

Geriatric hearing loss

Understanding the causes and providing appropriate treatment

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Presbycusis should not be diagnosed until other potential causes of hearing loss have been ruled out

Hearing loss that is significant enough to interfere with social function affects 25% of persons age 65 to 74 and 50% of those age 75 and older. Not being able to hear or understand conversations limits a person's use of the telephone, affects the ability to participate in social activities, and leads to a sense of isolation.^{1,2}

Geriatric hearing loss may be caused by a variety of problems, some of which are amenable to treatment. Presbycusis may be the most common cause of diminished hearing in the older population, but it should not be diagnosed until other potential causes of hearing loss have been ruled out.

In this article, we discuss the most common etiologies of geriatric hearing loss, suggest treatments for some types, and provide an overview of assistive devices that can be used to improve hearing.

Evaluation of hearing loss

Severity. The severity of a patient's hearing loss is determined by audiometry. Although physicians can use a small screening audiometer or audioscope to determine which patients should be referred for audiometry, it is probably best to refer a patient based on complaints about hearing, either from the patient or family members. Audiometry measures the intensity by which a tone must be increased before it is heard. The level of intensity (measured in decibels [dB]) required to hear a tone of a particular frequency is

called the threshold for that frequency. Audiograms provide a measurement of hearing threshold for pure tones at frequencies of 250, 500, 1,000, 2,000, 3,000, and 4,000 cycles per second (hertz [Hz]). The most important frequencies for understanding speech are 500, 1,000, and 2,000 Hz. Pure tone average is the average of the hearing thresholds for these three frequencies. The normal range for adult pure tone average is 0 to 25 dB.

The severity of hearing loss increases as pure tone average increases, as illustrated in table 1. Normal conversational speech occurs at 40 to 60 dB, whereas sound from rock bands and airplanes occurs at approximately 100 to 110 dB.

Type. Hearing loss can be divided into two types, based on the components of the auditory system that are involved:

- Conductive hearing loss is caused by imperfect function of the ear canal, tympanic membrane, or ossicles, which are located in the outer and middle ear.
- Sensorineural hearing loss is caused by injury to the cochlea or auditory nerve, which are located in the inner ear.

Conductive hearing loss

Cerumen impaction. One of the most common causes of hearing loss in older adults is cerumen impaction. In fact, cerumen can accumulate significantly without any accompanying hearing loss. Even when the auditory canals are 90% occluded, normal hearing is possible. If the occlusion reaches 95%, however, significant

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Causes of conductive hearing loss

Photos provided by Peter S. Roland, MD

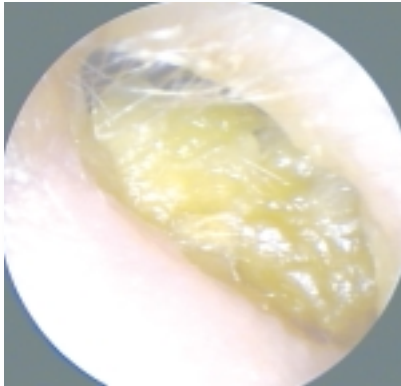


Figure 1. Cerumen impaction (95%) of the external auditory canal. A slight shift in the position of cerumen can change a 90% occlusion to a 95 or 100% occlusion and cause marked hearing loss.

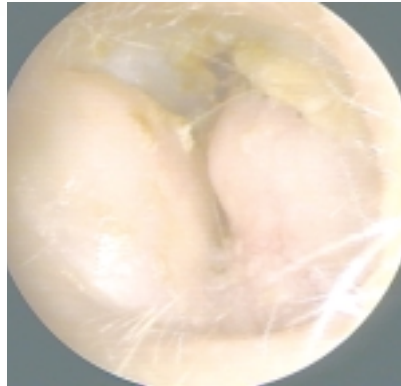


Figure 2. Multiple exostoses occluding the external auditory canal. The patient has significant conductive hearing loss and is at risk for cholesteatoma formation.

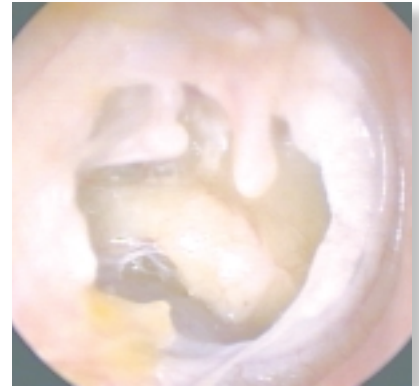


Figure 3. Marginal perforation with complete necrosis in the long process of the incus. The capitulum of the stapes and the long process of the malleus are visible. A hearing loss of 40 decibels is expected.

conductive hearing loss can occur (figure 1).³ A simple shift in the position of the impaction is all that is needed to change a 90% occlusion to a 95 or 100% occlusion. In addition, hydration of cerumen can increase its size enough to produce significant hearing loss.

Age-related atrophy of the modified apocrine glands leads to a decrease in the production of the watery components of cerumen, causing cerumen in the ear canal to become hard and dry. In addition in men, the tragi hair cells in the ear canal become longer, thicker, and coarser with age and trap dry cerumen more easily. These changes account for the substantial increase in the incidence of cerumen impaction in the older population.³

Exostoses and osteomas. Exostoses and osteomas are benign growths of the bony ear canal. Exostoses occur when the external canal is repeatedly exposed to cold air or water. Cold exposure irritates the periosteum and stimulates bony growth. Multiple nodular bony growths develop and are typically sessile and bilateral (figure 2). Osteomas are benign neoplasms of the bone. They are less common than exostoses and are usually single and unilateral.³

Treatment is indicated only when occlusion of the canal results in retention of debris, chronic infection, or sig-

nificant conductive hearing loss. Surgical excision is typically successful, and recurrence is uncommon.

Tympanic membrane perforation. Tympanic membrane perforations may be caused by otitis media, mechanical trauma, or barotrauma. They are fairly common causes of hearing loss in older patients.

Central perforations have a thin rim of normal membrane surrounding them, whereas marginal perforations extend to the edge of the tympanic membrane (figure 3). This distinction is important because marginal perforations are associated with the development of cholesteatoma, a cyst-like accumulation of squamous cells in the middle ear that can enlarge and erode surrounding bone. Untreated cholesteatomas can be life-threatening. They erode bone at the base of the skull and can cause sigmoid sinus

thrombosis, epidural and subdural abscess, brain abscess, and meningitis.

Surgical repair is indicated when the perforation:

- contributes to a significant conductive hearing loss
- produces chronic infection and otorrhea
- or presents a risk of cholesteatoma formation.

Advanced age is not a contraindication to repair as long as a patient is generally healthy.³

Middle ear effusions. Older patients may suffer from middle ear effusions caused by eustachian tube dysfunction. A patulous eustachian tube can allow reflux into the middle ear of nasopharyngeal secretions from allergies or extrinsic compression by a nasopharyngeal mass. Effusions within the middle ear cause flat conductive hearing losses of 10 to 40 dB.

continued

Table 1 Hearing acuity related to pure tone average

| Pure tone average | Hearing acuity |
|-------------------|----------------|
| 0 to 25 dB | Normal hearing |
| 25 to 40 dB | Mild loss |
| 40 to 60 dB | Moderate loss |
| 60 to 90 dB | Severe loss |
| >90 dB | Profound loss |

dB: Decibels

Source: Prepared for Geriatrics by Michelle C. Marcincuk, MD, and Peter S. Roland, MD

Sensorineural hearing loss patterns seen on audiogram

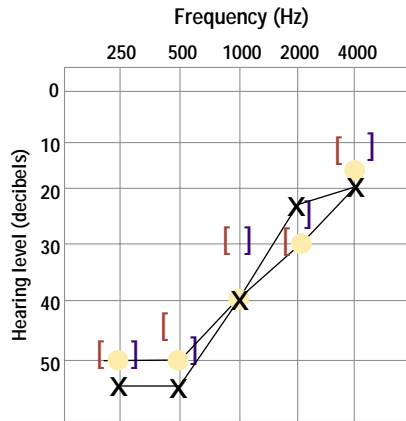


Figure 4. Upward sloping pattern

For all audiograms: ● indicates right air conduction, X indicates left air conduction, [indicates right bone conduction, and] indicates left bone conduction.

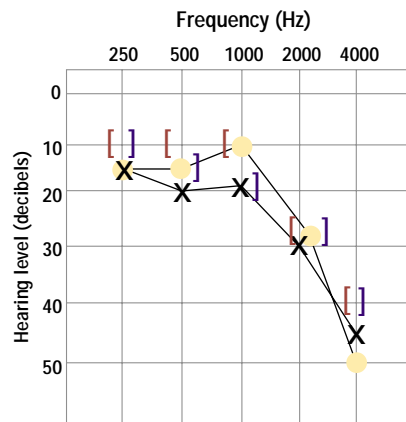


Figure 5. Downward sloping pattern

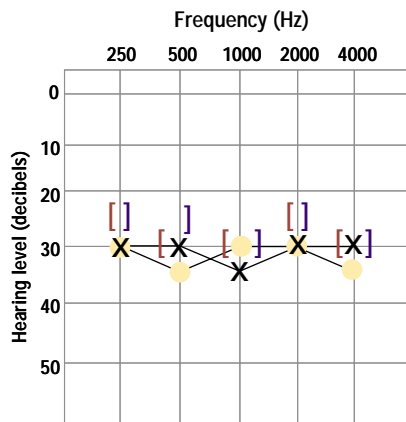


Figure 6. Flat hearing loss pattern

Initial therapy should focus on treating any underlying conditions, such as allergies, that may contribute to eustachian tube dysfunction. Because chronic effusions—particularly if unilateral—may signal the presence of a mass in the nasopharynx, patients with adult-onset effusions that persist more than 1 month should be evaluated with nasopharyngoscopy and MRI.³

Sensorineural hearing loss

Five commonly recognized patterns of sensorineural hearing loss can be seen on audiograms³:

- upward sloping (figure 4)
- downward sloping (figure 5)
- flat hearing loss (figure 6)
- “cookie bite” (figure 7)
- “Pike’s peak” (figure 8).

A unilateral upward sloping or flat hearing loss pattern is characteristic of Meniere’s disease, viral infection, and autoimmune disorders. A downward sloping hearing loss pattern is the most common and is characteristic of presbycusis, noise-induced hearing loss, and ototoxic hearing loss. “Pike’s peak” pattern is characteristic of Meniere’s disease. The etiology of bilateral flat hearing loss is almost always genetic, as are the “cookie bite” and bilateral upsloping patterns.

Sensorineural hearing loss can occur over the course of minutes to hours (sudden) or over the course of a lifetime (progressive).

Sudden sensorineural hearing loss

Viral cochleitis. A viral infection of the cochlea is the most common cause of sudden sensorineural hearing loss. Viruses responsible for cochleitis are probably the same ones that cause upper respiratory infections. Approximately 50% of individuals with viral cochleitis appear to have an associated upper respiratory illness.

Spontaneous recovery of hearing is common. The likelihood of a patient experiencing hearing recovery can be stratified on the basis of the pattern of hearing loss. For example, low-fre-

quency losses have the highest probability of recovery; spontaneous restoration of hearing occurs in 80% or more of such cases. Profound losses or those associated with disequilibrium or vertigo have the lowest probability of recovery.

Many practitioners institute a short course of high-dose oral corticosteroid therapy (eg, prednisone, 1 mg/kg/d, tapered over 12 days) for the treatment of viral cochleitis, although the evidence for its effectiveness is inconclusive.³

Perilymph fistula. Breaks or tears in the round window membrane or tissue around the stapes footplate allow leakage of perilymph from the inner ear into the middle ear. Perilymph fistulas are typically caused by a direct blow to the head (eg, from a fall) or barometric trauma (eg, airplane travel, scuba diving, heavy lifting or straining); occasionally they occur spontaneously. Diagnosis is difficult and usually relies on a history of head trauma or internal-external pressure changes.

Perilymph fistulas may close spontaneously in response to several days of bedrest. Refractory cases may be surgically repaired by grafting the oval and round window membranes to close the fistulas.³

Vascular occlusive disease. Vascular occlusive disease can cause diminished blood flow to the cochlea, resulting in sudden sensorineural hearing loss from vasospasm, embolism, or hemorrhage. The frequency with which cochlear hypoperfusion results in sudden hearing loss is unknown, but it is generally considered uncommon. Although their effectiveness remains unproven, vasodilators and aspirin are sometimes prescribed if vascular occlusive phenomena are believed to be the cause of sudden sensorineural hearing loss.³

Autoimmune diseases. Autoimmune hearing loss is often bilateral and typically develops over a period of days to weeks. Initial workup includes serologic evaluation for markers of autoimmunity such as:

- elevated serum immunoglobulin E (IgE)
- erythrocyte sedimentation rate (ESR)
- antinuclear antibody (ANA)
- anticardiolipin antibody
- the presence of circulating immune complexes
- and an abnormal antineutrophil cytoplasmic antibody (C-ANCA) test.

Recent studies have revealed the presence of a specific anticochlear antibody—the 68-kilodalton antigen—in up to 35% of patients with progressive sensorineural hearing loss. Prednisone, 1 mg/kg/d for at least 30 days with subsequent taper, is often used for initial treatment, but more potent therapies such as methotrexate are required in most cases.³ Doses of methotrexate should be individualized by the treating rheumatologist or immunologist.

Meniere's disease. Meniere's disease is characterized by a tetrad of symptoms: sensorineural hearing loss, aural fullness, tinnitus, and vertigo. Sudden, low-frequency hearing loss is a hallmark of Meniere's disease. Early in the course of the disease, hearing loss recovers within hours to days. Hearing loss is typically associated with episodic and recurrent paroxysms of vertigo.

The mainstay of treatment is salt restriction and diuretic therapy. Episodic use of vestibular suppressants (such as meclizine, 25 to 50 mg every 6 hours as needed; scopolamine patch every 3 days as directed on package insert; or diazepam, 2.5 to 5 mg every 8 to 12 hours as needed) is useful for treating incapacitating episodes of vertigo. If medical therapy fails, several surgical procedures can be considered.

Tumors. Masses and tumors of the temporal bone, cerebellopontine angle, auditory or facial nerves, or auditory cortex may cause sudden sensorineural hearing loss. Diagnosis requires gadolinium-enhanced MRI, which always should be used in the evaluation of patients who present with sudden or rapid unilateral sensorineural hearing losses.³

Progressive sensorineural hearing loss

Noise-induced hearing loss. Noise-induced hearing loss, which arises from accumulated noise exposure over time, is a significant cause of sensorineural hearing loss in older patients. The clinical effects of chronic noise exposure are proportional to the intensity and duration of exposure and the genetic susceptibility of the patient.

Noise-induced hearing loss initially manifests as selective hearing loss near 4,000 Hz, with better hearing thresholds for the surrounding frequencies. The audiogram will have a “notched” appearance. As the noise exposure continues and the damage to the cochlea progresses, the notch deepens and widens until a steeply downward sloping high-frequency loss occurs.⁴⁻⁷

Presbycusis. Presbycusis is sensorineural hearing loss caused by physiologic aging. It typically results in bilateral high-frequency hearing loss (figure 9). Conditions that may contribute to presbycusis include atherosclerosis, chronic noise exposure, chemical exposure, diet and metabolism, and genetics (table 2).⁸⁻¹⁶

Gacek and Schuknecht identified four sites of cochlear aging and divided presbycusis into four types:¹⁷

- *Sensory* presbycusis occurs in response to epithelial atrophy with the loss of sensory hair cells and supporting cells in the organ of Corti.

- *Neural* presbycusis occurs with the atrophy of the first-order cochlear neurons. According to Schuknecht, some 2,100 out of 35,000 cochlear neurons are lost every decade, and clinical hearing loss develops when approximately 50% of the neurons are lost.^{18,19} Because this process is diffuse, no precipitous threshold drop is seen on audiography. Instead, the individual develops an impairment in speech discrimination that is out of proportion with pure tone loss.

- *Metabolic* presbycusis refers to hearing loss caused by atrophy of the stria vascularis. When the stria atrophies, the normal biochemical environment of the cochlea is lost, causing

Sensorineural hearing loss patterns seen on audiogram

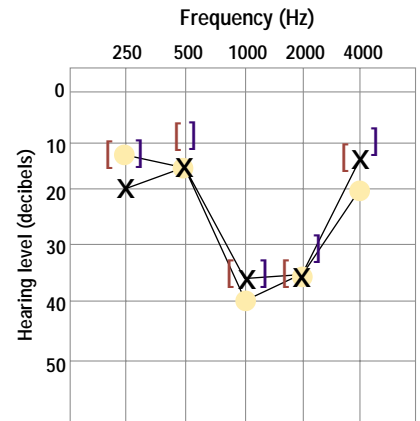


Figure 7. “Cookie bite” pattern

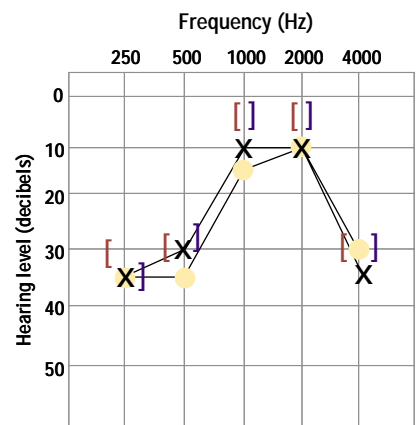


Figure 8. “Pike's peak” pattern

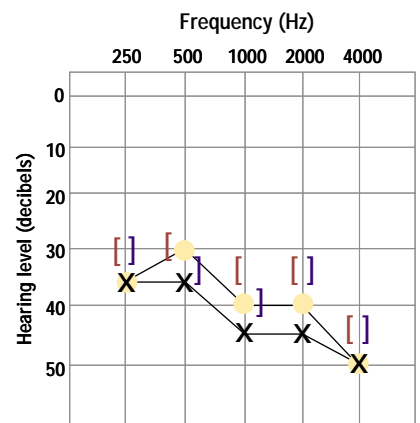


Figure 9. Bilateral downward sloping high-frequency hearing loss often seen in presbycusis.

Source: Audiograms provided by Michelle C. Marcincuk, MD, and Peter S. Roland, MD

Table 2 Variables that may contribute to age-related hearing loss

| Variable | Mechanism of action |
|----------------------------|---|
| Atherosclerosis | Causes diminished perfusion and hypoxia of the cochlea |
| Noise exposure | Accumulation over time damages hair cells |
| Drug exposure | Hearing loss may be caused by loop diuretics, quinine or chloroquine, aminoglycosides, vancomycin, IV erythromycin, salicylates such as aspirin, and some antineoplastic agents, particularly cisplatin Particularly problematic in patients with hepatic or renal dysfunction Not all ototoxic medications cause permanent losses (eg, salicylate-induced hearing loss typically reverses with cessation of therapy) |
| Diet and metabolism | Factors such as diabetes, which leads to accelerated atherosclerosis and vascular intimal hyperplasia, may cause poor cochlear perfusion and subsequent hearing loss |
| Genetics | May predispose to early aging of the auditory system or increased susceptibility to other environmental factors such as noise exposure |

Source: Prepared for Geriatrics by Michelle C. Marcincuk, MD, and Peter S. Roland, MD

diffuse hearing loss. This is represented by a flat hearing loss with preservation of speech discrimination. Onset of metabolic presbycusis typically occurs between age 30 and 60, and it may be slowly progressive.^{18, 19}

● **Mechanical** (cochlear conductive) presbycusis results from basilar membrane changes and leads to a gradually sloping high-frequency hearing loss. Speech discrimination is proportionate to the decrease in pure tone average.

The clinical presentation of any patient with presbycusis varies depending on the precise cochlear and neural changes. Treatment relies on audiologic rehabilitation using hearing aids or cochlear implants.¹⁸⁻²⁰

Auditory rehabilitation

Hearing aids. Analog or digital hearing aids are the treatment of choice for older patients with sensorineural hearing loss. They can be adjusted so that

the amount of amplification varies depending on the frequency of the sound. Hearing aids can be precisely tailored to the individual's pattern of hearing loss. Digital and programmable hearing aids are particularly useful for individuals with steep, high-frequency hearing loss who have difficulty with conversational speech in the presence of a high level of background noise.

Hearing aids can be placed completely in the canal (CIC), in the ear (ITE), or behind the ear (BTE). The CIC hearing aid fits deeply into the ear canal and is nearly invisible. The ITE version fills the conchal bowl and requires no postauricular attachment. The BTE hearing aid consists of a casing that rests behind the ear and an ear mold through which sound is delivered. The microchips are essentially the same for all of these devices.

Individuals with severe hearing loss who require a great deal of amplifica-

tion and power are candidates for BTE hearing aids, which have the largest power sources. Other advantages of BTE hearing aids include:

- greater separation of the microphone from the speaker to reduce feedback
- a softer, more flexible ear mold
- larger dials and controls, which increase ease of use for older individuals with impaired dexterity.^{3, 21-23}

Hearing aid fitting. An otologist or audiologist with a certificate of clinical competence should be consulted for hearing aid evaluation and fitting. An individual who has bilateral hearing loss should be fitted with bilateral hearing aids. Bilateral aids allow improved discrimination, better sound localization, and greater perception of speech in noise. Nevertheless, many individuals cannot afford two devices. Typical cost for a hearing aid is \$1,000 to \$2,500 for each device.

If a single hearing aid is the only feasible option, it should be fitted for the ear that has the least amount of hearing loss. This allows the patient to have close-to-normal restoration of hearing in at least one ear.

Most hearing aids with more than minimal gain (amplification) must completely occlude the external auditory canal to prevent feedback. Occlusion of the external auditory canal, however, produces an unpleasant, hollow quality to the sound.^{3, 24, 25}

Hearing aids cannot return the user's hearing ability to normal, but properly-fitted hearing aids can improve the patient's ability to understand conversational speech in the presence of background noise. To avoid disappointment, patients must understand these limitations prior to purchasing a hearing aid and recognize that hearing aids should be judged not on their subjective appeal but on their ability to restore functional hearing.

Individuals who lead quiet, sedentary lives with minimal workplace or social interaction are much less likely to find hearing aids useful than individuals who continue to work or have

active social lives. Motivation is such an important component of hearing aid use that it frequently determines whether or not hearing aids become a regular part of the individual's daily life.


Although vanity may play a role in resistance to use of hearing aids, often it is the stigma of infirmity and old age that makes patients balk. This is a difficult barrier for physicians to overcome. Physicians might be successful in improving the rate of use by gently reminding patients that poor hearing could make them appear confused, or worse—demented and ignorant.

Cochlear implants. Cochlear implants have been affectionately referred to as “bionic ears.” Unlike conventional hearing aids, which simply transmit amplified sound into the ear canal, cochlear implants transform sound energy into electrical impulses and deliver them directly to the auditory nerve through an electrode that is surgically implanted into the cochlea. Whereas conventional hearing aids require functional cochlear hair cells, cochlear implants are effective even when the cochlea is not functioning.

For individuals who acquired normal speech and language skills prior to losing their hearing, cochlear implants can usually restore the ability to engage in conversational speech and to use the telephone. Most individuals with severe-to-profound hearing loss are potential cochlear implant candidates.²⁵ Implants also are indicated in patients who receive no meaningful benefit from conventional hearing aids.²⁶

Conclusion

Many forms of hearing loss are treatable, and treatment can lead to significant improvements in productivity and quality of life. Although age-related hearing loss (presbycusis) is common in older patients, the diagnosis should not be made until other possible causes have been ruled out. Once the type of hearing loss has been diagnosed, hearing aids can be used to improve hearing and social functioning. Hearing aid selection should be

based upon the patient's level of hearing loss, comfort with wearing the device, and ability to operate it. 



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