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Hearing loss in the ageing patient

inside

Background and pathology

HEARING loss in the ageing patient is common. In recent Australian surveys, 26.6% of the population have some hearing impairment, while in the 70+ age group this prevalence rises to 87.5%.[1] Deterioration of hearing with increasing age is not inevitable. As a case in point, the Mabaan people of Sudan are known to maintain a healthy diet, exercising daily, avoiding tobacco smoke and noisy environments; most of this population maintain their hearing in the normal range well into old age.

The normal processes of ageing affect all subsections of the ear, but it is the effects on the inner ear and the resultant sensorineural hearing loss that causes elderly patients the most morbidity. Presbycusis is the term used to describe sensorineural hearing loss secondary to the ageing process and is presumed to be the result of multiple, repeated insults to a patient's cochlear function. Presbycusis is both a diagnosis of exclusion and an umbrella term for multiple presumed pathological processes.

Damage to the cochlea occurs due to the age-related accumulation of genetic damage and gradual decline in the numbers of neural and supporting cells within the cochlea. Other possible causes of cochlear damage include:

- Noise.
- Repeated exposure to ototoxic medications.
- Vascular pathology.
- Inflammation from nearby middle-ear disease.

The higher incidence and greater severity of presbycusis in men is thought to be largely due to the differences in noise exposure experienced by men and women in occupational and recreational activities. Cell population decline has been observed at all locations along the auditory pathway.

Central changes leading to difficulty with hearing can be classified as primary or secondary. Primary changes include reduced volume of brain tissue involved in auditory processing. Lipofuscin accumulation has also been noted in ageing central auditory neurons, as it has in ageing tissues elsewhere in the body.

This senescent change is in addition to other pathologies common in the elderly that affect brain health, such as arteriosclerosis or respiratory failure. Overall, these hearing-related changes are referred to as central effects of biological ageing and have been found to cause difficulty in judging the duration of sounds, perceiving gaps in sounds and localising sounds in space.[2]

Secondary brain changes occur in situations of auditory deprivation from hearing loss due to pathology anywhere in the ear. Hearing-loss-induced neuroplasticity, or central effects of peripheral pathology, can increase the sensitivity (decreased decibel threshold) of the deprived central auditory neurons, typically at the expense of frequency and temporal resolution. There is, however, evidence for beneficial neuroplasticity when auditory input is restored, such as with 'aiding' of a previously unaided ear (ie, use of a hearing aid or implanted device).

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Classifying types of hearing loss

Based on audiology findings, the severity of hearing loss is described as mild, moderate, severe or profound (figure 1A). Basic audiograms are used to identify and classify hearing loss with standard notation as indicated in figure 1A.

Hearing loss is broadly categorised into a loss of either conductive or sensorineural origin. Conductive hearing loss refers to a loss in the sound conduction system of the external ear, tympanic membrane and/or middle-ear bones. Sensorineural hearing loss refers to that due to damage of the cochlea, the cochlear nerve or higher auditory centres. A mixed hearing loss implies a component of conductive and sensorineural hearing loss (figure 1B, C, D).

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Hearing loss in the elderly is predominantly sensorineural in nature. It is accepted that the exact site of sensorineural hearing loss has an effect on the type of disability experienced. Retrocochlear pathologies (see table 1) are often associated with disproportionately poor speech understanding scores compared with the patient's actual decibel hearing thresholds. Cochlear pathology is generally associated with speech understanding scores in line with the patient's hearing thresholds, but decreased dynamic range of hearing (the difference between the softest sound we can perceive and the loudest [painful]; normal is about 120 dB).

Figure 1: A: Audiogram demonstrating bands of hearing loss severity and notation. B: Pure tone audiogram, demonstrating a largely symmetrical, down-sloping, mild-to-severe sensorineural hearing loss. C: A largely flat, mild to moderate, right-sided conductive hearing loss. D: Audiogram demonstrating a largely flat, moderate mixed hearing loss on the left side. There is a mild-to-moderate sensorineural hearing loss in most frequencies with about 20dB of conductive overlay.

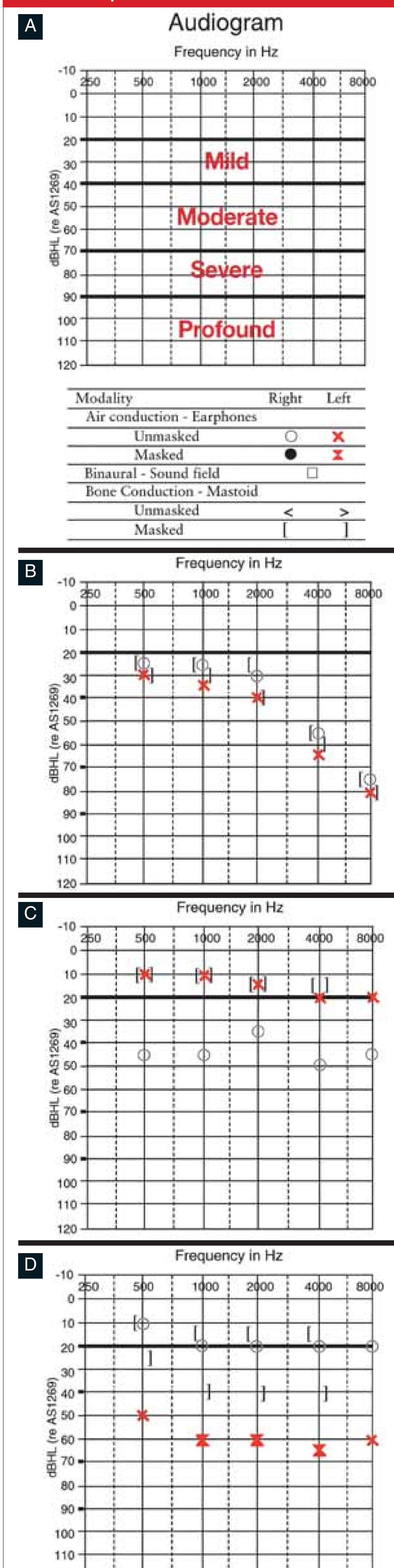


Table 1: Glossary of commonly used audiology terms

Head shadow	Head shadow is exactly what it sounds like, an acoustic shadow due to obstruction of sound by the head. In binaural hearing, the effect of the head shadow is vital in sound localisation. Head shadow causes particular difficulty for people with single-sided deafness.
Interaural attenuation	Interaural attenuation is the sound energy lost between presentation of an auditory stimulus at one ear, and perception of the sound by the contralateral cochlea. Interaural attenuation for a given source depends on both the frequency of the sound (higher frequencies are attenuated less than lower frequencies) and the way that the sound is presented. There is no attenuation of sound presented directly on bone. Conventional air-conduction earphones still transmit a portion of their output directly into bone, with a result that interaural attenuation of their stimulus is between 40 and 60dBHL (decibel hearing level). Inset earphones transmit very little stimulus directly to bone, with resultant interaural attenuation of >70dBHL.
Loudness recruitment	Elevated hearing thresholds with a narrow dynamic range of hearing. Once above the threshold, the perceived increase in sound intensity is greater than the actual increase in sound intensity. A small increase in sound intensity above threshold can therefore lead to an uncomfortable increase in perceived sound intensity, occasionally resulting in pain.
Post-lingual deafness	Refers to the onset of deafness after the time at which a patient has developed speech and language skills. Auditory memory developed between development of language and the onset of deafness has implications for hearing rehabilitation. In the context of cochlear implantation, rehabilitation can involve months of re-education/rehabilitation with an audiologist before a patient gains maximal benefit from their new hearing.
Pure tone average	Average of the pure tone thresholds (in dBHL) at 500, 1000 and 2000Hz (the usual range of human communication).
Retrocochlear pathology	Refers to pathology in the eighth (Cochlear) nerve or the cerebellopontine angle in the area of the eighth nerve. Gadolinium-enhanced MRI is the investigation of choice for possible retrocochlear lesions, though audiological investigations can be reasonably accurate in determining the site of eighth-nerve dysfunction.
Rollover	An audiological phenomenon characteristically seen in retrocochlear pathology. The patient's speech discrimination increases with increasing sound intensity to a point before falling rapidly with further increases.
Telecoil	A telecoil is a magnetic coil within a hearing aid or speech processor for the purpose of receiving auditory information transmitted by an individual or large-area inductive loop.
Tonotopic organisation	Cell populations throughout the auditory system are organised 'tonotopically', or according to the frequency of auditory stimulus to which they will respond. This is particularly important in the cochlea, where the basal portion of the cochlea (closest to the round and oval windows) is responsible for perception of high frequency sounds. Lower frequency sounds are perceived further towards the apex of the cochlea.

cont'd page 30

Management

The effects of hearing loss on the ageing patient

THE psychological, emotional and financial burdens of hearing loss on the ageing patient are significant and well established. Hearing loss can cause feelings of isolation, both on the part of the patient and the people close to them.

When combined with a lack of understanding on the part of the people attempting to communicate with the patient, hearing loss strains relationships. Dissatisfaction with, or unwillingness to use, hearing aids can cause family members and friends to feel that the patient does not care about them enough to try to communicate. Although some patients may be accepting of hearing loss, others may feel that acknowledging their disability by seeking treatment is an admission of either their age, or may reveal their vanity.

Furthermore, hearing loss can compromise a patient's ability to perform their activities of daily living as well as reducing their enjoyment of these activities. Difficulties in communication can also jeopardise a patient's health both because of the inability to perceive auditory alerts (ie, to dangers), and because of interference with participation in medical and allied health interventions. Elderly patients with a hearing disability have also been found to have rates of depression almost twice as high as those in the same age group with preserved hearing.[3,4]

Key management options are summarised in the box above.

Management of hearing loss in the ageing patient

- Counselling the patient about the impact of hearing loss and how it affects them
- Tips for family and friends on how to talk to the deaf patient
- Hearing assistive listening devices
- Alerting devices
- Hearing aids (air and bone conduction)
- Hearing implants:
  - bone anchored hearing implants
  - middle-ear implants
  - cochlear Implants
  - hybrid (half implant/ half hearing aid) cochlear implants

Advice a GP can give to family and friends of deaf patients

DO

- Wait until the hearing-impaired person can see you before speaking. Touch is helpful to get their attention
- Position yourself close to the person when speaking
- Speak at a normal rate and try to enunciate clearly
- Reduce background and competing noise
- Clue the person into any changes in the conversation topic

DON'T

- Speak from another room or while walking away
- Speak directly into the person's ear (this distorts the message and hides visual clues)
- Shout (this may distort the message)
- Cover your mouth with your hands while speaking
- Repeat the statement if it is not understood (it is better to rephrase)

For a downloadable PDF patient handout see: www.northsidehearing.com.au

Counselling the ageing deaf patient, family and friends

The GP plays a critical role in identifying and treating hearing loss in the ageing patient. Often the GP will be the first point of contact for a patient having difficulty hearing (or a spouse who is having difficulty with their partner's hearing). The GP can play a role in understanding the situations in which the patient is having trouble, educating the patient about the effects of hearing loss as well as providing useful tips on how family and friends may help with communicating to the deaf patient (see box above).

A good screening question for the GP to ask patients troubled by hearing loss is whether they are coping in social situations or where there is background noise after being well fitted with hearing aids. The GP should not assume that because the patient is hearing well in a one-to-one situation that no problem exists. Rather, questions about their hearing in real-world situations are far more important. After an audiogram and confirmation of poor hearing, a referral to the ENT surgeon is generally the next step.

Hearing-assistive listening devices

HEARING-assistive listening devices can be thought of as hearing aids for particular tasks and environments, designed to transmit the sound from source to individual as directly as possible, therefore reducing surrounding noise. Devices vary greatly in design and application, but in all cases the device has an input, a method of transmission and an output. Input methods may be a direct connection, such as the audio output from a computer or television, or a microphone such as in a classroom FM setting.

Transmission of sound by an assistive listening device can be wired, or wireless. Wireless transmission has traditionally been through FM radio, line-of-sight infrared, or through an inductive loop directly to a telecoil (see table 1, page 28) in a user's hearing aid or implant.

Inductive loops can be individual or large-area loops. Large area loops encircle a room or public space, a common example being the transmission of audio from a film at a cinema. Individual loops, usually in the form of a pendant, allow transmission of sound from personal devices such as personal music players to a user's telecoil-equipped hearing aids or implant.

Figure 2: A Bluetooth hands-free adaptor. This acts as an intermediary between the Alera hearing aid (pictured) and Bluetooth devices such as mobile phones. (Image courtesy of GN ReSound Australia.)

Output from an assistive listening device can be independent, through a headset or earphones, or routed via the user's existing hearing device.

The proliferation of mobile phones and their increasing acceptance among the elderly sees additional challenges. Susceptibility to radiofrequency interference from mobile telephones varies between hearing aid designs, with newer designs generally more immune to radio frequency. Evolution of mobile phone technology has also seen other benefits, such as integrated telecoils. Integration of Bluetooth connectivity is also improving, with some hearing aids including the technology for connecting to mobile telephones and personal music devices (figure 2). Other users can use a Bluetooth-enabled (ie, wireless) individual loop system, generally worn as a necklace, to receive the wireless signal via their telecoil.

Alerting devices

Figure 3: A: The MiniVib, an alerting device commonly used in Australia. It receives alarms from four different sources. The combination of vibration and simple colour-coded alerts are helpful in dual sensory loss. B: The Lynx Tactum. This integrates up to seven different sources into a working wristwatch. Each input has a vibratory alert as well as a pictorial indicator on the face of the watch. (Images courtesy of GN ReSound, Sweden.)

WE rely on a remarkable number of acoustic signals to gain our attention or alert us to danger. The inability to hear a doorbell or alarm clock may be an annoyance, but the inability to hear a smoke alarm can be life threatening.

Alerting devices are designed to convert these alerts into either vibro-tactile or visual stimuli. Alerting devices may be specific to one device or source, or may integrate monitoring of several sources. Portable vibro-tactile receivers are generally packaged in the form of a wristwatch or pager, while alarm-clock receivers are typically attached to a vibrating pad, designed to be placed under the patient's pillow (figure 3A, B).

Hearing aids

Air-conduction hearing aids

HEARING aids are the next step in hearing loss management for the elderly when the above options have been exhausted and the patient still has many acoustically challenging environments. Conventional hearing aids are referred to audiologically as air-conduction hearing aids, with sound being amplified and transmitted through the normal auditory system. There are two broad types of air conduction hearing aid, the behind-the-ear (BTE) and the in-the-ear (ITE) aid.

Behind the ear

BTE hearing aids consist of a microphone, receiver and processor package that rests behind the pinna, connected by a polyethylene tube to a custom-made ear mould for the amplified output (figure 4A, B, page 32). BTE aids are generally less expensive than their ITE counterparts, and the bulky size of the BTE package allows for higher output gain and battery capacity.

Patients with poor manual dexterity may find BTE aids difficult to fit, but the larger package does allow manual volume or telecoil controls to be made larger. The ear mould has ventilation ports to allow dehumidification of the ear canal. The ventilation ports also lessen the amplification of low frequencies (which are generally preserved in the ageing patient); this decreases the feeling of blockage in the ear, called the occlusion effect. The separation of the microphone and output also means that acoustic feedback is reduced.

In the ear

ITE hearing aids consist of a single package, containing microphone, receiver, processor and output, surrounded by a custom-made shell to fit within a particular subsection of the external ear. The ITE can be within the patient's ear canal and conchal bowl (ITE), solely within the ear canal (in-the-canal [ITC] or completely-in-canal [CIC]). Unlike ITC aids, CIC aids do not protrude from the lateral opening of the ear canal and so have a clear filament attached to their body to aid removal (figure 4C).

As the size of the aid package reduces, so does the available output gain (amplification) and battery capacity. Correct fitting of the earmould is also more critical with CIC and ITC aids, as inadvertent ventilation can lead to considerable acoustic feedback. Smaller aid packages also means less accessible surfaces for the controls, which make automatic volume controls and speech detection systems invaluable. Remote controls are also an option for patients with limited manual dexterity.

Regardless of the choice of a BTE or an ITE package, an ear mould is required, and changes to the external ear in older people make this process more difficult. In the elderly, changes in wax production and migration, hair density and skin quality may mean that a correct fit is difficult to achieve and ports are frequently blocked by wax.

Although many older patients are eligible for government-subsidised hearing aids (see box, far right), they may be dissatisfied with the performance of these aids. Extra features that older patients may require are available with co-payments to the government scheme.

Reasons why patients may not receive approval for hearing aids are shown in table 2.

When hearing aids are appropriately fitted and tuned, about 70% of patients will have notable reduction in their hearing-related disability, while just over half will note improvement in their quality of life.

Single-sided deafness

Single-sided deafness may go undiagnosed for some time because of relatively normal hearing on the unaffected side. Patients with single-sided deafness are difficult to fit with conventional air-conduction aids, as a hearing aid in the affected ear typically provides a distorted sound compared with the normal hearing on their opposite side.

The disability caused by single-sided-deafness is greater than just the inability to perceive auditory stimuli on the affected side. The loss of binaural hearing has been shown to reduce the ability to localise an unseen sound in space, as well as to decrease perception of speech in noisy environments. Additionally, the overall 'effort of listening' is increased in common situations, leading to increased tiredness and frustration.

Figure 4: Comparison of air-conduction hearing aids.
A: A high-powered BTE hearing aid.
B: A mini-BTE air-conduction hearing aid.
C: A completely-in-canal air-conduction hearing aid.
(Images courtesy of GN ReSound).

Bone-conduction devices

Bone-conduction hearing devices may be offered to patients who are not suitable for conventional air-conduction aids. Bone-conduction hearing aids employ a system of microphones and signal processors, as with any other modern hearing aid, but differ in the method of output. The signal processor is connected to an oscillator, which when placed adjacent to the bone of the skull, transmits the auditory stimulus into the bone as a vibration that is perceived as sound by the functional cochlea(e).

The oscillator must be held firmly against the skull to facilitate transmission of the vibratory stimulus through skin and subcutaneous tissue to the underlying bone, so a tight-fitting metal headband is generally used. This headband can be both uncomfortable and aesthetically unpleasing.

Table 2: Why patients may not receive approval for conventional air-conduction hearing aids

Condition	Reason for non-approval
Microtia or aural atresia	Abnormalities in the conformation of the pinna may make fitting of a BTE hearing aid impossible. Narrow ear canals in lower grades of aural atresia make fitting of moulds difficult, while higher-grade aural atresias will obtain little, if any benefit from air-conduction aiding
Discharging ears: • Recurrent otitis externa • Discharging otitis media	Discharge will decrease the effective output of an air-conduction aid, while the presence of the mould will make effective treatment of the infection impossible
Dermatological conditions of the ear canal	Dermatological conditions affecting the ear canal can be exacerbated by the presence of the ear mould, humidification of the ear canal and wax obstruction
Further investigation required	An ENT surgeon may delay approval for aiding pending further investigation of a patient's hearing loss (see table 3)

Table 3: Red flags that warrant referral for further assessment

Red flag	Reason
Asymmetrical sensorineural hearing loss	Can be a presenting feature of a cerebellopontine angle tumour, eg, vestibular schwannoma
Associated cranial nerve deficits	Can be due to, eg, facial nerve palsy in destructive inflammatory or neoplastic processes of the temporal bone
Ear canal or middle-ear mass	Can be due to, eg, squamous cell carcinoma or adenoid cystic carcinoma of the ear canal presenting as a conductive hearing loss
Deep ear pain	May be indicative of a destructive inflammatory or neoplastic process involving the temporal bone
Discharging ear	May be indicative of a destructive inflammatory or neoplastic process involving the temporal bone

Who is eligible for an Australian Government Hearing Services voucher?

- Pensioner concession card holders
- Those receiving sickness allowance from Centrelink
- Gold card holders
- White card holders covered for hearing loss
- A dependent of any of the above
- Members of the Defence Forces
- Those undergoing, and referred by, a government vocational rehabilitation service

Contralateral routing of sound

Contralateral routing of sound (CROS) refers to the gathering of auditory information from one ear and transferring it to the better hearing ear (cross-aiding). In general, bone-conduction hearing aids are cross-aids, as the vibration conducted through bone stimulates both inner ears. With air-conduction CROS aids, the patient wears a hearing-aid mould in their better-hearing ear, typically connected to the contralaterally placed microphone package by a headband.

The same complaints about poor comfort levels and cosmesis apply to air-conduction CROS aids as to bone-conduction CROS aids, but with the added disadvantage of occlusion of the better-hearing ear's external canal. Hearing benefits from CROS aids are thought to be modest at best.

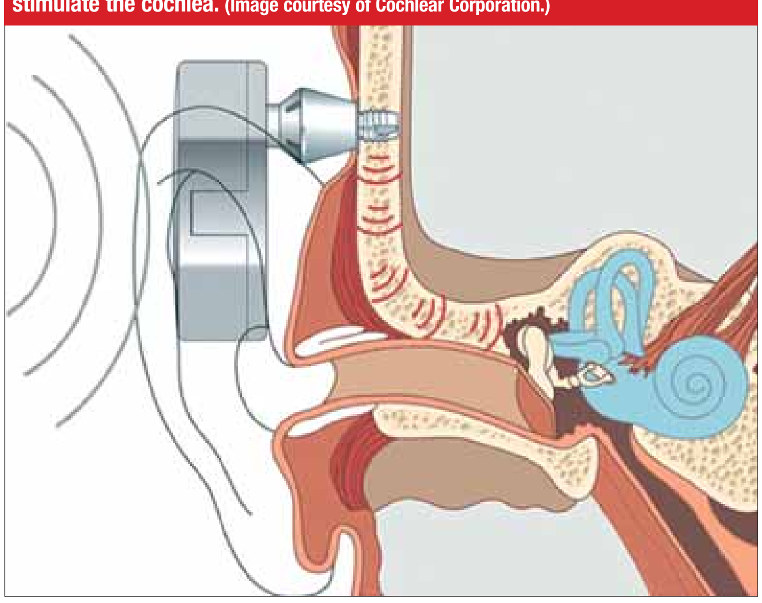
Hearing implants

Bone-conduction osseointegrated hearing implants

BONE-anchored hearing implants were first developed in Sweden in 1977 and have been commercially available since 1987. These devices seek to build on the benefits of bone-conduction hearing aids while reducing the perceived disadvantages.

The device consists of an external microphone, processor and oscillator, which are usually combined in a single package, together with a titanium coupling (the abutment) and a titanium implant. The titanium implant is inserted into mastoid or calvarial bone and allowed to osseointegrate before being attached to the external package via the abutment (figure 5).

Figure 5: The Cochlear Baha bone-anchored hearing implant sends sounds directly through the skull, bypassing a defective conduction system to directly stimulate the cochlea. (Image courtesy of Cochlear Corporation.)



This direct transmission from oscillator to bone eliminates sound attenuation (loss of sound energy) by soft tissue, said to be in the order of 10-15dBHL (decibel hearing level).[5] Firm attachment to the patient's skull also allows the microphone to be placed on the same side, allowing the patient to hear auditory stimuli on the implanted side.

Depending on the manufacturer of the bone-anchored hearing implants, ear-level or body-worn microphone and processor packages are available, with body-worn devices generally capable of higher outputs. Body-worn devices can be clipped onto a belt, popped in a shirt pocket, or carried in a pouch that hangs around the patient's neck.

Bone-conduction devices have a number of applications:

- Inability to fit an air-conduction hearing aid because of ear-canal or pinna abnormalities (see table 2).
- Single-sided deafness. Auditory information gathered on the affected side is transmitted to the better-hearing ear through bone. Although a patient may have perfect hearing in the opposite ear, reducing the effect of 'head shadow' (see table 1) means that patients with a bone-anchored hearing implant often notice improvements in directionality of hearing as well as hearing in background noise.
- Mixed-hearing loss with an air-bone gap >30dBHL with reasonable sensorineural reserve.
- Bone-anchored devices were initially developed for implantation

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in patients with chronic suppurative otitis media, in whom frequently discharging ears made aiding of conductive or mixed hearing losses difficult without worsening the infection (see table 2).

Middle-ear implants

The goal of middle-ear implants is amplification of normal ossicular chain movement as an alternative to conventional hearing aids in the treatment of patients with moderate to severe sensorineural loss. The most commonly seen middle-ear implant, the Vibrant Soundbridge, from Med-El, uses an electromagnetic driver attached to the incus to stimulate the stapes.

Surgery is required to place the implant through the mastoid bone into the middle ear. The electromagnetic driver, known as the floating mass transducer, is attached to a receiver/stimulator package, which is placed underneath the skin, behind the mastoid cavity. The external microphone/processor unit is coupled to the internal receiver/stimulator via a magnet and induction coil. For a middle-ear implant the patient must be fit to undergo a surgical procedure and must have a healthy middle ear.

Implanted devices such as the Vibrant Soundbridge allow treatment of moderate to severe sensorineural losses while avoiding occlusion of the ear canal. Directly driving the ossicular chain reduces the effect of acoustic distortion inherent in higher levels of amplification, with particular advantages in amplification of high frequencies. Direct stimulation of the ossicular chain means that this is essentially a single-sided stimulus and patients can maintain two sound fields, with resultant benefits in terms of sound localisation, compared with bone-conduction devices.

More recently, patients have been treated with a Vibrant Soundbridge device for mixed or conductive losses in the mild to severe range. For this indication the floating mass transducer is placed next to the round window in the middle ear to provide direct mechanical stimulation of the round-window membrane.

Other strategies for middle-ear implantation include placement of a magnet on the ossicular chain, which is driven by a coil, included in a package similar in appearance to an ITE hearing aid. Given that the ear canal is still occluded with these designs, the advantages over a conventional air-conduction hearing aid are small.

Cochlear implantation

Cochlear implants are hearing devices surgically inserted into the cochlea. These devices directly stimulate the cochlear nerve, completely bypassing the conductive system (figure 6). Common community perception is that cochlear implantation is a procedure for children. However, cochlear implants were originally developed for adults with profound post-lingual deafness (see table 1). Most cochlear implant recipients each year are adults, often deafened by the process of ageing, and who do not gain any benefit from conventional BTE hearing aids.

Figure 6: Cochlear implantation. A graphic demonstrating the cochlear implant electrode array directly inserted into the cochlea, stimulating the spiral ganglion neurons and in turn, the cochlear nerve. (Image courtesy of Cochlear Corporation.)

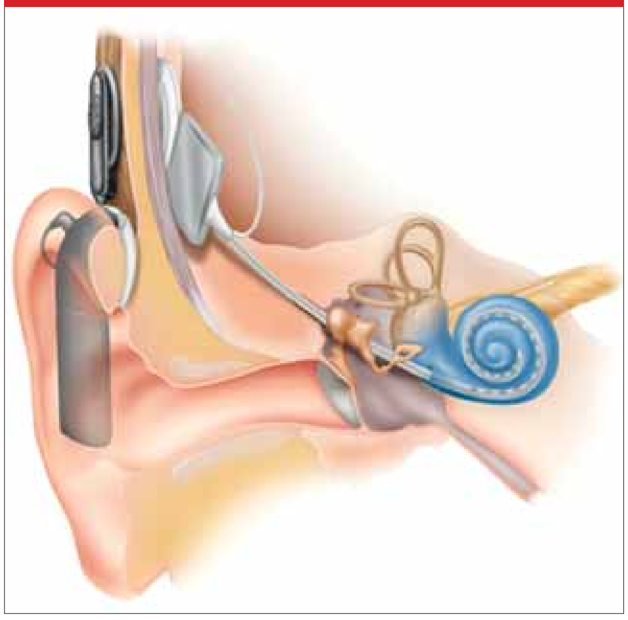
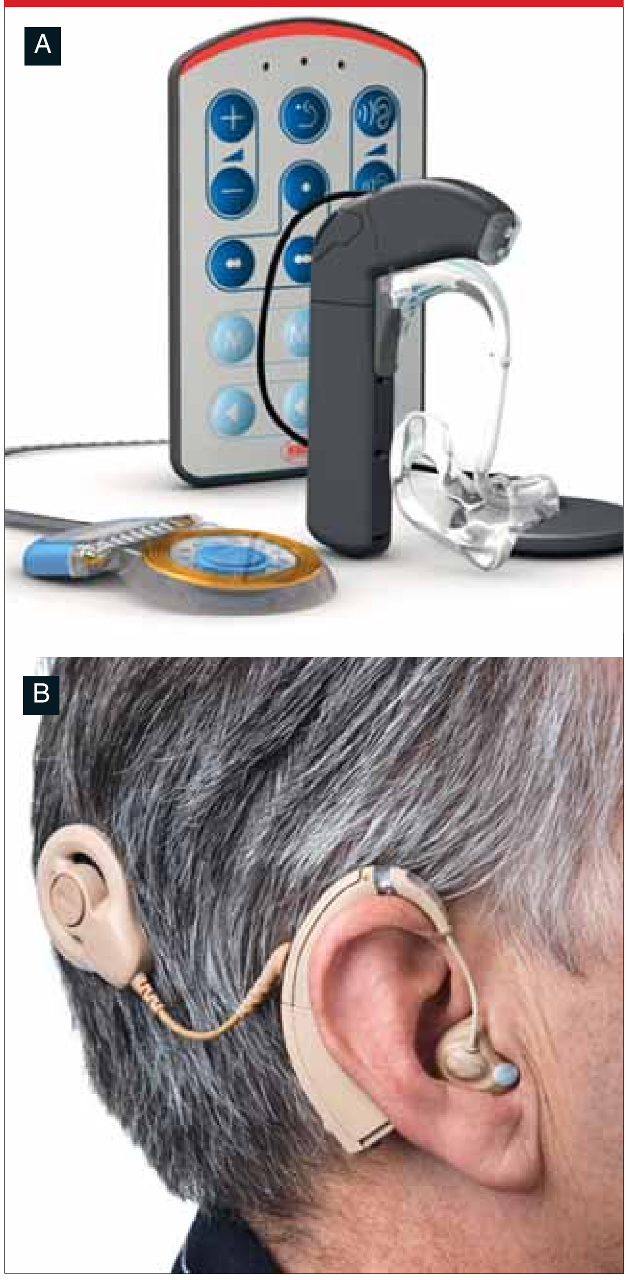


Figure 7: A Cochlear implant device, demonstrating the Nucleus receiver/stimulator package, straight ground electrode and precurved electrode array that is inserted into the cochlea. (Image courtesy of Cochlear Corporation.)

Figure 8 A: An electro-acoustic stimulation system, consisting of a Sonata cochlear implant with FlexEAS electrode and a combination of speech processor and air-conduction hearing aid in the Duet 2 BTE package. (Image courtesy of MED-EL GmbH.)
B: A patient wearing a Cochlear Hybrid device. (Image courtesy of Cochlear Corporation.)



Most cochlear implant recipients each year are adults, often deafened by the process of ageing, and who do not gain any benefit from conventional BTE hearing aids.

Originally, patients were required to have an unaided pure tone average (see table 1) of at least 100dBHL and of 60dBHL with best-fitting aids, along with no speech recognition ability. With re-evaluation of results and evolution in implant technology and surgical technique, the candidacy requirements have relaxed substantially.

The surgical procedure

Most cochlear implants are inserted via a 'transmastoid' approach. An incision is made behind the ear, and the periosteum over the mastoid process is raised. The bone of the mastoid cortex is drilled away under irrigation until the facial nerve, chorda tympani nerve and the mastoid antrum (the connection between the middle ear and the mastoid air spaces) are visualised. Bone is removed between the facial nerve and chorda tympani to allow direct access into the middle ear from behind. A well is often drilled in the skull bone to allow the implant receiver-stimulator package to be set into the bone.

The cochlea is entered from the middle ear, either directly through the membrane of the round window, or through a hole (a cochleostomy) drilled adjacent to the round window. The cochlear implant electrode (see figure 7) is then inserted into the lumen of the cochlea, preferably within the space known as the scala tympani. Some surgeons will further fix the implant package in place with sutures.

The skin and subcutaneous tissues are closed in layers over the cochlear implant and mastoid defect. While the patient is still anaesthetised, intraoperative testing of the implant is often performed to test the integrity of the implant.

Partial deafness cochlear implantation

Partial deafness cochlear implantation is the practice of electrical stimulation of the cochlea via a cochlear implant electrode for only part of the frequency spectrum. Earlier implants and surgical techniques resulted in the destruction of any residual acoustic (ie, natural) hearing during the implant procedure. Recent advances mean that residual low-frequency hearing can be preserved reasonably reliably.

An extension of this concept is combining electrical stimulation of high frequencies using a cochlear implant, and acoustic amplification of low frequencies via an air-conduction hearing aid. The BTE components of the cochlear implant processor and air-conduction hearing aid are combined in one package (figure 8A, B). This concept is referred to as hybrid implantation or electric-acoustic stimulation, depending on the manufacturer of the equipment used.

The technique of hybrid implantation claims to have the advantage of preserving natural hearing at lower frequencies. This preservation of hearing is said to improve speech understanding in noisy environments, and also possibly improve musical appreciation, which is typically difficult for the conventional cochlear implant recipient.

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Online resources

- Northside Audiology: www.northsidehearing.com.au
- Hearing Aid Forums.com: www.hearingaidforums.com
- Cochlear. Hearing and hearing loss: www.cochlear.com/au/hearing-and-hearing-loss-adults
- MED-EL — Hearing implant support: www.medel.com/int/show4/index/id/4/title/USER-SUPPORT
- Advanced Bionics — Learning centre: www.advancedbionics.com/CMS/Rehab-Education/Learning-Center/
- Better hearing institute: www.betterhearing.org
- RNID — Action on hearing loss: www.rnid.org.uk/information_resources

cont'd page 34

GP's contribution

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Case study

I OFTEN find that my elderly patients are a 'two-for-one' deal. They always come together to all their appointments. Mr and Mrs B did just this, but no matter which question I was asking and to whom, it was always Mrs B who answered the question. Mr B seemed happy with this arrangement; he never made a fuss — just sat there while Mrs B did all the talking.

Mrs B often complained about her husband, and how it was just easier for her to do everything, as he was becoming forgetful and distracted.

It was only during one consultation, when Mrs B needed to provide a urine sample that I was left alone with Mr B. It was only then that I realised how hard of hearing he actually was. I talked more slowly and more loudly but he still found it hard to make out what I was saying.

When Mrs B returned I asked her about this and the need for a hearing test and maybe a hearing aid. Mrs B said that Mr B had hearing aids but they made no difference at all so he didn't bother to wear them. I checked his ears, and his canals were filled with enough wax to make a candle or two! Both of them were amazed how well his hearing aids worked after his ears had been syringed.

Questions

Wax build-up is a constant problem with hearing aid use. Do you suggest regular use of wax-clearing agents as a preventive?

Cerumen (wax) build-up is indeed a frequent problem with hearing aids. Regular use of cerumenolytics may be beneficial for some patients, but cerumen has protective and clearing effects in the ear canal that will be lost with frequent use of cerumenolytics. Irritant dermatitis is also possible with frequent use of these agents.

In general we would suggest that prophylactic use of cerumenolytics is unnecessary, with their primary purpose being softening of cerumen before manual removal. Olive oil (applied with an eye dropper, twice a week after prewarming in the patient's hand) can be helpful in assisting wax to come out naturally.

The aids themselves can also cause irritation of the canal, and during treatment the users are unable to wear their aids. Are there any suggestions to minimise these occurrences?

Ear canal dermatitis secondary to hearing aids is often multifactorial. Patients may experience an irritant dermatitis due to components of the aid, such as either the acrylics or gold. Most patients with aid-related dermatitis will have problems related to the occlusion of their ear canal. Occlusion of the ear canal alters the environment in the ear canal through humidification and interruption of cerumen migration. Excessively tight or mobile aids can also cause direct trauma to the canal skin.

How often do you recommend patients be reassessed regarding their hearing aids?

A yearly visit to a hearing professional will allow for cleaning of hearing aids as well as periodic re-evaluation of the aid's effectiveness.

There are many flaws in the current government scheme, especially with an increasing proportion of elderly patients in the community. Can any of the newer more effective hearing aids be produced more cost effectively to help alleviate the financial burden?

With advances in design and manufacturing processes, one would hope that manufacturing costs of aids would fall. Overlap of technologies between hearing aids and other devices such as mobile phones and music devices should further reduce manufacturing cost through higher production volumes. This decrease in cost for current designs will inevitably be offset by the development and inclusion of emerging technologies.

When purchasing hearing aids, patients should be aware that the device with the most out-of-pocket expense may be packed with the latest technologies, but these technologies may be surplus to their requirements and may, especially in the case of miniaturisation, make their aids less user-friendly.

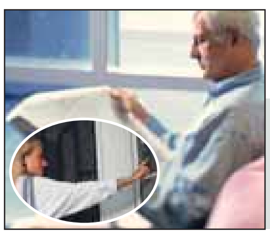
Have mobile phones been found to cause any noticeable increase in hearing loss?

In a frequently quoted study in India, no significant difference in audiological measures between long-term mobile phone users and non-users were seen. However, there was a trend towards an association between heavier long-term use of mobile phones and an increased rate of high-frequency sensorineural hearing losses.[1] This study suffered because of its small population and retrospective nature.

At this stage there is no convincing evidence of a detrimental effect of mobile phone use on hearing. One caveat is the use of earphones as part of a hands-free device, where the user has to be mindful of the recognised dangers of listening at excessive volumes for long periods. The European Union requires manufacturers of portable music players and mobile phones to impose volume limits, but this requirement has not been imposed in Australia.

Reference

1. Panda NK, et al. Audiologic disturbances in long-term mobile phone users. *Otolaryngology — Head and Neck Surgery* 2010; 39:5-11.



How to Treat Quiz

Hearing loss in the ageing patient — 15 April 2011

INSTRUCTIONS

Complete this quiz online and fill in the GP evaluation form to earn 2 CPD or PDP points. We no longer accept quizzes by post or fax.

The mark required to obtain points is 80%. Please note that some questions have more than one correct answer.

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1. Which TWO statements are correct?
a) The hearing loss of ageing is primarily of the conductive type
b) Presbycusis is thought to be the result of multiple, repeated insults to a patient's cochlear function
c) Deterioration in the central auditory neurons causes difficulty in perceiving gaps in sounds and localising sounds in space
d) Auditory deprivation from hearing loss due to peripheral ear pathology does not affect central auditory processing

2. Which TWO statements are correct?
a) Sensorineural hearing loss is due to damage to the cochlea, the cochlear nerve or higher auditory centres
b) Cochlear nerve pathology is associated with speech understanding scores in line with the patient's hearing thresholds
c) Cochlear pathology is often associated with disproportionately poor speech understanding scores, compared with the patient's hearing thresholds
d) Elderly patients with a hearing disability have rates of depression almost twice as high as those with preserved hearing

3. Which TWO statements are correct?
a) If the patient is hearing well in a one-to-one situation with the GP, it is unlikely there is a functionally significant hearing loss
b) When speaking to a person with hearing loss you should position yourself close to the person
c) When speaking to a person with hearing loss you should speak directly into the person's ear
d) When speaking to a person with hearing loss you should rephrase (rather than repeat) the statement if it is not understood

4. Which THREE statements are correct regarding hearing-assistive listening devices?
a) They are designed to transmit the sound from the source (eg, audio from TV) to the individual as directly as possible
b) Wireless transmission of the source sound is not currently available
c) The output can be heard through a headset or earphones, or via the user's existing hearing device
d) Alerting devices are designed to convert auditory alerts (doorbell, smoke alarm) into either vibrotactile or visual stimuli

5. Which TWO statements are correct regarding hearing aids?
a) Conventional hearing aids amplify and transmit the sound through the bone adjacent to the ear
b) Behind-the-ear (BTE) hearing aids allow easier adjustment of volume or telecoil function than in-the-ear (ITE) aids
c) Ventilation ports placed in the ear-mould component of BTE aids increase the amplification of low frequencies
d) Separation of the microphone and the output of BTE aids reduces acoustic feedback

6. Which THREE statements are correct regarding in-the-ear (ITE) hearing aids?
a) ITE hearing aids have a single package containing microphone, receiver, processor and output
b) The size of the ITE aid package increases the available amplification compared with BTE aids
c) Correct fitting of the ear mould is more critical with ITE aids, as inadvertent ventilation can lead to considerable acoustic feedback
d) Changes to the external ear in older individuals make the fitting of an ear mould more difficult

7. Which TWO statements are correct?
a) Patients with single-sided deafness are good candidates for conventional air-conduction aids, achieving near-normal binaural hearing
b) The disability in patients with single-sided deafness is limited to the inability to perceive auditory stimuli on the affected side
c) Bone-conduction hearing implants have an externally located package and a titanium coupling implanted in bone
d) The microphone of a bone-conduction hearing implant can be located near the affected ear, or elsewhere on the body

8. Which TWO statements are correct?
a) A bone-conduction hearing implant does not improve directionality of hearing in patients with single-sided deafness
b) Middle-ear implants amplify normal ossicular chain movement without occluding the ear canal
c) A middle-ear implant reduces the acoustic distortion associated with high amplification, especially of high frequencies
d) A middle-ear implant has no advantage over a bone-conduction implant in terms of benefits to sound localisation

9. Which TWO statements are correct?
a) Cochlear implants directly stimulate the cochlear nerve, completely bypassing the conductive system
b) Cochlear implantation is a procedure only for children
c) Deaf adults who do not gain any benefit from conventional BTE hearing aids may benefit from cochlear implantation
d) The procedure of cochlear implantation always destroys any residual natural hearing

10. Which THREE statements are correct?
a) The electrode of a modern cochlear implant can selectively stimulate a specific part of the frequency spectrum
b) A cochlear implant and an air-conduction hearing aid are incompatible and should not be used together
c) Asymmetrical sensorineural hearing loss can be a presenting feature of a cerebellopontine angle tumour
d) A discharging ear with hearing loss may be due to a destructive inflammatory or neoplastic process involving the temporal bone

CPD QUIZ UPDATE

The RACGP requires that a brief GP evaluation form be completed with every quiz to obtain category 2 CPD or PDP points for the 2011-13 triennium. You can complete this online along with the quiz at **www.australiandoctor.com.au.** Because this is a requirement, we are no longer able to accept the quiz by post or fax. However, we have included the quiz questions here for those who like to prepare the answers before completing the quiz online.

Australian Doctor Education

HOW TO TREAT Editor: **Dr Giovanna Zingarelli**
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NEXT WEEK The next How to Treat begins a two-part series focusing on retinal conditions. The authors are **Associate Professor Samantha Fraser-Bell**, Sydney Eye Hospital; Save Sight Institute, University of Sydney; and Royal North Shore Hospital, NSW; and **Professor Mark Gillies**, Sydney Eye Hospital and Save Sight Institute, University of Sydney, NSW.