics. The implant (picture above right) is placed underneath the skin and contains a magnet to hold the audio processor over the implant. The key component distinguishing from other implantable devices is the Floating Mass Transducer (FMT) which is the little ball at the end of the wire in the picture above right.

The steps in the process are:

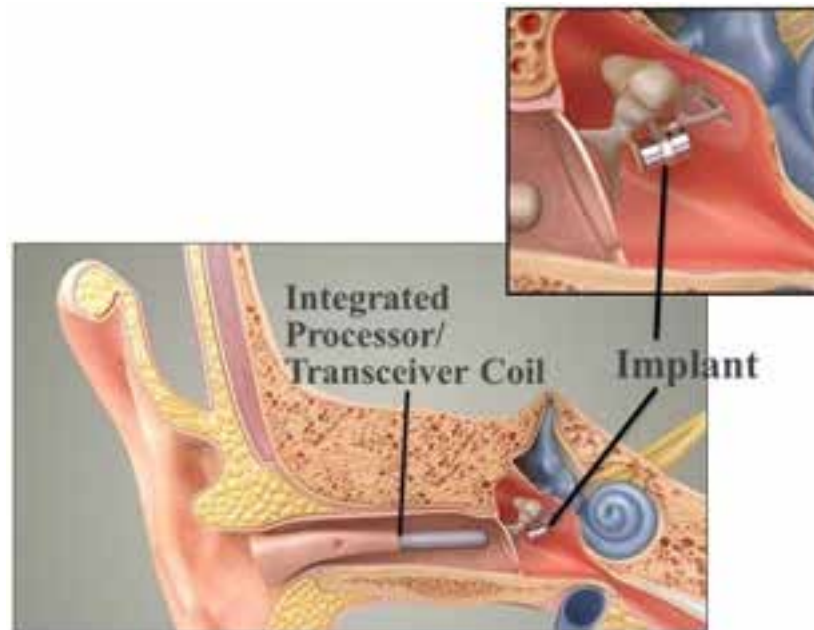
1. Sounds are picked up by the microphone of the audio processor
2. The audio processor converts environmental sounds into electrical signals
3. The electrical signals are transmitted across the skin to the implanted part
4. The implant relays the signal down to the FMT
5. The FMT converts the signal into mechanical vibrations that directly stimulate a middle ear structure causing it to vibrate. This direct drive stimulation does not involve the ear canal.
6. These vibrations then conduct sound to the inner ear where they are passed on to the brain and are perceived as sound.



The audiograms show the application range of the Vibrant Soundbridge to conductive and mixed hearing loss (left) and to sensorineural loss (right).



The Ototronix Maxum, introduced in 2009, is also semi-implantable and based on electromechanical or electromagnetic stimulation. The surgical procedure for the Maxum is minimally invasive, transcanal under local anesthesia.



Shown above is the audio processor integrated with the transceiver coil, or magnetic coil. The pinna helps to direct the acoustic energy into the processor. That is transformed into electromagnetic energy in the middle ear by the transceiver coil. The implant in the ossicles picks up the electromagnetic waves and vibrates. Shown top inset is the implant - a magnet attached to the incudostapedial junction similar to the Vibrant Soundbridge.

There are two other middle ear devices. These are fully implantable. The Carina, developed by Otologics, in Boulder, Colorado, and now owned by Cochlear, is in its fourth generation. The processor is also implanted; there is nothing visible outside the ear. It can be placed in people as young as 14 years old. It is used in Europe, Asia and Latin America.



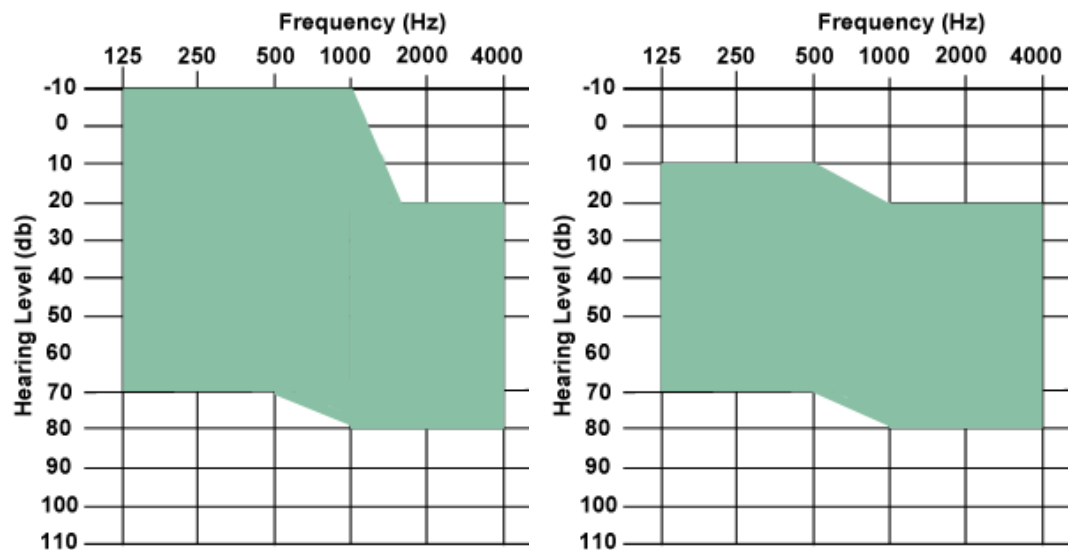
The microphone (A) under the skin captures sound and sends it to the implant via a lead. There are transmission losses across the skin so the microphone needs to be very sensitive to pick up soft sounds. The implant (B) processes the sound and sends it to the actuator. The actuator (C), a transducer, converts the electrical signal into mechanical vibrations and then transfers these to the ossicles (D) via a laser-drilled hole in the bottom of the incus. The inner ear senses the vibration, converts it to electrical signals, which are interpreted as sound by the brain.

The actuator is kept firmly in place using a special fixation system (E). The hardware of the Cochlear Carina system - implant, remote control and charger - are shown left to right below:



There is nothing visible on the head or in the ear canal. Recipients can swim and shower with it and only have to use the charger for about an hour a day.

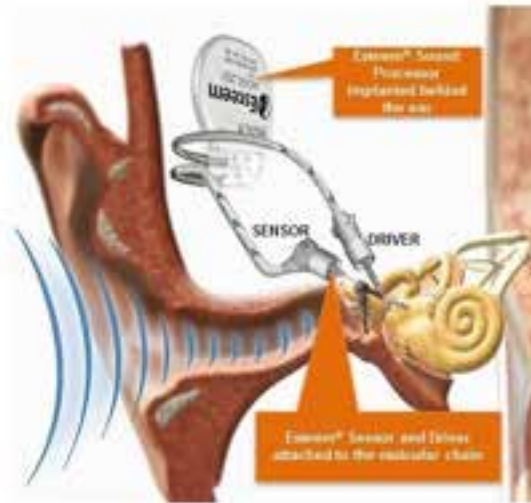
The audiograms show the application range of this middle ear stimulator for mild to severe conductive or mixed type hearing loss (left) and for moderate to severe sensorineural loss (right).



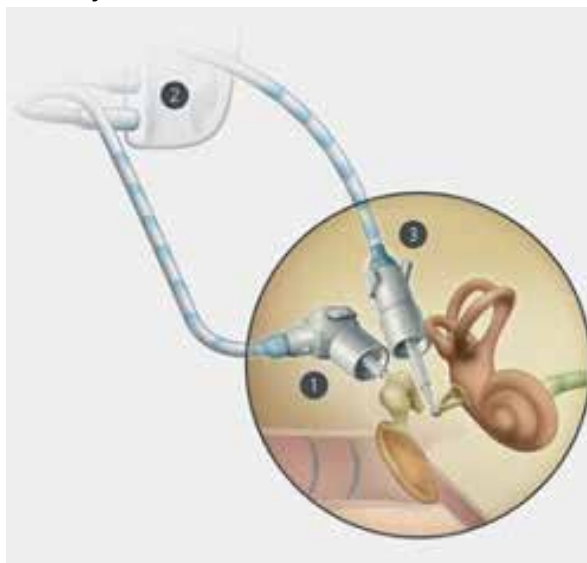
The other fully implantable middle-ear implant is the Envoy Esteem implant, which has been available in the U.S. for about 10 years now. It was developed by Envoy Medical Corporation based in Minnesota. It is for bilateral sensorineural hearing loss and speech discrimination greater than 50%. The Esteem is an amplification system, analogous to conventional hearing aids, though entirely implanted. It uses the natural dynamics/vibrations of the ossicular chain.

There are two transducers, a Sensor and a Driver, that are placed in the middle ear. The Sensor picks up vibrations from the incus as the input signal, comparable to the microphone in a conventional hearing aid. The Driver delivers an amplified output signal as mechanical energy to the stapes, comparable to the receiver or speaker in a conventional hearing aid.

The Sound Processor processes and amplifies acoustic signals according to programmed settings and algorithms. This is comparable to the processor in conventional hearing aids.



Unlike other middle-ear implants, which are based on electromagnetic stimulation, this is based on piezoelectric stimulation. The entire device is imbedded. It uses no speaker or artificial microphone, no external components, and requires nothing in the ear canal. The Esteem is invisible. It can be used 24 hours a day, 7 days a week. It enables a person to swim, shower, or exercise without worry of damage or discomfort. It is waterproof and safe for diving down to a depth of 33 feet. It requires no daily maintenance. The battery lasts between four-and-a-half to nine years. When it runs out, one has to remove the whole processing unit, which contains the battery.



The patient has to have a fairly large mastoid bone in order to accommodate this device. Additionally, the incus and stapes are disarticulated, and the long process of the incus is removed to eliminate any feedback vibrations. A key difference is the way in which the implant uses the tympanic membrane (TM) as a microphone. This means less processing of input sound. The vibrations generated at the TM produce input signals naturally. It allows for retention of pinna and

ear canal resonances, which result in spectral shaping of acoustic sound waves as they approach the TM.

AUDIOLOGIST COMMENT 11

NEW DEVICES

Middle Ear Implants are relatively new compared to Cochlear Implants and certainly hearing aids. They do not yet have track records to reveal any risks for using them long-term. A few audiologists comment that attaching anything to middle ear bones adds weight to an already minute and fragile chain of bones.

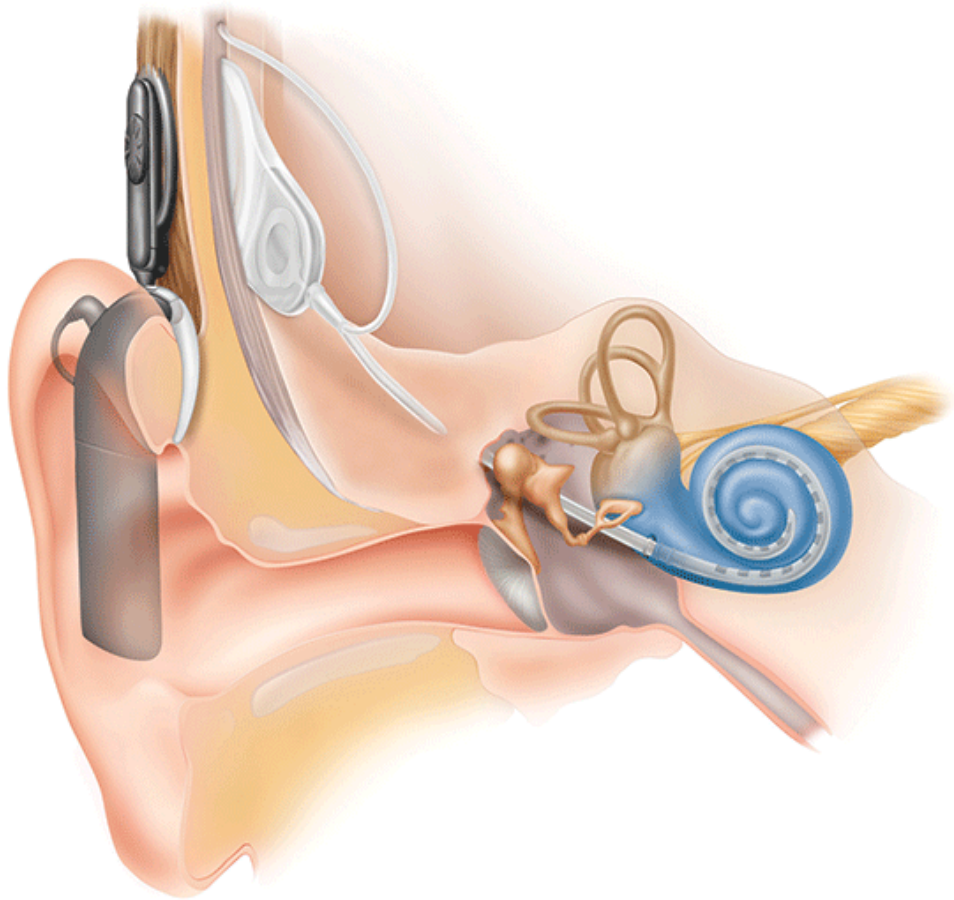
(III) Cochlear Implants (CIs)

Most people today have heard of only one kind of device which is surgically implanted into the skull to improve hearing - the cochlear implant. What is less well-known is that:

- cochlear implants have been commercially available for 30 years
- cochlear implants are well-established and long-accepted worldwide
- newborn screening, early implantation and auditory-verbal therapy (AVT) are becoming standard
- educational and social outcomes for children born even profoundly deaf are now commonly similar to those for their hearing peers if they get a cochlear implant early
- cochlear implants mean special schools for deaf children are becoming redundant
- some in the signing Deaf community oppose cochlear implants as “cultural genocide” because they see a major generational threat to their way of life.

Cochlear, MedEl, Advanced Bionics (now part of the Sonnova group which includes Phonak) and Oticon (who took over Neurelec) are the main suppliers, with Cochlear (whose HQ is in Australia), having 70% of the world market.

CIs comprise an external BTE Sound processor with transmission coil that is held against an implanted receiver from which a flexible multi-electrode array is led to the inner ear where it coils into the cochlea. The implant consists of an external portion that sits behind the ear and a second portion that is surgically placed under the skin.



An implant has the following parts:

- A microphone, which picks up sound from the environment
- A speech processor, which selects and arranges sounds picked up by the microphone
- A transmitter and receiver, which receive signals from the speech processor and convert them into electric impulses
- An electrode array, which is a group of electrodes that collects the impulses from the stimulator and sends them to different regions of the auditory nerve.

The microphone, speech processor and transmitter (coil) are external components. The receiver is surgically embedded into the skull, and the electrode array is inserted into the cochlea.

Illustrations of implantable components from the four manufacturers:



Illustrations of behind-the-ear sound processors:



along with examples of all-in-one sound processors where everything is combined into a cable-free, compact and single-unit processor. It is worn off the ear against the implanted magnet, so is especially convenient for individuals who wear glasses.



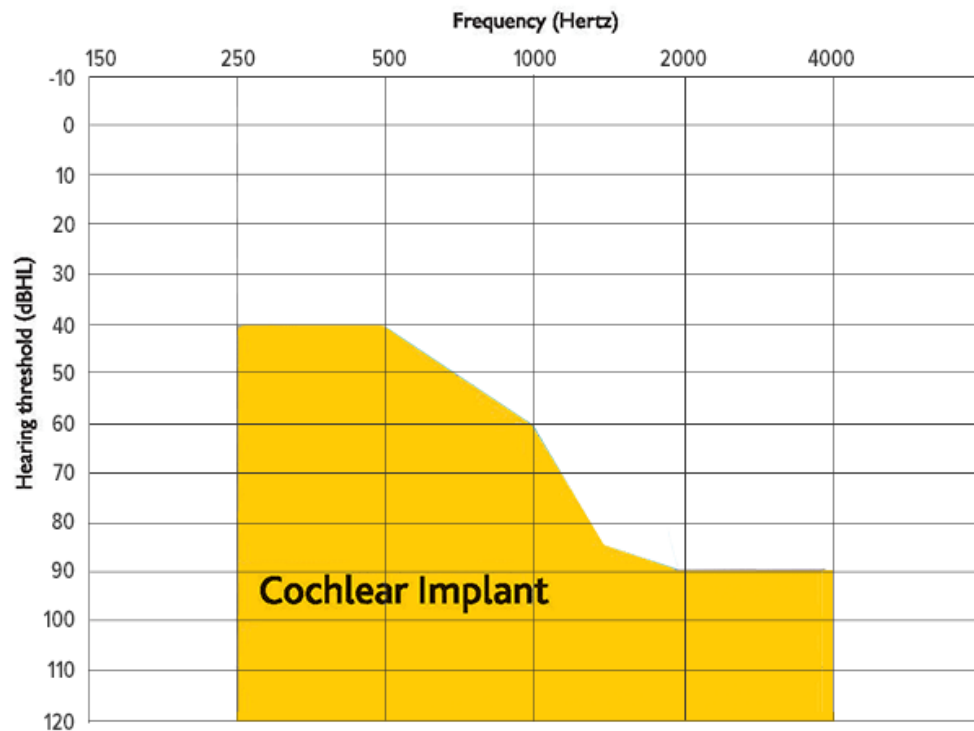
Wireless accessories have developed from Assistive Listening Devices (ALDs) and digital hearing aids into cochlear implants and other implantable devices, exemplified by Phonak's interaction with Advanced Bionics under the Sonnova group umbrella. These accessories are a major and important advance. Bluetooth microphone, television and mobile phone accessories allow users to listen to audio devices, television, and have phone conversations more clearly and without background noise.

The figures below illustrate the Cochlear suite of accessories and their functions.



Remote assistants - examples above - allow settings, functions and accessories to be managed without touching or removing the processor.

The usual application range for the Cochlear Implant is shown below.



Many people are receiving benefit from wearing a cochlear implant on one ear and a hearing aid on the other.

Cochlear implants are now very well established and accepted worldwide. Bilateral cochlear implants are increasingly common and their advantages well demonstrated. There are far fewer manufacturers than for hearing aids, and their websites are sources for more specific and detailed information. Cochlear implants are also becoming established as a solution for single-sided deafness, where the recipient can have normal or near-normal hearing in the other ear.

(IV) Hybrid Cochlear Implant/Hearing Aid (Electroacoustic Device)

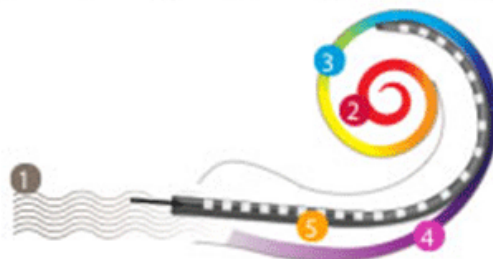
This is essentially an integration of the features of a hearing aid into a cochlear implant. The BTE component (left and right below) is both a speech processor and amplifier, and it has both transmission coil and earmould connections. The implant component (centre below) is similar to that for the cochlear implant except that the electrode array is shorter, since it does not need to penetrate as far into the cochlea because its function is to stimulate the high frequency end only. The acoustic amplification acts on the inner hair cells, which are still functional (and are not exposed to the small risk of damage that a full length electrode array insertion might entail).



Electro-acoustic implant systems allow people with high frequency hearing loss to hear high frequency sounds which are so important for understanding speech and for successful communication.

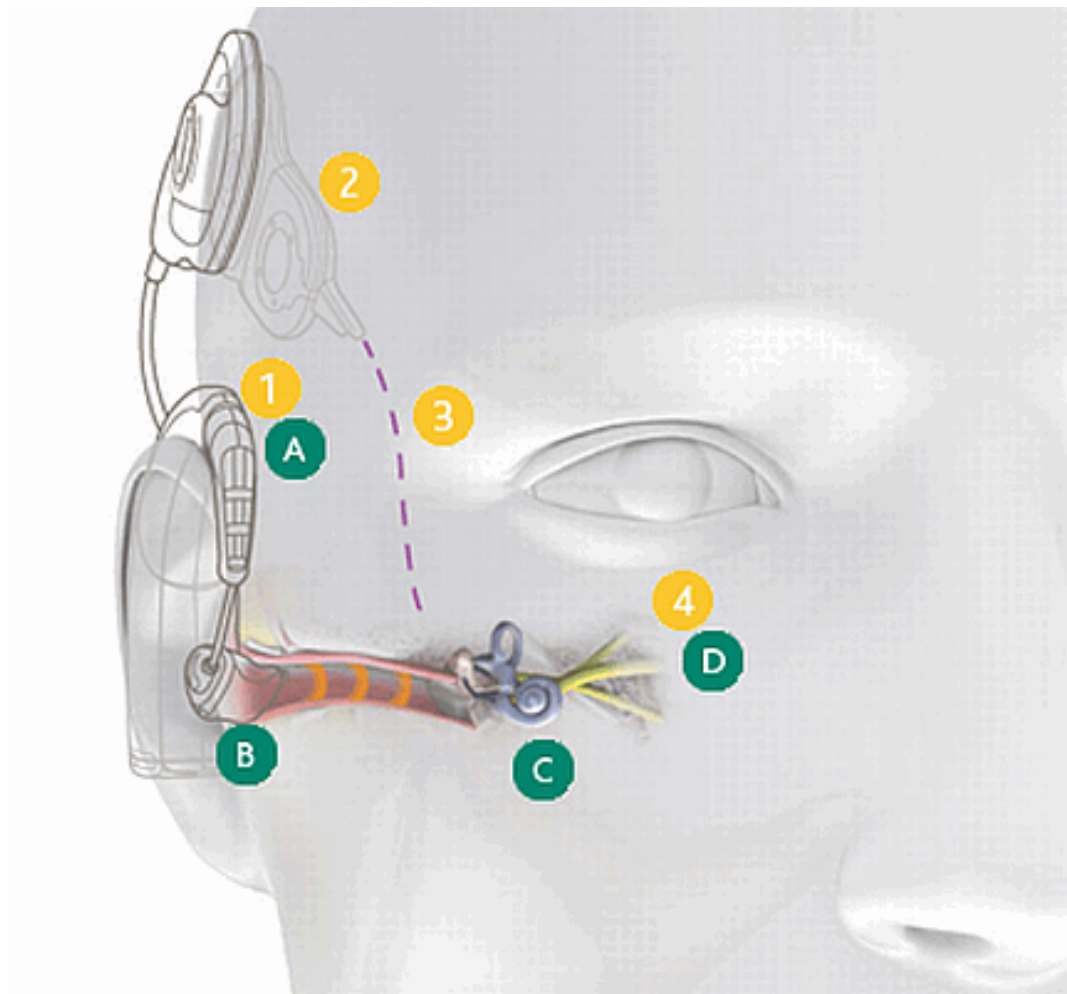
The acoustic component amplifies sound, strongly stimulating the low frequency hair cells deep inside the cochlea, and improving the perception of low frequency sounds in the brain. The implanted electrical component directly stimulates the high frequency hearing cells bypassing the damaged hair cells and creates the perception of high frequency sound in the brain.

Frequencies that are audible:

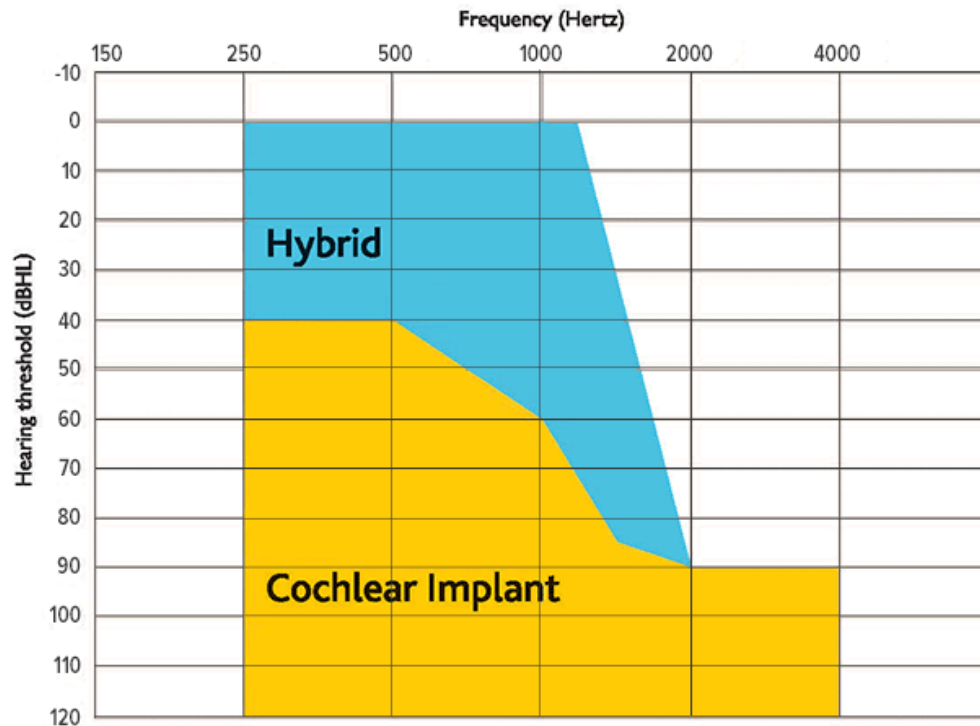


- ① Amplified sound
- ② Low frequencies: functioning hair cells
- ③ Mid frequencies: partially damaged hair cells
- ④ High frequencies: electrode bypasses damaged hair cells
- ⑤ Hybrid electrode

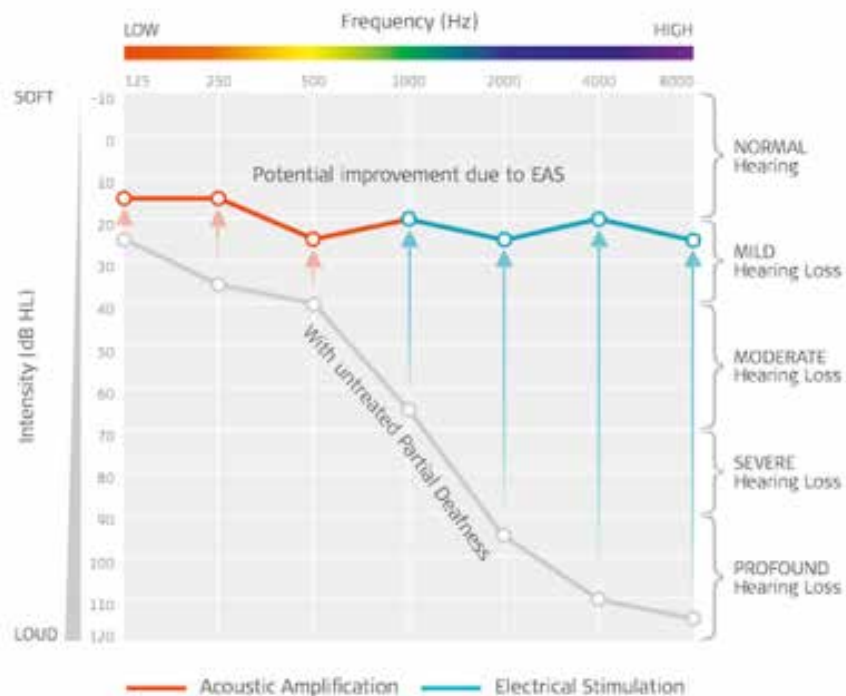
Electrical pathway	Acoustic pathway
1 The external sound processor captures sound and converts it into digital signals	A The external sound processor sends low frequency sounds to the Acoustic Component
2 The sound processor sends digital high frequency signals to the implant	B The Acoustic Component amplifies the low frequency sounds and sends them via the normal hearing pathway
3 The implant converts high frequency signals into electrical energy, sending it to an electrode array inside the cochlea	C The amplified sounds activate the hearing nerves
4 The nerve hearing response caused by electrical and acoustic stimulation is sent to the brain which combines them into a perceived sound	D The nerve hearing response caused by electrical and acoustic stimulation is sent to the brain which combines them into a perceived sound



The application range for the hybrid or electroacoustic devices is illustrated below; the blue tint represents the acoustic (hearing aid) component and the yellow tint the cochlear implant component.



The audiogram below illustrates a typical hearing test using the hybrid electro-acoustic device compared with the unaided hearing results that reflect the ski-slope of hearing loss.



It was noted in Section 4(iv) that the opposite of the above high frequency hearing loss can occur, that is “reverse slope” hearing loss. Any electrical stimulation would need to be confined to the low frequency end at the back of the cochlea where the profound hearing loss is located. So a normal cochlear implant rather than a hybrid would seem more appropriate, provided the reasonable to good high frequency hearing at the front of the cochlea could be substantially preserved! Also the acoustic amplification aspect of the hybrid processor would need to be programmed for the high frequency reverse slope! There is little or no information in this context; indeed a well-designed and specifically-programmed hearing aid seems to be a better option, to quote from experience of users below:

“Fortunately, with new digital hearing aid technology, having frequency-transposing hearing aids is much less of a concern. This is largely because of two innovations. The first is that new digital hearing aids have multiple channels in them, which allow dividing up the audio frequency spectrum so that each channel can be programmed independently from each other. So hearing aids can be set - theoretically - to exactly match a reverse slope hearing loss—frequency by frequency.

The second innovation is the development of wide-band hearing aids. Typical hearing aids cover the frequencies up to 6,000 or 8,000 Hz. New wide-band hearing aids can work up to 16,000 Hz where many with reverse-slope losses typically have reasonable to good hearing.”

(V) Auditory Brainstem Implant (ABI)

ABI is a small device that is surgically implanted in the brain of a deaf person whose auditory nerves are lacking or damaged. ABI uses similar technology as the cochlear implant but instead of electrical stimulation being used within the cochlea, it is used to stimulate the brain directly.

An auditory brainstem implant provides hearing to people with hearing loss who cannot benefit from a cochlear implant. Most commonly this is when there is an absent or very small hearing nerve or severely abnormal inner ear (cochlea). The auditory brainstem implant directly stimulates the hearing pathways in the brainstem, bypassing the inner ear and hearing nerve. Originally developed for adults diagnosed with neurofibromatosis type 2 (NF2), a rare genetic condition that causes tumors to grow on nerves, the surgery is now considered for adults and children with other nerve and inner ear abnormalities.



In people with NF-2, the ABI usually is placed at the same time the nerve tumors are removed, so it is completed within one surgery. The ABI connects directly to the brainstem, bypassing the damaged cochlea and cochlear nerves. The microphone picks up sounds from the environment and digitally transmits them to the decoding chip under the skin. The chip stimulates the brainstem electrodes, allowing the patient to hear a variety of sounds.

The device does not give the full range of hearing, but it provides increased environmental noise awareness. Most recipients are able to hear noises like a telephone ringing or horn honking, but the degree of hearing usefulness can vary greatly. Some people get good word recognition, while others get more general sound cues. In combination with lipreading, the cues help improve communication with others. Due to the brain surgery required for the implantation and the limited effectiveness of the implant, the number of ABI recipients is very small compared to the number of CI recipients.

The neural disorder CAPD referred to under types of hearing loss is not normally treated with implantable devices (or hearing aids) - rather a variety of therapies, training programs, and strategies help children and adults manage the condition. In the case of ANSD, in some cases - particularly in children who have the neonatal form of AN, hearing aids can help by making sound and speech more audible. In other situations cochlear implants can also provide some benefit by bypassing the regions in the auditory system that are damaged.

8. SOLUTION OPTIONS - MATCHING WITH HEARING LOSS TYPES

The Table below is distilled from the Section 5 on Hearing Aid Solutions and Section 6 on Implantable Device Solutions and summarised into a logical format.

Type of Hearing Loss	Degree of Hearing Loss	Solution Options
Conductive	Mild to Moderate	1. Bone Conduction Hearing Aids 2. Bone Conduction Implants e.g. Baha, Bonebridge, Alpha 1 3. Some Air Conduction Hearing Aids
	Mild to Moderately Severe	4. 1 to 3 above 5. Middle Ear Implant
Sensorineural	Mild to Moderately Severe	1. ITE & BTE Air Conduction Hearing Aids
	Mild to Severe	1. BTE & RITE Air Conduction Hearing Aids 2. Middle Ear Implants
	Severe to Profound in one ear, other ear normal	1. CROS Hearing Aids and Bone-Anchored Implants 2. Cochlear Implants
	Severe to Profound	1. Cochlear Implants
	Mild to Severe at low freq. and Severe to Profound at high freq. ("ski slope" profile)	1. Hybrid Hearing Aid/Cochlear Implant 2. High Power BTE Hearing Aids
	Reverse ski slope hearing loss (profound to severe at low frequency; moderate to good at high frequency).	Multichannel wide band hearing aids specially programmed
Mixed/Combinations	Mild to Profound	1. Specific Combinations of Hearing Aids and Implantable Devices
Neural	Profound	1. Auditory Brainstem Implant
ITE = in the ear BTE = behind the ear RITE = receiver in the ear CROS = Contralateral Routing of signal		

9. HEARING AIDS AND IMPLANTABLE DEVICES - COMMON FEATURES

Hearing aids are outer ear devices that amplify incoming sounds. Implantable devices bypass the outer ear and transform sound to electro-mechanical or electrical signals applied to the middle or inner ears. Bone conduction hearing aids also bypass the outer ear, and may be implantable (bone-anchored) or not. All types of devices reduce the perception of tinnitus in most cases.

AUDIOLOGIST COMMENT 12

POSITIVE IMPACT on TINNITUS

TINNITUS by definition is the “Perception of a sound or noise within the ears or head **IN THE ABSENCE OF AN EXTERNAL SOUND OR NOISE**”, **THE FACT** that this perception can be and is reduced with the use of hearing devices is **VERY IMPORTANT** and can be the very reason an individual uses amplification even if they do not accept they have that much of a communication problem. **IF THEY CAN GET RID OF THEIR TINNITUS**, they can **CONTROL** their life and improve their sleeping. (many tinnitus sufferers use their instruments all night and sleep much better)

Today nearly all hearing solutions are miniature electronic devices using digital technology. This means incoming signals are converted into a series of numbers, which is then processed using mathematical equations, enabling very complex manipulation of signals, for example, to separate speech from noise. Their sound processing chips are designed to deal with enormous amounts of data. Complex algorithms separate sound into different frequency regions and amplify or process each region selectively.

Digital processing ensures a precise replication of the original signal with minimal distortion, resulting in good sound quality. All devices contain one or more microphones to pick up sound, the component that amplifies and processes sound, a receiver or speaker that sends the signal into the ear and a battery, or power source.

All these components are packaged into various styles. Sound inputs are enhanced to different degrees across the frequency range, reflecting that hearing loss does not apply equally at all frequencies; thus the devices are adjustable for the particular type and degree of hearing loss in one or both ears so that the wearer can hear all pitches as clearly as possible. This programming or mapping is specific to an individual.

Many devices have dual directional microphones and automatic and/or manual programs for listening to speech in quiet or speech in noise, or to music. All hearing devices prevent wanted or unwanted sounds from

becoming uncomfortably loud, most offer feedback cancellation of steady noise sources. Most have telecoils and T switches whereby one can connect to radio frequency hearing loops in venues and telephones so that one can hear the speaker while not hearing background noise and other voices. Wireless accessories are becoming established to help users of hearing aids and implants understand better in noisy environments, on the telephone, listening to audio devices and watching TV.

Remote controls can provide the user with easier programming, adjustment and troubleshooting. Basic, advanced and premium models of hearing aids may be available which reflect the degree of manual or automatic control, directional microphones, number of channels and hence capability of fine tuning, number of programs for different listening situations and for impulse and steady noise reduction, wind reduction and feedback management, telecoil, and cable or wireless connection to audio equipment.

AUDIOLOGIST COMMENT 13

REDUCE LOUDNESS and DISCOMFORT

Some people are afraid that since they cannot tolerate 'loud' or 'louder' sounds, when a 'normally hearing' person can tolerate very loud sounds, they will be even more intolerant of loud sounds if they wear amplification. The fact that devices can and do **REDUCE THE DISCOMFORT** of loud sounds, while still allowing the user to perceive softer sounds, **IS VERY IMPORTANT**. Hearing aid wearers are, in many incidences, protected from day to day street noises, far better than those who do not use any devices and who must put up with extreme street noises or in the movies or theatre.

The most common type of hearing aid and the sound processor part of implantable systems are both behind the ear (BTE).

If people have a hearing loss in both ears, they should wear two appropriate devices. The brain is wired to use input from both ears. Two devices thus reflect the natural hearing process, give better clarity/quality (like stereo vs mono), better sense of direction of sounds, no turning one's good ear towards the sound, better performance in noise and for music, and more relaxed listening with less straining or fatigue.

Research shows that children with normal hearing in one ear and total hearing loss in the other, are ten times more likely to repeat a grade in school. Wireless communication allows two hearing devices to communicate and perform binaural processing. Implantable devices are also now an established solution option for this single-sided deafness (SSD).

Learning to hear sounds again with hearing devices is a gradual process. At first, sounds may seem unnatural. As the brain adjusts to hearing again, over time, things will sound more natural. Whether one or two devices, hearing aids or implants, an adjustment (refitting, remapping) period of weeks or months is common, and no device provides natural hearing, nor allows hearing everything in every situation. People with normal hearing also miss things and generally have difficulties in noisy situations.

At the other extreme people with untreated hearing loss have been shown to have a greater risk of dementia, which increases with the degree and duration of the untreated hearing loss. It is important to use hearing aids and implantable devices to keep the brain active; indeed brain plasticity is such that people with a high degree and/or long duration of hearing loss who do receive implants exhibit rewiring of the brain's auditory pathways and significantly reduce risk of dementia.

AUDIOLOGIST COMMENT 14

USE IT or LOSE IT

ALTHOUGH digital processing may indeed ensure precise replication of the original signal - **IF THE USER HAS WAITED TOO LONG, THEIR BRAIN FORGETS WHAT THE SIGNAL REALLY SOUNDED LIKE. IT IS THE USE IT OR LOSE IT PRINCIPLE.** Hearing aid users could be perceived as younger and more alert, if they used their instruments for all their awake hours.

10. CONCLUSION - DO SOMETHING ABOUT IT, YOU WILL BE IN GOOD COMPANY



100 Celebrity Ambassadors Hear the World Foundation

The Hear the World Foundation led by the Swiss Sonova company has over 100 celebrity ambassadors supporting 80 projects in 39 countries across all five continents.

Among those are Hear Armenia, All Ears Cambodia, Hear Malawi and a long-term partnership with the Centro Cristiano de Servicios Medicos in the Dominican Republic. Among these actor, model, musician and other ambassadors are Bryan Adams, Michel Buble, Cindy Crawford, Roger Daltrey, Placido Domingo, Linda Evangelista, Jerry Hall, Annie Lennox, Kate Moss, Rod Stewart, Sting, Tina Turner, Dionne Warwick.

Their fund-raising includes annual calendars featuring some of their celebrity supporters.

Ben Affleck, Johnny Depp



These Hollywood stars are active with the Starkey Hearing Foundation which distributes free hearing aids in developing countries. Affleck founded the Eastern Congo initiative (image above right) while Depp and his wife handed out customised hearing aids to 200 recipients in Brazil - image left shows Depp with friend and musician Alice Cooper. The Foundation, part of ex-President Clinton's global initiative, aims to fit more than one million hearing aids to people in need.



Jason Akermanis

He played AFL for 15 years with the Brisbane Bears, Brisbane Lions and Western Bulldogs and won a Brownlow medal. After moving to coach North Albury in 2013, Jason and his wife Megan, a speech pathologist, have been helping youngsters with hearing loss reap the social, health and well-being rewards from being involved in team sport. His involvement with the deaf community sprang from Megan's parents, who were both born profoundly deaf after their mothers contracted german measles.

Geoffrey Rush - Hearing Sounds as Colours



Renowned for his performances in the movies Shine and The Kings Speech, and the TV series Genius about Einstein, Rush has a condition called synesthesia. Our brains and ears work together in rapid, complex ways and sometimes our senses get mixed up. Sounds, days of the week and everyday noises have colours while music evokes both sounds and colours for the actor. Synesthesia seems to have enhanced the careers of creative types such as Rush, musicians Billy Joel and Stevie Wonder, artist Vincent Van Gogh and actress Marilyn Munroe to name a few. In a few cases synesthesia is associated with hearing loss or with using hearing aids.

Keira Knightley - Amusia



Keira's movies include Star Wars, The Imitation Game, Anna Karenina and Begin Again. She easily hears voices and environmental sounds but not music because her brain does not "tune in" to melody or beat. That was part of her challenge in doing Begin Again where she

is married to a musician, her friends and relatives are into music. Like the rehabilitation process for cochlear implant recipients, music training can help those with amusia.

Stevie Nicks and Mick Fleetwood - Fleetwood Mac

Stevie's music career has spanned 4 decades despite hearing loss threatening her singing. She started to lose higher-frequency sounds and began using hi-tech headphones. Mick also has noise-induced hearing loss following years of drum-playing. They back hearing loss awareness campaigns and Nicks makes



every effort to stay proactive and upbeat. Their message should resonate particularly with seniors facing hearing loss given the range and versatility of hearing assistance technology available today.

Billy Connolly

Comedian and actor Billy Connolly wears miniature hearing aids. His wife Pamela Stephenson, a clinical psychologist, blamed his deafness on years of hanging around rock 'n' roll venues with the speakers at full blast. She had to force her husband to seek medical treatment for his problem because he was "too proud" to wear a hearing aid. Then he started having problems during his live performances, where people thought he was forgetting his lines but he was having trouble hearing the audience and a comedian has to get immediate feedback. As soon as he got help it became like night and day. He became better on stage than he has been for years and years.



Emilie Biggar - My Kitchen Rules



Deaf contestant Emilie (on right), on the pressure-cooker environment of the TV show, encountered debilitating hearing issues. While she has worn a regular hearing aid since the age of six, Biggar's hearing in her right ear disappeared completely during the show — a symptom of the stress she was enduring. She had to go on with the show completely

deaf. The sound was so different ... it was like someone had a paper bag over her head. Some judges were impossible to understand. Biggar is an advocate for the deaf community and after the show was considering a cochlear implant.

Troy Cassar-Daley

The award-winning country singer recognises hearing health as priceless. A lifetime on stage next to loudspeakers and screaming crowds underpins the precautions he takes himself and his campaigning for hearing health. He and his wife were watching a TV program about cochlear implants and were deeply affected by profoundly deaf parents hearing their children for the first time. He subsequently became ambassador for Australian Hearing.



Jodie Foster



In her 50s and a hearing-aid wearer, Foster continues to work as one of the world's highest-paid actresses in an industry defined by its emphasis on youth and beauty.

Ben Cohen - former England Rugby Union player



At the peak of his international career in 2004 Ben found he was going deaf. His issues were mainly off the pitch given the macho image of rugby. It was Elton John (as ambassador for the Starkey Hearing Foundation) who encouraged Ben to wear modern bidirectional hearing aids. He puts his energies into making sports more accessible to hearing-impaired children alongside his major interest against bullying, as founder of the Stand Up Foundation.

Halle Berry



Berry is probably best known for emerging out of the sea in the Bond movie *Die Another Day*, reminiscent of the older classic *Dr No* with Ursula Andress. Although she does not publicly discuss it, Halle lost 80% hearing in one ear after being physically abused by a former boyfriend.

John Farnham, Chris Martin, Al Jarreau, Paul Stanley

Typical of older musicians with hearing loss, Farnham and jazz player Jarreau have worn hearing aids on their more recent tours and performances. Stanley, lead singer and guitarist for rock band Kiss, has a bone-anchored hearing implant.

Martin, lead singer of Coldplay is plagued by tinnitus, and makes sure his then wife (Gwyneth Paltrow) and children (image below) have good ear protection at concerts. He is also a supporter of Action on Hearing Loss, the major UK charity



All of the above summaries were extracted and adapted with permission from Hearing HQ magazine 2013-2016 issues.

Some further examples from Australia:



Many know Stephanie Alexander as a former restaurateur, food writer, celebrated cook book author, champion of the quality and diversity of Australian food and Junior Masterchef judge. She has done it all with a significant hearing loss!

CICADA Magazine autumn 2011

Sir Jack Brabham was a three times world champion racing driver and the first driver in history to be knighted for services to motorsport. He battled with deafness largely associated with race car driving since the 1970s, wore hearing aids initially then received a cochlear implant in 2006

CICADA magazine Autumn 2012

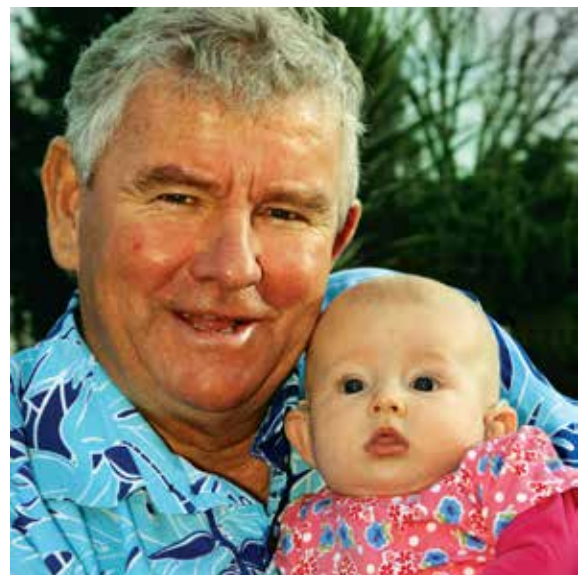




Jennie Brand-Miller, a Sydney University professor best known for her research and publications on the Glycemic Index, received her first implant in 1998 and her second in 2007.

New Zealand cricketing legends, father and son duo Lance and Chris Cairns have both experienced the extraordinary impact that cochlear implants can make on one's life. Theirs is a powerful story of the benefits of early intervention for newborns or adults who experience hearing loss.

CICADA magazine summer 2011/12

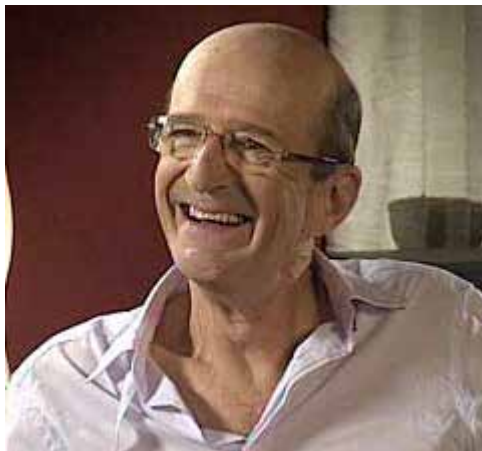




Recently John Farnham toured the nation as a commemoration to the 25th anniversary of his much celebrated 'Whispering Jack' album. The 61-year-old performed the first half of the show unplugged, easing the audience in with his sense of humour before roaring to life in the second half with much-loved favourites and concluding with the ever popular 'You're the voice'. John has recently admitted there is one major difference this time around – he is wearing hearing aids.

CICADA magazine winter 2011

Australia's former Prime Minister, The Hon John Howard AC is the Patron of Hear For You each year sharing his experiences growing up with a hearing loss since the age of nine.



Garry McDonald, the TV, movie and stage actor best known as Norman Gunston and as Arthur in "Mother and Son". He developed increasing hearing loss which he overcame successfully using hearing aids.



Tim Bowden, former ABC presenter of Backchat and author. He has moderate to severe sensorineural hearing loss particularly at high frequencies, possibly starting from his time as cadet on the rifle range and with the Australian Army. He has worn hearing aids for many years.

Harry M Miller, prominent in major theatre productions and in celebrity management, has spoken about his difficulties and hearing aid solution.



Here are some further examples of prominent people with hearing loss and/or tinnitus and balance issues:

Bill Clinton, former US President - his past activities in marching bands, as a band player and as a rock concertgoer, along with noise from campaign rallies and presidential helicopters, probably all contributed to his hearing loss. He has worn a pair of virtually invisible hearing aids since 1997.

Ronald Reagan, another former President - had hearing aids fitted to his right ear in 1983 and left ear in 1987. His hearing loss was partly the result of a gun fired near him in his movie career. He was a public advocate of hearing solutions.

Arnold Palmer, legendary golfer and golf course designer - wore hearing aids for a long time and was another public advocate. He commented that the sounds with the hearing aid of the ball being hit by the club are more realistic and better represent what he knew.

William Shatner, actor famous for his role in Star Trek as Captain Kirk - he and his co-star Leonard Nimoy (Spock) were standing near an explosive device on the Star Trek set when it accidentally went off. Nimoy had a problem in his right ear, Shatner in his left ear. Shatner used a hearing aid device that provided tinnitus retraining therapy.



Marlee Matlin remains the youngest winner of an Oscar for Best Actress, securing the award for *Children of a Lesser God* when she was only 21 years old. She was awarded a Golden Globe for that same movie too. She has starred in numerous television shows (like *Seinfeld*, *Desperate Housewives*, *CSI: NY* and *Law and Order SVU*). She also managed to advance through five rounds on *Dancing with the Stars*. She has written four novels. She has been instrumental in the fight for universal captioning in videos to be legislated. And she's been profoundly deaf since she was 18 months old.

CICADA magazine summer 2011/12

Jane Lynch, Emmy Award-winning comedienne, actress and singer, is just one of many successful hearing-impaired individuals who refuse to let deafness limit them. With a successful career spanning theatre, television and the big screen, Lynch certainly hasn't let a hearing disability affect her career. She starred in the award-winning American musical television series *Glee* as sharp-tongued cheerleading coach Sue Sylvester. *CICADA magazine winter 2011*



Barbara Striesand, Whoopi Goldberg, Lou Ferrigno (*The Incredible Hulk*) are other actors who use hearing aids.

Musicians with hearing loss are too numerous to list! Not surprisingly there is an Association of Adult Musicians with Hearing Loss (AAMHL). Among the interesting observations is that U2 rock singer Paul David Hewson (Bono) saw a billboard for Bonavox hearing aids at a clinic in his Dublin hometown and developed the nickname Bono Vox! Pete Townshend of The Who, Roger Taylor of Queen and Paul Stanley of Kiss are other musicians mentioned in the *CICADA magazine* issues.