

**An Overview of**

# **HEARING LOSS**

Patrick J. Antonelli, MD  
Professor, Otology & Neurotology  
Department of Otolaryngology  
University of Florida  
352-265-6808

Revised 12.31.2002

## THE HEARING PATHWAYS

In order to understand how hearing loss occurs, one must understand how the hearing (auditory) system works. The hearing pathway is made up of five main divisions: the external ear, the middle ear, the inner ear, the hearing nerve, and the brain.

**External Ear:** The external ear consists of the auricle (the only part that can be fully seen without instruments) and the external ear canal. These structures collect sound waves like a funnel and transmit them to the eardrum. External ear problems that may cause hearing loss include wax build-up, foreign bodies (eg, cotton balls), outer ear infections, and certain birth defects.

**Middle Ear:** The middle ear includes all of the structures between the eardrum (aka, tympanic membrane) and the inner ear. This chamber contains the three hearing bones (aka, ossicles): the malleus, the incus and the stapes (hammer, anvil and stirrup). Vibrations of the eardrum are transmitted across the middle ear space by these three small bones. Movement of the third bone (stapes) results in fluid waves in the inner ear. Sound is amplified by the hydraulic action of the eardrum relative on the stapes bone (a function of the surface area) and, to a lesser extent, by the lever action of the hearing bones.

In order for the eardrum and hearing bones to move properly, they must be surrounded by air. The middle ear is connected to the back of the nose by a small channel called the Eustachian tube. The Eustachian tube serves to maintain equalization of pressure between the middle ear chamber and the outside atmosphere, as evidenced by the popping sensation noted in the ear during swallowing, yawning, or altitude changes.

Many problems affecting the middle ear may lead to hearing loss. These include, middle ear infection or fluid build up, environmental or food allergies, problems with the middle ear bones, a hole (perforation) in the ear drum, and cysts or tumors of the middle ear.

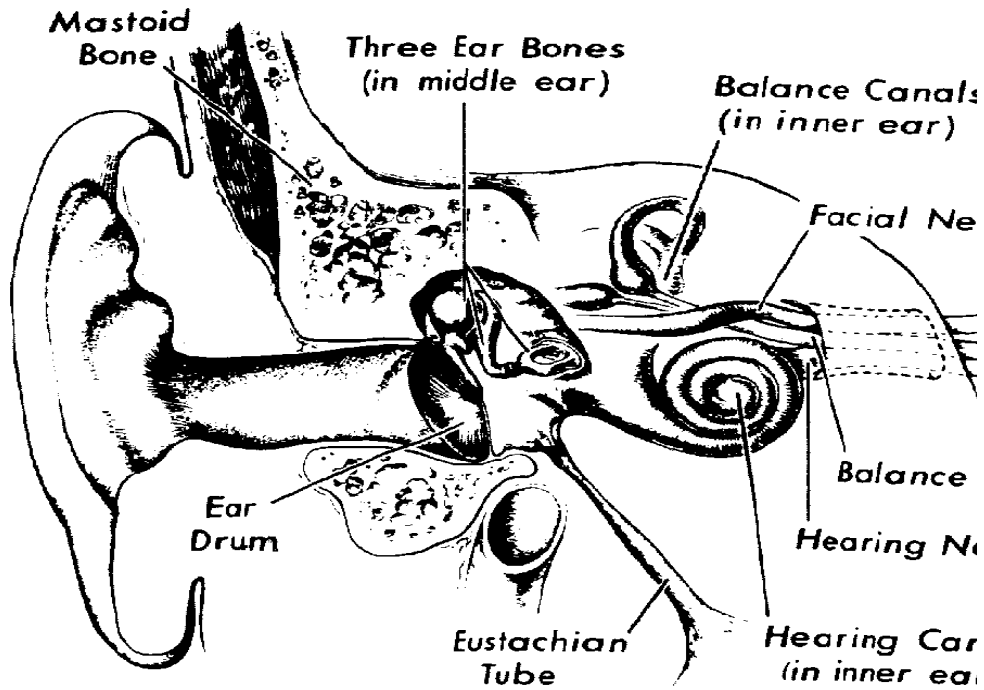
**Inner Ear:** The hearing part of the inner ear is called the cochlea. It is composed of a dense bony capsule that contains fluid-filled chambers. Within the central fluid filled chamber are tiny hair cells--known for the very fine hair-like “stereocilia” on their surface. The hair cells lie between two delicate membranes, the basilar and tectorial membranes. Sound waves that cause movement of the stapes are transmitted as waves in the inner ear fluids. These fluid waves cause vibrations of the membranes that displace the stereocilia, resulting in the generation of electrical impulses by the hair cells.

Problems in the inner ear that cause hearing loss include many birth defects that can be either inherited or caused by insults to the baby while in the womb, noise exposure, and certain medications, infections, degeneration (often determined by the genes) and head injury.

**Hearing Nerve:** The electrical impulses created by the hair cells of the inner ear are transmitted

to the brain by the hearing, or cochlear, nerve. The nerve pathways leading to the brain are enclosed in a small bony canal along with the nerve of balance and the nerve that stimulates movement of the facial muscles. Damage to the hearing nerve may be caused by tumors, compression by blood vessels, infection around the brain (meningitis), trauma, aging, some metabolic problems, and birth defects.

**Brain:** The hearing nerve pathways divide as they reach the lower part of the brain (brainstem), into an inter-communicating system far more complex than the most extensive telephone exchange. Nerve impulses are then transformed into recognizable sound by the upper portions of the brain (auditory cortex on the cerebral hemispheres). Brain damage or other problems are usually not limited to just the hearing centers, so hearing loss due to problems in the brain are usually found in association with other brain or nerve problems. More commonly, the ear may detect sound appropriately, but the brain may not process the hearing signal appropriately. This is know as a central auditory processing disorder.



## TESTING FOR HEARING LOSS

It is important to understand a number of terms when discussing hearing and hearing loss. Hearing sensitivity is typically described in terms of how loud the sound must be in order to be detected. This is reported in decibels relative to the hearing of people without ear problems. Sensitivity is tested for a number of frequencies. Sound frequencies are reported in cycles per second, or Hertz (Hz). Though humans can typically hear up to 20,000 Hz, testing is usually done from 250 to 8,000 Hz. Most speech understanding comes in the 500 to 4000 Hz range. Lower frequencies are important for hearing vowels, middle frequencies are important for the harder consonants (like k or b), and high frequencies are important for softer consonants (like f or s). Results of frequency sensitivity testing are commonly reported as a graph. Word understanding is reported as a percentage of words that were repeated correctly.

Hearing can be tested in people of all ages. The standard hearing test, known as (behavioral) audiometry, requires the individual being tested to signal when a sound is heard. This is an ideal test, because it checks the entire hearing pathway. Adults and older children can usually be tested in this manner. This type of testing can be made into a game that will allow younger children to be tested too. Testing that does not depend on active participation may be used for infants and uncooperative adults.

The middle ear and inner ear can be tested very quickly with otoacoustic emissions (OAEs). If an infant passes the OAE test, it is very unlikely that there will be a hearing impairment. However, OAEs do not check the hearing nerves or the brain's response to sound. If there is any question about hearing after passing an OAE test, additional testing may be performed.

Response to sound by the ear, hearing nerve, and lower brain can be tested with auditory brainstem audiometry (ABR). This test requires the infant to remain very still for at least 20 minutes, so testing is usually not a problem for very young infants. Older children may require some medicine or even anesthesia to make them sleep through the test. ABRs check the integrity of the lower hearing pathways, but they do not readily allow for testing of every frequency of sound. If there is any question about hearing after passing an ABR test, additional testing may be necessary.

Impedance testing consists of two middle ear measurements. Tympanometry charts the way changes in air pressure affect the tympanic membrane or eardrum. This helps to determine whether fluid build-up in the middle ear may be contributing to a hearing loss. Acoustic Reflexes measure how loud a sound must be to cause the middle ear muscles (tensor tympani and stapedius) to contract. This is a very quick and easy screening test to determine whether the lower hearing pathways are working.

Many other hearing tests are available, but less commonly used. The need for additional testing is based on results of the ear examination, findings on the initial hearing tests, and how well an individual is doing with response to sounds and language development.

## TYPES OF HEARING LOSS

Difficulty in the external or middle ear, it is known as a *conductive* hearing. If the trouble lies in the inner ear or the hearing nerve it is known as a *sensorineural* or nerve hearing loss. When there are problems in both the middle and inner ear, a combination of conductive and sensorineural impairment exists, it is known as a *mixed* hearing loss. Conductive hearing losses may be correctable with medicine or surgery. Sensorineural hearing is typically permanent. On occasion, the exact nature of the hearing loss cannot be determined. This type of hearing loss is called “*indeterminate*.”

## CAUSES OF HEARING LOSS

Causes of hearing loss are usually classified by the type of hearing loss. The most common causes of hearing loss are listed below.

***Conductive:*** The most common cause of conductive hearing loss is fluid in the middle ear. This may be a result of repeated or chronic infection (otitis media), or it may develop as a result of Eustachian tube obstruction (eg, due to allergies). Holes in the eardrum (tympanic membrane perforation) and skin cysts (cholesteatoma) are fairly common and may or may not be associated with repeated or persistent ear infections. The hearing bones may be either damaged or fused to surrounding structures as a result of other middle ear problems, birth defects, or certain bone conditions.

***Sensorineural:*** Many problems may cause this type of hearing loss. Many, if not most, cases are inherited. These may or may not be apparent at birth, and they may very well progress with time. Problems with inadequate oxygen at birth, noise exposure, certain intravenous antibiotics used for serious infections (eg, gentamicin), viral infection of the inner ear, and infection around the brain (meningitis).

***Mixed:*** Certain birth defects (eg, large vestibular aqueduct syndrome) and disorders of the inner ear bone (eg, otosclerosis) may affect both the inner and middle ear. Middle ear infections can cause mixed hearing loss, but the sensorineural component is usually, nearly completely reversible.

## IMPACT OF HEARING LOSS

***Mild Hearing Loss:*** Most adults can compensate for a mild hearing loss by addressing the speaker, face-to-face, and avoiding noisy environments. A child with mild hearing loss usually has normal speech, but may have trouble in the school setting because it is more difficult to hear speech from a distance or when there is background noise. This is because much of the meaning

in language is contained in the voiceless consonants which are high-pitched and soft. They are s, sh, t, p, k, f, ch, and th. People with a mild hearing loss in both ears will need some amplification in each ear to hear clearly at school, in groups, or at a distance.

Some children with a mild loss are not suspected of poor hearing until they reach first grade. They are often thought to be 'slow', because they cannot understand when the teacher speaks from a distance, and therefore respond erratically. When these children receive hearing aids, they usually find that school is easier.

**Moderate Loss:** People with moderate hearing loss can clearly hear speech only when the speaker is very close - less than two feet away. They need hearing aids to hear the softest sounds and to acquire understandable speech. Adults with moderate hearing loss will usually have difficulty in both social and work situations, such that hearing aids or other means of amplification will be necessary. If they receive hearing aids before four years of age, they usually progress rapidly in learning to talk. They can attend regular schools, but may need special help.

**Severe Loss:** People with severe hearing loss do not perceive speech, no matter how close they are to the speaker. With hearing aids, they can detect vowel sounds, pitch, some consonants, and stress clues from speech. With their eyes, they can learn to detect about 25% of the consonant sounds. With lip-reading and listening together, they may receive about half of the clues that normal hearing people use to understand speech.

Children with severe loss will not learn to talk intelligibly without hearing aids and special help. Severely impaired children who receive hearing aids early have a far better chance of acquiring speech than children who remain unaided longer. This is not to say that a child with a severe loss who gets hearing aids after age three will never learn to speak, but it does mean the task will be harder. Having suitable hearing aids at all times is a significant factor in determining whether the child will learn to speak. Many children that do not receive aids until after age six never develop clear speech or the ability to easily understand spoken words. All children with severe hearing loss require special help because they receive only a portion of the clues usually available in speech sounds.

**Profound Loss:** People with a profound hearing loss receive little or no auditory information from hearing aids. Fortunately, a scientific advancement called the cochlear implant now allows many deaf individuals to hear sound. With this device, a deaf person can hear sounds at normal conversation levels, although hearing is not normal.

Cochlear implant users need a lot of special training to learn about sounds. All profoundly impaired children - whether they use the cochlear implant or hearing aids - need auditory therapy and continuous use of amplification or the implant.

## **MEDICAL EVALUATION FOR CHILDREN WITH HEARING LOSS**

There are no clear guidelines that define which diagnostic testing should be performed in

children with hearing loss. The most common causes of hearing loss cannot be determined with routine tests. Most diagnostic tests are very low yield (ie, they are very unlikely to show any cause), so many physicians tend to not order many tests. The highest yield study is radiographic imaging (x-ray pictures of the ear and brain). CT scans will reveal a birth defect of the inner ear or hearing nerves in roughly one of three children with a sensorineural, mixed, or indeterminate hearing loss. CT scans will demonstrate underlying problems in a higher percentage of children with a conductive hearing loss, but a CT scan may not be necessary, because the cause may be apparent on direct examination of the ear. Magnetic resonance imaging (MRI) is usually used to evaluate the inner ear, hearing nerves, and brain in older children and adults that present with hearing loss. Some physicians may request blood tests, EKGs (heart wave tracings), eye examinations, or neurologic evaluations. The need for these tests depends on the presence of other findings from the history, examination, or hearing testing. Recent evidence suggests that blood tests for certain genetic problems may be of growing importance, but its value is yet to be determined.

## **TREATMENT OF HEARING LOSS IN CHILDHOOD**

It is very important that childhood hearing loss be aggressively treated. In some cases, surgery may correct the underlying problem. More often, however, amplification of the sound will be necessary.

Sound amplification is can be achieved in a number of ways. This is usually accomplished through the use of hearing aids. Several types of hearing aids are available, but they all do basically the same thing: amplify sound. Most hearing aids today can make some sounds louder than others. Usually the high frequencies, which are more difficult to hear, can be made louder than the low frequencies, which tend to cover up or mask speech sounds.

***In-The-Ear (ITE) & In-The-Canal (ITC):*** These devices are placed in the bowl of the ear (ITE) or in the ear canal (ITC). As they are cosmetically more hidden, they are popular among adults. The disadvantage of these devices are that they will not allow for growth of the ear and will not provide the power necessary for many people.

***Behind-The-Ear (BTE):*** These consist of an amplifier worn behind the ear, connected to an earmold by tubing. Since every ear is different, each earmold must be made from an impression of the ear - much as false teeth are made from an impression. This type of hearing aid is very useful for children, as they allow for a greater range of amplification, are sturdier, are easier to maintain, and can be adjusted to accommodate growth of the outer ear (with a new ear mold).

***Body Aids:*** With this device, a small microphone and amplifier are worn in a pocket or on a necklace. The amplifier is connected to an earphone by a cord. The receiver (earphone) snaps into an earmold. This device allows for the strongest amplification, but is not used much because BTE hearing aids are nearly as powerful and far less cumbersome.

***Eyeglass Aids:*** These contain an amplifier, microphone, battery and transducer inside the

eyeglass frame and a mold. These have also fallen out of favor to the BTE models.

***Bone conductor:*** These devices work differently from those listed above. Instead of passing sound into the ear canal, they pass sound through an oscillator, directly into the skull bone. The oscillator is usually held on the mastoid bone, behind the ear, by a headband. As no molds are worn in the ear, these devices are very helpful for individuals that have irresolvable medical problems with the middle or external ear. This device is also helpful for children with fluctuating hearing loss, such as that encountered with persistent middle ear fluid. Some individuals do not like these devices because of the pressure that they exert behind the ear.

Bone conducting hearing aids need to be firmly pressed against the skull to be effective. In some cases, this causes discomfort for the user. An alternative to wearing a headband is a surgical procedure called a bone anchored hearing aid (BAHA). This involves the surgical placement of a small titanium “button” in the bone and removal of some hair follicles behind the ear. This device can be of tremendous benefit to people with conductive hearing loss or with profound deafness in one ear (with normal hearing in the other).

### ***General Considerations with Hearing Aids***

If both ears are afflicted with hearing loss, both ears should usually be treated with amplification. Hearing with both ears (binaural) enables one to locate sound and to separate speech from background noise. This happens when identical signals are received in the right ear at a slightly different time than in the left. The discrepancy helps the brain locate the source of sound.

Most children resist their hearing aids at first. But, to get good response to sound, they need to wear their hearing aids all day. Once used to them, however, children are likely to fuss when the aids are taken off.

The audiologist needs to know how your child responds to sounds. What can your child hear with the aids? What situations are troublesome? If the child complains a lot, or resists wearing the aids, report this to the audiologist. Loud sounds may be uncomfortable or there may not be enough sound to make listening interesting.

Watch for redness or irritation of the outer ear and report these observations to the audiologist or physician without delay.

As children mature and receive regular hearing tests, their listening skills will improve and the audiologists will get better test data, both for adjusting the hearing aid and for evaluating a child's progress.

### **How Hearing Aids Work**

Like a loudspeaker system in an auditorium or church, hearing aids have the following components: Power is provided by a **battery**. The **microphone** picks up sounds. An **amplifier** makes sounds louder. A **speaker** generates (loud) sounds.

A **volume control** makes sounds softer or louder. Turn this up if your child doesn't respond. Turn it down if (s)he blinks or jumps at sounds. **Be sure you report these adjustments to your audiologist.**

**Tone controls** select out low frequencies or high frequencies. Some aids have a 'low tone' cut that the user can turn on or off in noisy or quiet conditions. Most tone controls are inside the device or under a cover, and should not be changed without consulting the audiologist.

### **Microphone/Telephone (m/t) Switch**

With this switch in the microphone mode environmental sounds can be heard. This can be switched to the telephone mode, so that only telephone sounds can be heard. The special M/T switch can be used in a classroom with an auditory trainer. The teacher speaks into a special FM microphone worn around the neck; background noise is cut out, and only the teacher's voice can be heard.

### **Gain or Output Control**

This control, usually inside the device or under a cover plate, controls the maximum loudness that can be sent into the ear. It is set by the audiologist to suit the individual's hearing loss. If it is on the outside, check frequently to make sure it stays set correctly.

**Earmold** fits into the ear canal and carries the amplified sound from the receiver into the ear. The mold must fit in the ear exactly. If too large, it hurts the child's ear; if too small, sound will leak and cause feedback (squeal, ringing, buzz, whistle; the sound that drives parents crazy). Earmolds are made of plastic material such as acrylic or vinyl. Normally, a soft translucent substance is best for children. It is very important that children with severe to profound losses have a good fit that seals the ear. Often a small vent hole will be made in the earmold to prevent the build-up of moisture in the ear canal.

### **Other Means of Amplification**

There are other ways of amplifying sound that may take the place of or work with hearing aids. First, children with hearing loss should have preferential seating in larger group settings. In the classroom, the child should be seated closest to the teacher.

Another important consideration is an FM trainer. This device is used in the classroom. The teacher wears a microphone that is attached to an FM transmitter. The hearing-impaired child wears an FM receiver that is attached to an amplifier and either his/her own hearing aids or a pair of earphones. This allows the child to hear the teacher, preferentially over the background noise of the classmates. The state is required by law to supply these devices if prescribed by a physician. Some classrooms, particularly if many students are hearing impaired, may provide amplification by means of speakers that amplify the teacher's voice. Though effective, and not complicated by any stigma of having a hearing impaired child stand out as different, this is less commonly used.

Devices may also be used to connect hearing aids to the telephone and other electronic sound

systems (such as in theaters and churches).

### ***Parental Responsibilities***

Guidelines for the use of hearing aids are included in Appendices A & B.

1. Make sure that your child wears hearing aids during all waking hours.
2. Keep the aid at the correct settings.
3. Keep the volume control at the proper level.
4. Be sure the hearing aid is working properly.
5. Make sure the molds are good.
6. See that your child has regular hearing tests.
7. See that your child's hearing aids have regular checkups (electronic analysis).
8. Take the aid for repair promptly if not working properly.
9. Let your audiologist know at once if there are changes in your child's response or in the hearing aid.
10. Give your child meaningful sound to listen to all day; talk, sing, read, call, point to noisemakers, and ask questions. Even if your child doesn't talk yet, this auditory input is important.

Most children will want to take over the responsibilities of caring for their hearing aids, and they can learn to do many of these things. However, you must be sure that amplification is adequate and continuous.

## **COCHLEAR IMPLANTS**

If hearing loss is profound, hearing aids may not prove to be of benefit. In these cases, children may be candidates for a cochlear implant. This device is not a hearing aid. It is more of an artificial ear, because it does not amplify sound. Rather, it processes sound and stimulates the hearing nerve directly with an electrical signal. Though cochlear implants can give the vast majority of deaf people sound awareness, not all benefit sufficiently to warrant the surgery.

Candidates for cochlear implants include both individuals that lost their hearing after they already developed language skills (post-lingual deafness) and children that were either born deaf or lost their hearing before developing language skills (pre-lingual deafness). Cochlear implants may be done at any time in post-lingually deafened individuals. People that are pre-lingually deaf must have the implant placed early in life to derive the full benefit of the device.

There are four steps to determine whether your child is a candidate for a cochlear implant. First, the ear surgeon will screen for medical conditions that need to be addressed before surgery. Second, a CT or MRI of the ear and brain will be obtained to ensure that the ear can accommodate a cochlear implant and that the implant will stimulate the brain appropriately. Third, the audiologist will determine whether hearing aids, a cochlear implant, or neither will

provide optimal benefit. Finally, a psychologist will determine if the child and family are prepared for the cochlear implant surgery and postoperative rehabilitation. In some circumstances, a social worker may help address any special needs that a given child and family may have. The cochlear implant team (ear surgeons, audiologists, psychologists, and social workers) meets monthly to review the progress of individuals being considered for cochlear implant placement. If all issues have been addressed and cochlear implants are felt to be the best means of rehabilitating your child, surgery will be scheduled.

The cochlear implant device that is placed in the body consists of an antenna (to pick up the signal that is transmitted across the skin), a magnet (to locate the antenna after surgery), a receiver (a computer to process the signal), and an array of electrodes (to stimulate the hearing nerve fibers). In order to place the stimulating electrodes next to the hearing nerve, the inner ear must be exposed through the mastoid. A long curved incision is made behind the ear and the mastoid bone is partly removed. The nerves that give motion to the face (facial nerve) and taste to the front of the tongue (chorda tympani nerve, a branch of the facial nerve) lie in the mastoid, over the inner ear. The cochlear implant electrode is passed between these nerves, directly into the inner ear with the help of an operating microscope and a nerve integrity monitor. In some circumstances the taste nerve may need to be cut to provide adequate access for the electrode array. (See Appendix D for a list of surgical risks with cochlear implants).

After surgery, the incision and skin flap over the implant must heal fully before the implant is activated (4 – 6 weeks). The implant is powered by a devices that sit on the ear or are worn on a necklace or carried in a breast pocket. These external devices look like hearing aids. They consist of a microphone, a computer to process the sound, a magnet to locate the implanted magnet, and a transmitter device that delivers the electrical signal and power to the internal implant. The only batteries in most implants are found in the external portion of the device.

Cochlear implants cannot be just turned on, like a light-switch, to work properly. They must be fine-tuned over many sessions with an audiologist to work optimally. Fine-tuning involves adjustment of the strength, frequency, and pattern of the electrical stimulation. The brain must also adapt to the new hearing signal. Results with cochlear implants depend on the age at implantation, time since deafening, amount of language development before deafening, and effort with rehabilitation. Some deaf children with cochlear implants attend regular public schools and cannot be readily distinguished from their normal hearing peers. Please ask your ear surgeon and audiologist to give you an idea of how your child might be expected to perform with a cochlear implant.

Cochlear implants are man-made devices. Hence, they may fail at sometime during your child's life. If this occurs, the device may be replaced with another surgical procedure. Fortunately, revision surgery is rarely needed.

## **COPING WITH HEARING LOSS IN YOUR CHILD**

Learning that your child has a hearing impairment may be a shock. Perhaps you suspected this, but hoped you were mistaken or that the doctor could somehow correct it. Do not be embarrassed to ask your pastor, a friend, or a counselor for help if you have trouble coping with strong emotions. Remember, your child is a normal person who just happens to have a hearing impairment and should not be treated much differently than other children. All youngsters need love, guidance and discipline.

However, your child may not benefit from the same verbal instruction and praise as hearing children. You need to act out your expectations, and then show your approval with hugs and smiles. Be sure that discipline occurs immediately after unacceptable behavior, so the connection between the two is obvious.

Because of your child's hearing loss, you will be in constant contact with doctors, audiologists, teacher, therapists, nurses and other professionals. You will find they do not always agree about what is best for your child, so you will have to make some important decisions. If you have questions, ask. Learn as much as you can about sound, hearing loss, hearing aids, testing, and speech development (Appendix C). Many resources are available. Please consult with your physician or audiologist if you have questions.

## Appendix A

### **PUTTING ON THE HEARING AID**

Each morning, be sure the aid is put on correctly.

1. Put the battery in. Make sure the positive (+) end of the battery matches the (+) plus on the aid. Be sure the battery is a good one.
2. If using a body aid, check the cord for breaks and knots.
3. If using an ear level aid, look at the tubing on the earmold; be sure it isn't twisted or bent. If it has been twisted or bent a few times, it is time to get a new tube. Is the tubing yellow and hard? It may be time for a new tube and maybe a mold too. Check to be sure there is no moisture in the tubing. Water droplets will block the sound.
4. Listen to the aid with a Listener ( a stethoscope, or stenorette device) to hear how the aid sounds. It should sound clear, with out distortion. Listen for vowel sounds and "s" sounds.
5. Put the mold in the child's ear.
6. Turn the aid on. Check that the switch is on (M) for the microphone mode.
7. Turn the volume to the correct number. You might want to mark the volume control with a red "Sharpie" pen so you can check it quickly. (Sharpie pens write permanently on plastic or metal.)
8. Play a listening game with your child. Have the child turn around at the sound of his/her name. Play the Go Game where the child responds to a sound by putting a penny in the bank. Use the Ling Five Sound Test (oo, ah, ee, sh, s). Ask your audiologist to teach you and your child how to do this test so that you can do it daily.

## **Appendix B**

### **CARE OF HEARING AIDS**

Hearing aids are of little value unless they work properly. Keep them in good working order so that your child can have adequate amplification.

The most common problem is a poorly-fitting earmold. Children grow quickly and need to have earmolds replaced often - about every two months during the first year. At age two, replace molds every four months. By the time the child is five, new earmolds may only be needed every 9-12 months.

Keeping your child's hearing aids in good working order is more than just turning down the volume until there is no feedback (or squeal). Sometimes parents feel that if a mold is NEW it must be good. But if it has feedback at the setting your audiologists advises, it is not good and should be remade at no cost.

The following tools will help.

**Listener (stethoscope or stenorette)**

**Battery tester**

**Blower** (a little syringe)

**Dri-Aid kit** for humid climates and perspiring children.

Hearing aids should be analyzed with electronic instruments twice a year or more often if possible. In between electronic checks, learn to check the hearing aid daily and become familiar with the quality and volume of sound. After the best volume setting has been established, mark the volume wheel with a Sharpie marker or nail polish.

In a quiet room, remove the earmold and with a "Listener" attached to the aid, gradually turn up the volume until the red mark is reached. Listen carefully to a soft radio or your own speech sounds (ssss, shhhh). They should sound clear even if the sound is louder than is comfortable for you. If your child has a severe to profound loss, be very careful when listening to the aid. You may not be able to turn it up as loud as your child wears it. You can cause damage to your own ears.

#### **If the sound is not clear:**

Wipe off the battery and try again.

Blow gently in the battery drawer.

Test battery.

Check earmold

Send for repair.

#### **If the sound is too soft:**

Check battery.  
Check earmold.  
Send for repair.

**If the aid rattles:**

Send for repair

**If there is no sound:**

Test battery.  
Check to see if T switch is on.  
Check battery position.  
Check tubing for droplets of moisture.  
Dry out with blower if necessary.  
Send for repair.

**If there is feedback.**

Put your finger over the mold opening.  
If feedback stops, get a new mold.  
If feedback continues, remove mold.  
Put finger over hook. If feedback stops, check tubing for holes.  
If feedback continues, remove hook.  
If feedback stops, get a new hook.  
If feedback continues, send aid for repair.

**Feedback**

Squeal in body aids may be due to internal feedback or a loose mold. It may be caused by a poor seal between mold and receiver or between cord and receiver. Once you know the cause, you may be able to solve the problem by inserting a washer and sealing with clear nail polish. Your audiologist can do this for you, if you wish.

**Care of Batteries**

Test batteries at night. Batteries may recharge themselves slightly if left alone overnight. Replace batteries that do not test to 1.4 volts. Turn off the aids at night and open the battery drawer. Use a Dri-Aid kit in humid weather or if your child perspires.

**Care of Controls**

Moisture, food, and dirt cause problems with hearing aid controls. Because body aids have larger openings, water, soup or Kool-Aid are more of a problem. Take immediate action if spills or dunking occur. Wipe off and dry with a fan or your hair blower. Do not use heat. If your home remedy works, and it often does, the aid will keep working. If it doesn't, call your dispenser or

audiologist for more suggestions. Have an acoustic analysis as soon as possible to be sure the mishap did not cause distortion in the hearing aid.

Hair spray is more of a problem for ear-level aids. Use hair spray before putting the hearing aids on.

### **Care of Molds**

To clean molds, remove them from the aid or receiver, and wash them in warm soapy water. A commercial earmold cleaner can be used instead of soap. Be sure to wipe thoroughly and use a blower to dry the inside. Do not use heat.

One droplet of water can prevent sound from being heard. On a warm day after playing, perspiration droplets may collect in the tubing. Remove the mold and blow dry with the blower. Do not use heat.

A yellow, dry, or hard earmold shrinks and causes feedback. Replace it. If tubing is loose or torn but the mold is still good, tubing can be replaced by your dispenser or audiologist. Feedback is usually caused by poor molds, but can also be caused by internal problems or a cracked hook. See the Checklist (p 17) for a simple diagnostic test before buying a new mold or sending your aid in for repair.

### **Hearing Aid Insurance**

You can get insurance on any hearing aid through the manufacturer, or through an agency that insures all hearing aids. Some policies protect against workmanship flaws for one year, some for two. Others may extend the warranty period for a fee.

Children's hearing aids have fallen in oceans, rivers, toilets, and gardens. One fell into the street and was run over by a truck. A dog mangled another so that it resembled a piece of chewing gum. One was flipped off in some bushes and hung suspended in the snow, sleet, and rain. A mother lost her child's hearing aid at the beach in the sand. A hearing aid was in a purse which was stolen. More things than you can imagine have already happened to hearing aids and your inventive child may come up with a new disaster.

When recovered, aids often need repair which cannot be covered by the warranty. If not recovered, a new aid has to be purchased.

The best place for a hearing aid is in the ear (unless the user is swimming or bathing).

You will feel more comfortable about allowing your child to wear hearing aids all the time if they are insured.

## Appendix C

### Information and Support Resources for Parents of Children With Hearing Loss

AG Bell Association for the Deaf and Hard of Hearing  
3417 Volta Pl NW  
Washington, DC 20007  
(202) 337-5220  
[www.agbell.org](http://www.agbell.org)

American Academy of Otolaryngology  
8201 Greensboro Drive, Suite 300  
McLean, VA 22102  
(800) 222-2366  
(703) 610-9022  
email: [cfisk@audiology.org](mailto:cfisk@audiology.org)

American Academy of Otolaryngology Head and Neck Surgery  
1 Prince St  
Alexandria, VA 22314  
(703) 519-1585  
[www.entnet.org](http://www.entnet.org)

American Speech-Language-Hearing Association  
10801 Rockville Pike  
Rockville, MD 20852  
(800) 638-8255  
[www.asha.org](http://www.asha.org)

Auditory-Verbal International, Inc  
2121 Eisenhower Ave., Suite 402  
Alexandria, VA 22314  
(703) 739-1049  
(703) 739-0874  
email: [avi@auditory-verbal.org](mailto:avi@auditory-verbal.org)

Cochlear Implant Club International  
5335 Wisconsin Ave. NW, Suite 440  
Washington, DC 20015-2003  
(202) 895-2781  
[www.webmaster@cici.org](http://www.webmaster@cici.org)

Cued Speech Center

**The Joyner House**  
304 E Jones St  
Raleigh, NC 27601  
(919) 828-1218  
email: [nccue@aol.com](mailto:nccue@aol.com)

**League for the Hard of Hearing**  
71 W 23<sup>rd</sup> St  
New York, NY 10010  
(877) 544-4327  
[www.ihh.org](http://www.ihh.org)

**National Association of the Deaf**  
814 Thayer Ave  
Silver Spring, MD 20910-4500  
(301) 587-1788  
[www.nad.org](http://www.nad.org)

**National Information Center on Deafness**  
Gallaudet University  
800 Florida Ave NE  
Washington, DC 20002-3695  
(202) 651-5060  
(202) 651-5052  
[www.gallaudet.edu/~nicd](http://www.gallaudet.edu/~nicd)

**National Institute on Deafness and Other Communication Disorders (NIDCD)**  
1 Communication Ave  
Bethesda, MD 20892-3456  
(301) 241-1044  
[www.nih.gov/nidcd.clearing.htm](http://www.nih.gov/nidcd.clearing.htm)

**Self-Help for Hard of Hearing People, Inc**  
7910 Woodmont Ave, Suite 1200  
Bethesda, MD 20814  
(301) 657-2248  
(301) 657-2249  
[www.shhh.org](http://www.shhh.org)

## **Appendix D**

### **COCHLEAR IMPLANTATION: SURGICAL RISKS**

**HEARING LOSS** - Cochlear implantation is usually performed for severe or total nerve hearing loss. If there is some slight hearing that does remain before surgery it will most likely be lost afterwards.

**FACIAL WEAKNESS** - The facial nerve moves the face and also provides some taste function for the tongue. Weakness of facial movement is quite rare although disturbance of taste is not unusual. Changes or loss of taste are usually temporary but may be permanent.

**SPINAL FLUID LEAK** - This is a rare complication of this surgery, but if it occurs a second procedure may be necessary.

**INFECTION** - Infection may occur after any surgery and if it does it may require further antibiotic treatment, or possible removal of the implant.

**BLEEDING** - Some blood loss occurs with every surgery. It is very rare for blood loss to be severe enough to cause a hematoma (build up around the implant) or require a transfusion.

**EAR NUMBNESS** - Ear numbness is common after any surgery where an incision is made behind the ear. It is rarely permanent but it may take several months for feeling to return.

**DIZZINESS** - Dizziness rarely occurs after this procedure, but if so, it is usually temporary.

**TINNITUS** - Ringing of the ears is often present in many patients prior to the surgery. Many patients in note an improvement of tinnitus, but very rarely it may be worse.

**IMPLANT PROBLEMS**- Patients who have a cochlear implant should avoid certain types of electrical and magnetic tests or procedures subsequently. If in doubt please contact your surgeon. Device failure or extrusion occurs in a small minority of patients. If this occurs, revision surgery may be necessary.

**POOR HEALING** - The skin over the implant may sometimes have problems healing. This is a rare complication generally requiring only local skin care, however, local areas of skin may have to be moved to cover the implant.