

**The American Academy of Otolaryngology—  
Head and Neck Surgery Foundation  
(AAO-HNSF) Presents. . .**



## **Chapter 6: Hearing Loss**

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## Chapter 6: Hearing Loss

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Dr. Gregory Staffel first authored this short introduction to otolaryngology for medical students at the University of Texas School for the Health Sciences in San Antonio in 1996. Written in conversational style, peppered with hints for learning (such as "read an hour a day"), and short enough to digest in one or two evenings, the book was a "hit" with medical students.

Dr. Staffel graciously donated his book to the American Academy of Otolaryngology—Head and Neck Surgery Foundation to be used as a basis for this primer. It has been revised, edited and is now in the second printing. This edition has undergone an extensive review, revision and updating. We believe that you, the reader, will find this book enjoyable and informative. We anticipate that it will whet your appetite for further learning in the discipline that we love and have found most intriguing. It should start your journey into otolaryngology, the field of Head and Neck Surgery.

Enjoy!

Mark K. Wax, MD

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## Chapter 6: Hearing Loss

People suffer from hearing loss for a wide variety of reasons. Patients may present with the complaint of being unable to hear, or they may complain of difficulty understanding. Often, a family member brings the patient for a hearing test because of difficulties in communication. Older individuals often complain of **tinnitus**, which may be described as a sound like "ringing," "buzzing," or "crickets" in the ears. Tinnitus is usually a manifestation of hearing loss, although it may have other causes as well. Hearing loss in children may be particularly difficult to detect, and is often confused with inattention or speech delay.

It is important to determine whether the problem is with the **conductive pathway of the ear** or with the **inner ear** or **8th cranial nerve**. **Conductive hearing loss** can be due to **cerumen impaction**, swelling of the external auditory canal, tympanic membrane perforations, middle ear fluid, or **ossicular chain abnormalities**. **Sensorineural hearing loss** can occur as a result of injury to the hair cells in the **cochlea** or neural elements innervating the hair cells. The most common etiologic factors are persistent noise exposure, age-related changes of the 8th cranial nerve (**presbycusis**), familial or genetic factors, infectious or postinflammatory processes. Tumor growth along the course of the 8th cranial nerve can also be the etiology of sensorineural loss and must be included in the differential diagnosis. Treatment of these different types of hearing loss can be dramatically different.

**Pure tone audiometry** ("the hearing test") is frequently used to assess the patient's hearing levels. The test requires that the patient is able to, and wishes to cooperate (difficult in very young children). Hearing threshold levels are determined



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between 250 and 8000 **hertz (Hz)** for pure tones and measured in decibels (dB). The 0 dB level is "normalized" to young, healthy adults and doesn't mean there is absence of detectable sound. Some patients hear 0 decibels. To reach the threshold of hearing usually requires louder test signals. The higher the threshold is, the poorer the patient's hearing. Thresholds higher than 25 dB are considered abnormal.

During the **audiogram**, independent thresholds are determined for each ear for both **air conduction (conductive hearing)** and **bone conduction (sensorineural hearing)**. Air conduction measures the ability of the external and middle ear to transmit sound to the cochlea. Any blockage to sound transmission in this pathway (cerumen, perforation, middle ear fluid) will create an **air-bone gap**

between the air and bone conduction thresholds on the

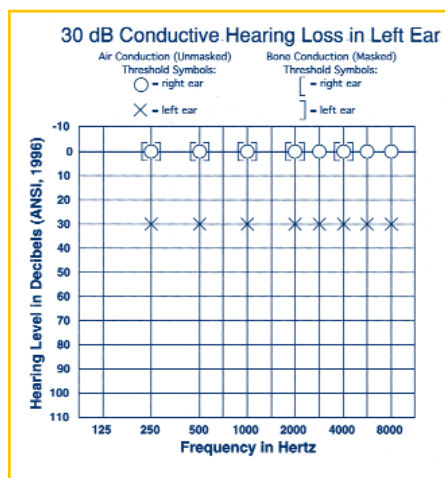


Figure 6.1. A conductive hearing loss in the left ear due to otitis media with effusion. Note that bone conduction thresholds on both ears are normal but that air conduction on the left is 30 dB poorer than that measured on the right. Zero (0) dB doesn't refer to absence of sound, but rather represents an average of thresholds for young, healthy adults.



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audiogram, and is an example of a conductive hearing loss. However, if the air conduction and bone conduction thresholds are equal but higher than 25 dB, this is called a sensorineural hearing loss.

Our ability to hear is more complex than just listening to single pure tones in a sound-proof booth. Therefore, a test of the patient's ability to understand spoken words is done as well. This is tested by presenting phonetically balanced words (love, boat, pool, sell, raise) into the audiogram, reported as the **speech discrimination** score (90-100% is normal). This test of clarity also assesses the function of the auditory division of the 8th cranial nerve. The ability to understand speech is very important, especially with respect to determining to what degree a hearing aid will help a particular patient. **Amplifying** garbled speech (with a hearing aid) has limited benefit for patients with very poor speech discrimination.

**Tympanometry** is commonly used to evaluate the tympanic membrane and middle ear status. This test assesses the mobility of the tympanic membrane and its response to pressure changes in the external auditory canal. Three common patterns are shown in figure 6.4. **Type A** plots are present when the external auditory canal is patent and the middle ear and tympanic membrane are healthy (maximum TM mobility when pressure in the canal is atmospheric). **Type B** plots occur when the middle ear is filled with fluid or the tympanic membrane has a perforation (no peak in eardrum mobility). **Type C** plots (peak eardrum mobility when pressure is subatmospheric) are very typical of patients with retracted tympanic membranes secondary to eustachian



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tube dysfunction. Tympanometry can help in the detection of middle ear fluid when the physical exam is unclear.

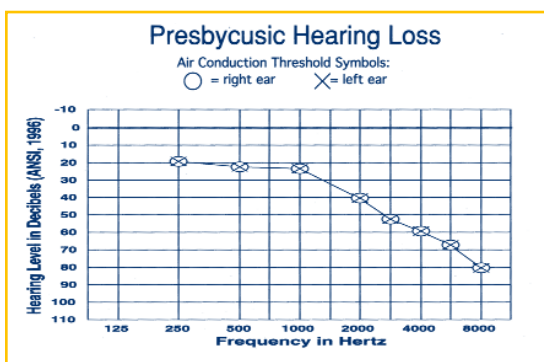


Figure 6.2.

Audiogram of a patient with presbycusis. Note that low tone thresholds are relatively normal with a drop in thresholds at higher frequencies. This is a consequence of the normal aging process and may vary widely from patient to patient.

### Conductive Hearing Loss:

Careful physical examination of the ear with the aid of a microscope, tuning fork tests, and audiometric testing can frequently determine the cause of a conductive hearing loss. Swelling of the external auditory canal secondary to otitis externa can be treated with appropriate topical medication. Cerumen impaction can be cleaned with specialized instruments. Middle ear fluid is a common cause of hearing loss in children and can be treated with antibiotic therapy or myringotomy tubes, and tympanic membrane perforations can be surgically repaired. Cholesteatoma often presents with hearing loss, and in the physical examination, it can be confused with cerumen. Conductive hearing loss present on the audiogram and is not readily apparent on the physical exam suggests problems with the ossicular chain. One common disease process affecting the ossicular chain is **otosclerosis**. This is a hereditary dis-



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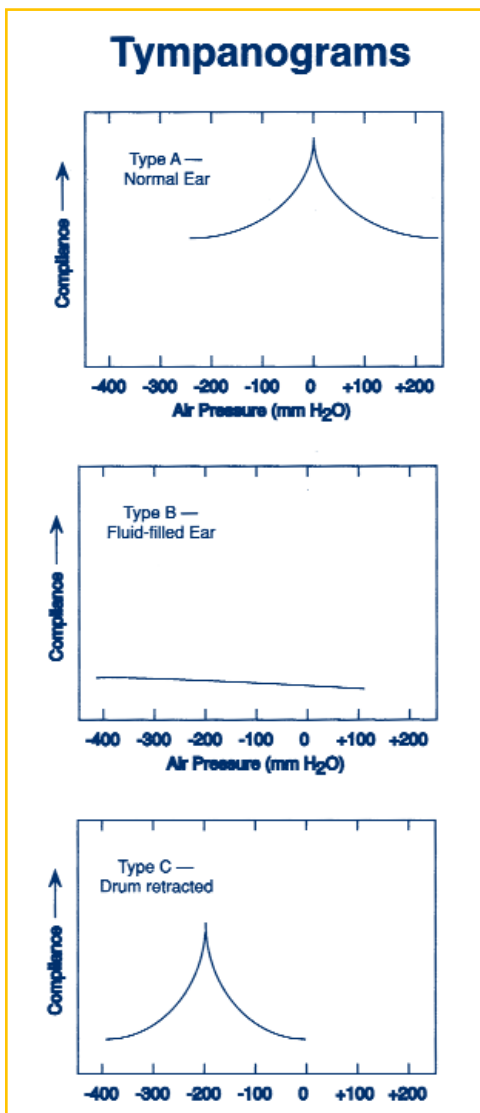


Figure 6.4. Three tympanograms demonstrating change in compliance of the middle ear (vertical axis) with changes in ear canal pressure. Type A is normal, with the greatest compliance at the point where the pressure in the ear canal is equal to that of atmospheric pressure (peak is at 0). Type B demonstrates very poor compliance at any frequency, suggestive of a tympanic membrane immobilized by fluid in the middle ear (no peak). Type C represents a tympanogram in which the compliance of the membrane is greatest at a point where the pressure in the canal is 200 mm of water below that of atmospheric pressure (peak shifted to the left). This suggests inefficient eustachian tube function with persistent negative pressure in the middle ear.



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ease process that involves **bony proliferation within the temporal bone**. These bony changes commonly occur at the footplate region of the **stapes**, causing gradual fixation of the ossicular chain. This fixation **decreases the mobility** of the stapes footplate and creates a conductive hearing loss. Surgical correction—**stapedectomy**—is available. This procedure involves removing the fixed stapes ossicle and placing a prosthesis between the **incus** and the **vestibule of the inner ear**, which re-establishes **ossicular continuity**. Sound vibrations can then be transmitted from the ossicular chain into the inner ear through the prosthesis and restore the patient's hearing.

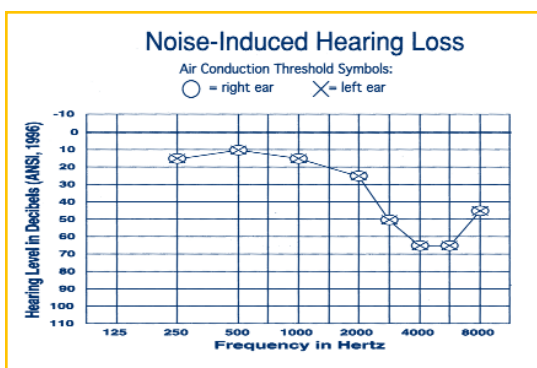


Figure 6.3.

Audiogram of a patient who has been exposed to noise. Note the high frequency dip, with a maximum loss at 4000 hertz. This audiogram suggests noise exposure that may be encountered occasionally in younger individuals who have been exposed to hazardous or "toxic" noise.

### Sensorineural Hearing Loss:

**Sensorineural hearing loss is the most common form of hearing loss.** Causes of this type of hearing loss are quite varied. However, age-related changes to the cochlea causing presbycusis are by far the most frequent cause. As



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we age, the outer hair cells within the cochlea gradually deteriorate, causing a **symmetrical** sensorineural hearing loss that begins in the high frequencies (figure 6.2). Patients with presbycusis may also have difficulty with speech discrimination ability and complain of tinnitus. Another common type of hearing loss is secondary to **acoustic trauma** or "noise exposure." Noise exposure is common in certain industries and is closely regulated by a federal government agency, the Occupational Health and Safety Administration (OSHA). Recreational target shooting, hunting with firearms, use of personal stereos with headphones, loud music exposure, power tools, etc., can cause a specific type of hearing loss with a characteristic audiometric pattern (figure 6.3). Patients suffering from noise-induced hearing loss have a symmetric "noise notch" in bone conduction thresholds at approximately 4000 Hz. Treatment consists of hearing education, noise avoidance if possible, and appropriate hearing protection with ear plugs or ear muffs when loud noise is present. Prevention is vital, and counseling should be part of routine health maintenance. Patients should also have regularly scheduled audiometric follow up.

Patients with **asymmetric** sensorineural hearing loss require a more thorough evaluation to rule out a benign tumor of the 8th cranial nerve known as an **acoustic neuroma**. Although most patients with an asymmetric hearing loss do not have an acoustic neuroma, hearing loss is by far the most common presenting complaint in patients with such tumors. In addition, these patients will frequently have very poor speech discrimination scores and tinnitus



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in the affected ear. They may also occasionally have disequilibrium complaints, although true **vertigo** is rare. Specialized audiometric testing can be done to assist in the diagnosis of acoustic neuromas, but magnetic resonance imaging (MRI) with gadolinium is now the gold-standard diagnostic test of choice.

Physical exam and testing may elucidate an easily treatable cause of hearing loss. However, more serious causes can be present that require careful assessment and complex management. Patients with hearing loss should be referred to an otolaryngologist for evaluation and management of their care. Many states require an evaluation by a physician before a hearing aid can be fitted, to ensure that diagnoses of such serious conditions as cholesteatoma or acoustic neuromas aren't missed.

Hearing aids are effective in rehabilitation of hearing loss in most patients. Aids vary widely in their power (gain), frequency response, size, and cost. Optimal fitting requires a professional knowledgeable in the nuances of amplification technology. For some patients with total sensorineural hearing loss, a cochlear implant provides direct stimulation of the cochlear nerve and is very helpful. Currently patients with bilateral profound hearing loss are candidates. We are able to implant younger and younger children as well, which has proven extremely helpful in their language and social development. All newborns should undergo hearing screening, so appropriate measures may be taken as soon as possible.



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### Questions, Section #6

1. The most common cause of a conductive hearing loss in children is \_\_\_\_\_
2. The most common cause of conductive hearing loss in adults is \_\_\_\_\_
3. The magnitude of a hearing loss is documented in the \_\_\_\_\_
4. The two major types of hearing loss are \_\_\_\_\_ and \_\_\_\_\_
5. Conductive hearing loss is present when there is a difference between \_\_\_\_\_ and \_\_\_\_\_ conduction thresholds.
6. Sensorineural hearing loss is present when abnormal air and \_\_\_\_\_ bone conduction thresholds one another.
7. Noise-induced hearing loss often produces a high-frequency \_\_\_\_\_ in the audiogram.
8. Otitis media with effusion produces a \_\_\_\_\_ tympanogram.
9. Presbycusis produces a hearing loss that slopes to the \_\_\_\_\_ side of the audiogram.



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10. A patient with an asymmetric sensorineural hearing loss must be evaluated for the potential of having an \_\_\_\_\_  
\_\_\_\_\_
11. Any facial paralysis of gradual onset, delayed (greater than 2 months) recovery, or that recurs requires further evaluation of the facial nerve with a \_\_\_\_\_  
\_\_\_\_\_

### Answers

1. Fluid in the middle ear (otitis media with effusion)
2. Cerumen impaction
3. Audiogram
4. Conductive, sensorineural
5. Air, bone
6. Approximate
7. Notch
8. Type B (flat)
9. Downward, right
10. Acoustic neuroma
11. Gadolinium-enhanced MRI scan



## More educational opportunities from the AAO-HNSF

The American Academy of Otolaryngology—Head and Neck Surgery Foundation offers many programs designed to keep you up-to-date without leaving your practice. Most activities offer Category 1 AMA/PRA credits. The Academy/Foundation also serves as a primary resource for otolaryngology/head and neck surgery activities and events, and serves as an online clearinghouse for patient education and specialty information.

Visit the Academy's website, <http://www.entnet.org> to learn more about these programs.

