

Audiology Module

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Field of Audiology

What is an Audiologist?

An audiologist is a professional who diagnoses, treats, and manages individuals with hearing loss or balance problems. Audiologists have received a master's or doctoral degree from an accredited university graduate program. Their academic and clinical training provides the foundation for patient management from birth through adulthood. Audiologists determine appropriate patient treatment of hearing and balance problems by combining a complete history with a variety of specialized auditory and vestibular assessments. Based upon the diagnosis, the audiologist presents a variety of treatment options to patients with hearing impairment or balance problems. Audiologists dispense and fit hearing aids as part of a comprehensive habilitative program. As a primary hearing health provider, audiologists refer patients to physicians when the hearing or balance problem requires medical or surgical evaluation or treatment.

Where do audiologists work?

Audiologists work in private practice offices, hospitals and medical centers, clinics, public and private schools, universities, rehabilitation or speech and hearing centers, health maintenance organizations and nursing homes. Audiologists work closely with government agencies, practicing physicians and hearing aid manufacturers. Audiologists conduct clinical activities with patients, dispense hearing aids and assistive listening devices, are involved in hearing research, and teach at universities and medical schools.

What do audiologists do?

- **Hearing Testing**

Audiologists use specialized equipment to obtain accurate results about hearing. These tests are typically conducted in sound-treated rooms with calibrated equipment. When hearing loss is identified and appears to be caused by medical problems, patients are referred to ear, nose and throat physicians (known as otolaryngologists) for medical management. Most persons with hearing impairment can benefit from the use of hearing aids, and audiologists are knowledgeable about the latest applications of hearing aid technology.

- **Hearing Services for Infants & Children**

Good hearing is essential to the social and intellectual development of infants and young children. Audiologists test hearing and identify hearing loss in children of any age. This includes newborn and infant hearing screening and diagnostic hearing tests with young children. Audiologists provide hearing therapy and fit hearing aids on babies and young children with hearing loss.

- **Services for School Children**

Audiologists provide a full range of hearing and rehabilitative hearing services in private and public schools for students in all grades. Such services are essential to the development of speech, language and learning skills in children with hearing problems.

- **Relationships with Other Disciplines**

Audiologists often work with many other health care disciplines to provide services to individuals with hearing loss and those at risk for hearing loss. Audiologists frequently receive referrals from primary care physicians, otolaryngologists, school audiologists, etc. for concerns about a child's hearing. One of the

primary reasons for a child to be referred to an audiologist for a hearing evaluation is for concerns regarding a child's speech and language development.

- **Team Assessment**

Audiologists may work within multi-disciplinary teams to diagnose and provide recommendations for children. The professionals included in a multi-disciplinary team are based largely on the setting in which the audiologist works. On a multi-disciplinary team that assesses children at risk for development disorders, an audiologist's role is to determine if hearing loss is a factor in the child's development. Cochlear implant teams might consist of otolaryngologists, audiologists, psychologists, social workers, radiologists, and speech language pathologists. A school team might include the special education teacher, psychologist, speech pathologist, audiologist, general education teacher and the school nurse.

- **Hearing Services & Counseling**

Audiologists are vitally concerned that every person, regardless of age, benefit from good hearing. Audiologists provide individual counseling to help those with hearing loss function more effectively in social, educational and occupational environments.

- **Hearing Aids & Assistive Listening Devices**

Audiologists provide complete hearing aid services to clients with hearing problems. Audiologists are also experts with assistive listening equipment and personal alerting devices. Audiologists provide education and training so that persons with hearing impairment can benefit from amplification and communication devices.

- **Hearing Conservation Programs**

Prolonged exposure to loud noise causes permanent hearing loss. Because audiologists are concerned with the prevention of hearing loss, they are often involved in implementing programs to protect the hearing of individuals who are exposed to noisy industrial and recreational situations.

- **Hearing Research**

Audiologists engage in a wide variety of research activities to develop new hearing assessment techniques and new rehabilitative technologies, particularly in the area of hearing aids. Research reports of audiologists can be found in the professional literature of medical and scientific journals. Audiologists write textbooks on hearing evaluation, hearing aids and the management of people with hearing loss. Audiologists help develop professional standards and are represented on the boards of national and government agencies.

Audiology Practice

History of Audiology

The profession of audiology had its origins in the 1920's when audiometers were first designed for measuring hearing.

Since the 1940's and 1950's, the study of hearing, hearing loss, and audiologic rehabilitation has escalated and expanded.

- New tests of hearing have been developed including evaluations of functions of the outer ear, middle ear, cochlea, acoustic nerve, and related brain areas.
- Techniques using physiologic measurements that were in the research stages 20-30 years ago are now routine.
- Modern digital technology have dramatically influenced hearing aids. Hearing aids have changed from "boxes" in shirt pockets and "cords" to the ear to highly sophisticated "completely-in-the-ear canal" aids. Virtually any kind of hearing loss can be improved by a hearing aid.
- Cochlear implants are increasingly common and successful.

Today, audiologists and the practice of audiology have widespread visibility. Audiology has a presence in public schools, health care centers, private practices, nursing homes, community agencies, the military, hospitals, colleges and universities, hearing aid dispensing centers, hearing and speech centers. They test hearing and listening ability; they fit hearing aids and assistive listening devices; they provide training and rehabilitation programs for individuals with hearing and listening disorders; they participate on health care and educational teams to plan and provide the most appropriate services.

Information about the audiology profession was obtained from the American Academy of Audiology website: <http://www.audiology.org>.

Audiology Training and Education

Audiologists working in the field may have a master's degree (M.S), an audiology clinical doctorate (Au.D.), or a doctorate (Ph.D.). In order to practice clinically, an audiologist must maintain clinical certification (CCC-A) through ASHA ([American Speech Language Hearing Association](http://www.asha.org)), the national organization. In most states, audiologists also must comply with state licensure standards to practice. The current entry level clinical degree is the audiology doctorate (AuD). The AuD graduate degree typically requires 3 years of didactic coursework in an accredited university program, as well as 12 months of a full-time clinical externship with a total of 1800 supervised clinical hours. Finally, graduates must pass a national board certification exam.

Professional Organizations for Audiologists

The **American Speech-Language-Hearing Association (ASHA)** is the professional, scientific, and credentialing association for more than 123,000 members and affiliates who are speech-language pathologists, audiologists, and speech, language, and hearing scientists in the United States and internationally.

The **American Academy of Audiology** is the world's largest professional organization of, by and for audiologists. The membership of more than 10,000 audiologists join together to provide the highest quality of hearing healthcare service to children and adults described by our national slogan "Caring for America's Hearing." [The American Academy of Audiology](http://www.audiology.org) promotes quality hearing and balance care by advancing the profession of audiology through leadership, advocacy, education, public awareness and support of research.

How to Find a Pediatric Audiologist

Infants and children should be evaluated by a pediatric audiologist who has experience with the unique challenges of evaluating and working with pediatric patients and their families.

Washington state has a listing of qualified pediatric audiology clinics:

[Audiology Clinics for Infants \(pdf\)](#)

In addition, audiologists in Washington state have developed guidelines for the audiologic assessment of infants and children:

American Speech-Language-Hearing Association

[Guidelines for the Audiologic Assessment of Children From Birth to 5 Years of Age \(pdf\)](#)

How the Ear Works

The ear is made up of three parts:

- External Ear
- Middle Ear
- Inner Ear

Outer (External) Ear

Sounds travel through the external ear or ear canal and cause vibration of the eardrum (tympanic membrane).

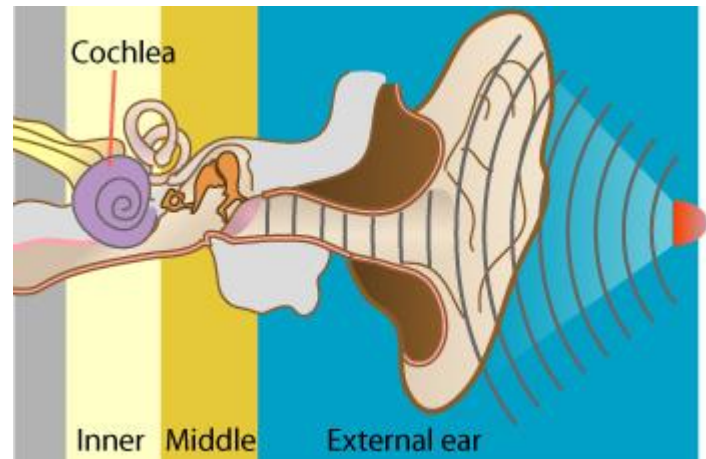
Middle Ear

Eardrum movement causes the three middle ear bones (ossicles) to vibrate.

This vibration creates movement of fluid in the inner ear (cochlea).

Inner Ear

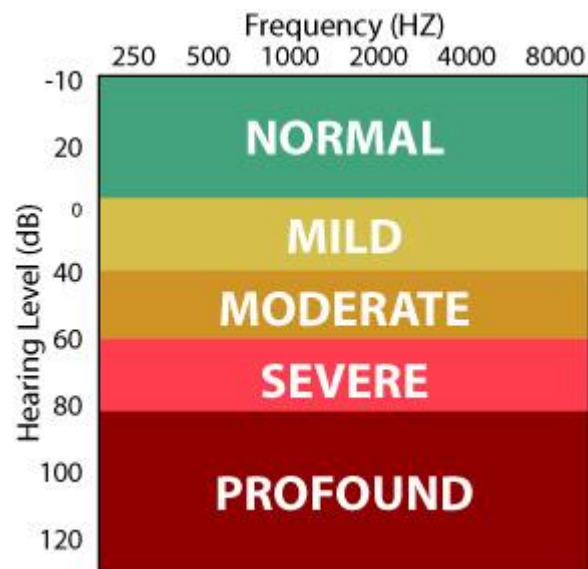
The inner ear, or cochlea, sends nerve impulses to the brain. Once the brain receives the message, we have a sensation of hearing.



Audiogram

What Does an Audiogram Show?

The **audiogram** is a plot of a person's hearing thresholds. Across the top of the audiogram is the pitch of the tones, from low to high pitch, plotted in frequency from 250 to 8000 Hertz (Hz). The level in decibels (dB) is plotted down the side. The normal range of hearing is from 0 to 20 decibels hearing level (dBHL).



- **Air conduction hearing thresholds:**

When a child is tested with sound presented through earphones, air conduction hearing thresholds are measured, representing hearing sensitivity for the entire hearing system. Because sound is presented to each individual ear, information can be gathered about the hearing in each ear, separately. The symbols used to represent air conduction testing are an X for the left ear and an O for the right ear. Sometimes colors are used for all of the different symbols: red for the right and blue for the left. If the child was tested with sounds presented from a loudspeaker, also called sound field, the hearing thresholds will be plotted with an S. Sound field hearing thresholds will reflect the hearing of the better ear, if there is a difference between ears. Ideally, children are tested under earphones to obtain information about each ear individually. However, in infants and toddlers, even small insert earphones are often rejected by the child and testing can only be conducted from the loudspeaker. If the child does not hear the sound at the loudest level of the audiometer (the machine used to test hearing), it may be indicated several different ways, with a NR (no response), or an arrow downward from the X or O.

- **Bone conduction hearing thresholds:**

Auditory stimuli can also be presented by bone conduction, a small box that sits behind the ear on the mastoid bone and presents sound by vibration to the inner ear. Bone conduction thresholds are represented by the symbols > and < or [and] on the audiogram. Bone conduction represent the responses from the inner ear, as the bone conducted signal bypasses the outer and middle ear systems. A comparison of bone and air conduction thresholds allows the audiologist to determine the type of hearing loss (conductive, sensorineural, or mixed).

This audiogram shows air conduction thresholds for a person with a moderate hearing loss:



Types of hearing Loss

Permanent hearing loss

Conductive Hearing Loss

If there is a problem in the external or middle ear, a conductive hearing loss exists. This means sound is not being conducted properly to the inner ear. Common causes of conductive hearing loss are ear wax (cerumen) in the external ear, fluid in the middle ear, or a hole or tear (perforation) in the eardrum. Most types of conductive hearing loss can be treated medically or surgically.

Sensorineural Hearing Loss

If a problem occurs in the inner ear, the hearing loss is sensorineural. Sensorineural hearing loss usually cannot be cured medically or surgically, but the use of hearing aids or other amplifying systems can help children hear and develop speech and language.

Neural Hearing Loss

If the outer, middle, and inner ear are functioning normally, but the auditory nerve and neural pathways to the brain do not function properly, the disorder is called a neural hearing loss, or

Mixed Hearing Loss

Children with sensorineural hearing loss also can develop middle ear problems (such as fluid in the middle ear) This can make the infant's hearing loss worse. When there is a combination of two problems (sensorineural and conductive hearing loss), this is known as a mixed hearing loss.

Degrees of hearing loss

Follow this link for recorded simulations of different degrees of hearing loss:

<http://www.babyhearing.org/HearingAmplification/HearingLoss/audiogram.asp>.

Mild hearing loss

The softest sounds a child hears are at levels of 25 dB to 40 dB. Without amplification, the child can hear most conversations up close and in quiet environments, but is likely to miss parts of words. A child with mild hearing loss will have trouble hearing faint or distant speech, and may have trouble hearing in a noisy environment. A child with mild hearing loss will benefit from amplification and should be able to hear all sounds with hearing aids.

Moderate hearing loss

The softest sounds a child hears are at levels of 40 dB to 65 dB. Speech can only be understood if it is loud. A child may have limitations in vocabulary, language comprehension and language usage. Without amplification, the child will have difficulty hearing spoken conversation such that 50 to 100% of spoken conversations may be missed. With amplification and intervention, a child with moderate hearing loss should be able to hear and recognize all sounds.

Severe hearing loss

The softest sounds a child hears are at levels of 70 dB to 90 dB. A child with a severe hearing loss will not hear voices, unless speech is very loud. Without amplification, the individual will not recognize any speech through listening alone. With amplification, a child with severe hearing loss should have good ability to hear speech, but may still have some difficulty distinguishing all sounds.

Profound hearing loss

The softest sounds a child hears are at levels of 90 dB or more. Historically, a child with a profound hearing loss would be called deaf, but a more appropriate term is “a child with a profound hearing loss”. Very loud sounds will not be detected. A child will rely on vision rather than hearing for primary communication. Many children with profound hearing loss with hearing aids can detect moderately loud sounds and spoken conversation under ideal listening conditions. Many children still need visual communication to assist them in understanding spoken conversation.

Unilateral hearing loss

Because one ear still has normal hearing, a child with unilateral hearing loss will hear well in “quiet and close” situations. However, children with a hearing loss in one ear will have hearing in situations when noise and distance create listening challenges, especially if the good ear is close to the noise. Individuals with unilateral hearing loss usually have difficulty knowing where sounds are coming from (localizing). If a child with unilateral hearing loss has usable hearing then the child will receive benefit from the use of a hearing aid, a standard hearing aid may not be helpful when the hearing loss is more severe. However, recent studies suggest that 25-35% of children with unilateral hearing loss are at risk for failing a grade in school. Therefore, a child with unilateral hearing loss will often benefit from an amplification device, an FM system, in the classroom.

Etiology of Hearing Loss

Causes of permanent hearing loss in children

Most professionals working with hearing loss are in general agreement that the cause of hearing loss in about 40% is **Non-genetic**, and about 60% **Genetic**.

Non-genetic hearing loss

Non-genetic hearing loss is most often caused by illness or trauma before birth or during the birth process. Older infants and young children can also hearing loss due to illness or trauma.

- **Congenital infections**

Some viral infections are known to be associated with hearing loss. These infections carry the highest risk of causing hearing loss if the mother has the illness during pregnancy or passes the infection to her baby during the birth process. The primary infections are toxoplasmosis, syphilis, rubella (german measles), cytomegalovirus (also known by the initials CMV) and herpes. The amount of hearing loss that can result varies widely and some babies show no hearing loss at all, even if they have one of these infections. These infections can affect other systems in the body as well and medical professionals will need extensive birth history and test information to identify these infections as a cause for hearing loss. Congenital CMV infection is the leading cause of acquired hearing loss in infants.

- **Complications associated with prematurity**

Low birth weight has also been identified as a risk factor for hearing loss. Newborn specialists identify 1500 grams (approx. 3.3 lbs.) as a cut-off point, with children weighing less than 1500 grams having an increased likelihood of hearing loss. For infants that are born premature, illnesses associated with prematurity can cause hearing loss.

Hyperbilirubinemia (jaundice) that is severe enough to require a blood transfusion can also result in hearing loss. This is related to the potential damage that high levels of bilirubin can cause to the nerves of hearing.

Sometimes *medications* that are known to be ototoxic (damaging to hearing) are prescribed to babies, usually to treat serious infections or birth complications. The most common ototoxic medications used at this time include a family of antibiotics called aminoglycosides with names such as gentamycin, tobramycin, kanamycin, and streptomycin. They present more of a risk to hearing when they are used multiple times or in combination with other medications, such as diuretics.

All babies are evaluated at birth on a 10-point scale, called an APGAR score, given at 1 minute and 5 minutes after birth. The higher the score, the healthier the baby is. When babies have scores of 0-4 at one minute or 0-6 at five minutes, their risk for having hearing loss increases.

Also, *prolonged mechanical ventilation* for a duration of five days or longer due to persistent pulmonary hypertension increases the risk for hearing loss. These conditions of breathing problems and other distress at birth do not mean that a baby will always have a hearing loss, but do indicate the need to monitor hearing closely.

- **Meningitis**

One illness that carries a high risk of causing hearing loss and/or balance problems is bacterial or viral meningitis. Because meningitis is an infection of the lining of the brain and spinal cord, the sense organs of hearing and balance are especially sensitive to this infection.

Genetic hearing loss

With genetic forms of hearing loss, an estimated 70% are due to recessive causes, about 15% have a dominant cause; and the remaining 15% include all the other forms of inheritance. Genetic scientists subdivide genetic hearing loss into two general categories: non-syndromic, meaning hearing loss and nothing else, and syndromic, meaning hearing loss with other clinical findings. By far, the more common is non-syndromic hearing loss which includes 2/3 of all genetic hearing losses. There are over 400 known genetic causes involving hearing loss. One gene, known as Connexin 26 (abbreviated CX26) alone is responsible for about 1/3 of all the cases of genetic hearing loss. Since CX26 accounts for about 1/3 of all cases of genetic hearing loss, that leaves about 1/3 of all cases as non-syndromic (this includes all types of inheritance) with the remaining 1/3 as syndromic. Among the remaining 1/3 of non-syndromic cases of genetic hearing loss, 13 dominant and 8 other recessive genes have been described.

Causes of temporary hearing loss in children

There are a number of types of conductive hearing loss in children that can be permanent due to congenital malformations of the outer and middle ear.

Otitis Media and Hearing Loss

Anything which interferes with the proper working of all parts of the middle ear is called a dysfunction. The most common dysfunction seen in children is an improperly working eustachian tube. This tube opens and closes many times during the day, providing an exchange of air between the middle ear and the air around us. If the eustachian tube does not open often enough, the middle ear pressure changes and fluid may fill the middle ear space. The fluid can become infected resulting in an ear infection, or otitis media.

Can Middle Ear Dysfunction Cause Hearing Loss?

Middle ear dysfunction is a health problem that requires medical attention. If left untreated, it may result in hearing loss and communication problems. Hearing loss caused by middle ear dysfunction is called conductive hearing loss. This type of hearing loss is usually temporary, and hearing can be restored with appropriate medical treatment. The amount of hearing loss varies from child to child and may even change from day to day. A complete hearing evaluation is needed to determine the extent of the hearing loss. The hearing test, ear examination, and a history of ear problems are used by the doctor to create a medical treatment plan which is right for the individual child.

Can Middle Ear Dysfunction Affect Speech and Language Development or School Performance?

Children learn speech and language by listening to the people around them. If middle ear dysfunction results in long-standing or repeated episodes of conductive hearing loss, speech and language development may be delayed. It also can cause listening problems in daycare or school, as well as at home. In some cases, the hearing problems may be mistaken for behavioral problems such as poor attention or distractibility.

Prevalence of Hearing Loss

At birth: With 3 of every 1,000 newborns (.3%) having a hearing loss, it is the most frequently occurring birth defect.

In childhood: For school-age children, the prevalence of hearing loss is 5 in 100 (5%).

As you can see, the prevalence of hearing loss increases across childhood, due to a combination of factors. Some hearing losses are missed at birth even with newborn hearing screening. Additionally, many hearing losses have onset in childhood due to a genetic condition, or from an acquired infection or trauma.

Detecting and Diagnosing Hearing Loss in Children

Newborn hearing screening

Early Hearing Loss Diagnosis and Intervention

Why is early diagnosis of hearing loss and early intervention important?

Left undetected, hearing impairments in children can negatively impact speech and language acquisition, academic achievement, and social and emotional development. If detected, however, these negative impacts can be diminished and even eliminated through early diagnosis and intervention. Because of this, the National Institutes of Health's (NIH) Consensus Development Conference on Early Identification of Hearing Loss (1993) concluded that all infants should be screened for hearing impairment, preferably prior to hospital discharge. At the time of the NIH Consensus Development Conference, there were only 11 hospitals screening more than 90 percent of their babies. Since then, there has been a rapid increase in the number of universal newborn hearing screening (UNHS) programs which have been implemented in the United States. Currently approximately 90% of babies born in the state of Washington receive newborn hearing screenings.

Research has compared children with hearing loss who receive early intervention and amplification before 6 months of age versus after 6 months of age. By the time they enter first grade, children identified earlier are 1 to 2 years ahead of their later-identified peers in language, cognitive, and social skills.

What are the 1-3-6 goals of EHDI?

Early Hearing Detection and Intervention (EHDI) refers to the process of screening every newborn for hearing loss prior to hospital discharge, whereby infants not passing the screening receive appropriate diagnostic evaluation before three months of age and, when necessary, are enrolled in early intervention programs by six months of age. In identifying infants with hearing loss and enrolling them in early intervention programs, an early hearing detection and intervention (EHDI) program should encompass these three basic components: newborn hearing screening, audiological diagnosis, and early intervention. Threaded throughout these components should also be some key elements—culturally-competent family support, medical home, data management, legislative mandates, and program evaluation tools.

Universal Newborn Hearing Screening

Hearing screening programs are called "universal" because the goal is to test all newborn babies. This means that babies in both the regular and intensive care nurseries are screened before they leave the hospital.

Newborn hearing screening tools

Behavioral test methods are not reliable measures for detecting hearing loss in newborn infants. Physiologic tests, the otoacoustic emission (OAE) test, and brainstem auditory evoked response (BAER) test are the recommended methods for newborn hearing screening. These methods are discussed in the section "[Hearing Testing](#)"

What does it mean when a baby does not pass a newborn hearing screening test?

When a baby does not pass the newborn hearing screening test, this does not necessarily mean the baby has a permanent hearing loss. Across the nation, between 20 to 100 babies per 1000 (2 to 10 percent) do not pass the screening test. Only three babies per 1000 (less than 1 percent) actually have hearing loss. This

means that many of the babies referred for follow-up testing will be shown to have normal hearing. However, all babies with congenital hearing loss will be in the group of babies who do not pass the newborn hearing screening. A baby with normal hearing could fail the newborn hearing screening test due to vernix in the ear canal, fluid in the middle ear, or movement and/or crying during the test. If a baby does not pass the newborn hearing screening test, it is very important to make sure the baby gets follow-up testing to determine the baby's hearing status.

For more information about EHDl:

- [Centers for Disease Control and Prevention - CDC - Hearing loss in children](#)
- [National Center for Hearing Assessment and Management - NCAM](#)

Hearing Testing

There are a number of different audiological tests used to assess a child's hearing and auditory function. Typically, an audiologist will use a number of different tests together to provide a complete "picture" of the child's hearing status and function of the auditory system. The ages of children appropriate for audiological tests should be considered in relation to the developmental age of the child if the child is functioning below his/her chronological age.

Physiologic Tests

Otoacoustic Emissions Testing

Also known as: OAE, DPOAE, TEOAE

How it is done: A small earphone is placed in the ear canal and sounds are presented. An otoacoustic emission test measures an acoustic response produced by the inner ear (cochlea). The acoustic response measured is the response produced by the inner ear in response to a sound stimulus from the earphone. The OAE tests take about 10 minutes to perform in a quiet child.

Who it is for: The OAE test is often used for newborn hearing screening and re-screening of infants up to 6 months of age, or for children who cannot respond to other types of behavioral hearing tests.

What it will show: The OAE test is interpreted with pass/fail criteria. If the child passes the OAE test, there are no concerns about the child's hearing, but if the child does not pass the OAE test, the child is demonstrating at least a mild hearing loss. The OAE test does not distinguish the degree or type of hearing loss.

Brainstem Audiometry Evoked Response (BAER)

Also known as: BSER, BAER, ABR.

How it is done: The BAER test is a physiologic test that measures the function of the entire auditory system and the brain's response to sound. This test can only be done if the child is either asleep or sedated. Electrodes are attached to the child's head and behind the ears. Sounds are presented through the earphone and the electrodes measure the response of the child's hearing system. This test gathers specific information about the responses of the child's auditory system at different frequencies and hearing levels. A diagnostic BAER testing typically takes one hour of testing.

Who it is for: This test is used for infants up to 6 months of age, and for children who cannot respond to other types of behavioral hearing tests. The BAER test may be used for newborn hearing screening.

What it will show: The BAER provides information about the degree of hearing loss and the type of hearing loss across different test frequencies (itches). Earphone and bone conduction testing will determine the type of hearing loss (sensorineural vs conductive).

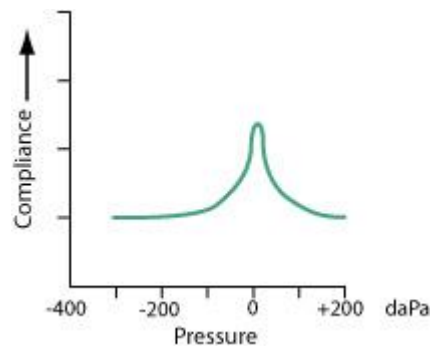
Tympanometry

Also known as: Immittance testing

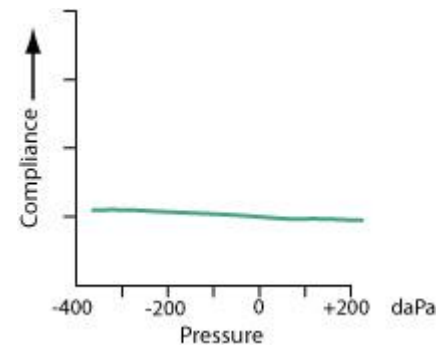
How it is done: Tympanometry is performed by placing a small probe earphone in the child's ear canal and gently changing the air pressure in the ear. The procedure takes a few seconds per ear.

Who it is for: Children and adults of all ages can be tested using tympanometry.

What will it show: Tympanometry is used to determine the function of the outer and middle ear. This test is important because fluid in the middle ear or other abnormalities can affect hearing. A normal tympanogram shows a peak on a graph, showing compliance, or movement of the eardrum as a function of changing pressure. A typical abnormal tympanogram in a child is a flat function, showing middle ear fluid.



Normal tympanogram



Flat tympanogram

Behavioral Hearing Tests

Visual reinforcement audiometry (VRA)

How it is done: During VRA testing, a child is seated on an adult's lap in a sound proof booth. Auditory stimuli are presented and the child is trained to turn to the sound and is then rewarded with an animated toy or video. The sounds, or auditory stimuli used are tones, noise bands, and speech stimuli and can be presented by earphones, loudspeakers, and bone conduction.

Who it is for: Children from 6 months of age to 2 ½ years can be tested using visual reinforcement audiometry.



What it will show: By using this technique, it is possible to obtain information about the child's hearing thresholds across frequencies. If only sound field (loudspeaker) testing is used, then the results give

information about hearing in at least one ear. Hearing thresholds will typically be plotted on an audiogram.

Play Audiometry

How it is done: Play audiometry is a game-like activity where the child is taught to do a specific task, such as dropping a block in a bucket, every time a sound is heard.

Who it is for: Children from 2 to 5 years of age



What it will show: As with VRA, it is possible to obtain detailed information about the child's hearing thresholds across frequencies in both ears. At this age, children often accept earphones more readily, so that ear-specific information can be obtained. If needed, bone conduction testing can be completed, as well. Hearing thresholds will typically be plotted on an audiogram.

Conventional Audiometry

Also known as: pure tone audiometry

How it is done: A child is seated in a sound proof booth and sounds are presented by earphones. The child is taught to raise a hand or press a button each time a sound is heard. The softest sounds that the child can hear, called hearing thresholds are recorded.

Who it is for: By the age of 5 years, children are able to reliably respond using conventional audiometry. This method is used through adulthood.

What will it show: Hearing thresholds are measured in each ear using headphones or earphones, and bone conduction, if necessary. Hearing thresholds will typically be plotted on an audiogram.

Medical Evaluations

Family physician

A child's family physician is crucial in monitoring a child for middle ear problems and hearing loss. A family physician will routinely treat a child with antibiotics if an ear infection is diagnosed. In addition, the physician will refer the child to an otolaryngologist if the middle ear problems are persistent. A family physician is also responsible for monitoring a child's development. Speech and language delays are the most common sign of hearing loss in children. If speech and language delays are suspected, the family physician will refer the child for a hearing evaluation to determine if hearing loss is a factor.

Otolaryngology

An otolaryngologist (ear, nose and throat doctor) completes a medical evaluation of the hearing system and obtains a comprehensive medical history. If a hearing loss is present, the otolaryngologist will be able to determine if medical or surgical treatment can improve it. If a hearing aid is needed, this doctor provides medical approval for its prescription. [American Academy of Otolaryngology— Head and Neck Surgery](#)

Medical Genetics

The purpose of a medical genetics evaluation is to determine, if possible, the cause of a hearing loss. It also may rule out any medical problems which could accompany a hearing loss. This evaluation involves a full family medical history, a physical exam of the child, a review of birth and delivery records, and, possibly, hearing tests for other family members. Based on findings of this evaluation, other tests may be recommended.

Intervention for Children with Permanent Hearing Loss

Fitting appropriate hearing aids or other sensory devices is one of the first steps in helping an infant with hearing loss. Today's advanced technology allows for the successful fitting of hearing aids on very young babies. Because language skills begin to develop within the first few months of life, it is important to fit a child with hearing aids as soon as possible.

Amplification

Hearing Aids



A hearing aid is a device that fits in or behind the ear and makes sounds louder. Hearing aids can be adjusted to increase desired sounds in a particular range depending on the particular hearing loss. The goal is to amplify sounds common in speech while keeping environmental sounds at a comfortable level. Hearing aids, however, are just that -- an aid to hearing. They do not restore hearing or correct the hearing loss; rather they amplify and shape incoming sounds to make them more accessible to the wearer. For many children, amplification can provide benefit and access to sounds. Even very young infants can be fit with hearing aids.

Consistent and early auditory access is essential for spoken language and speech growth. Hearing aids may provide benefit for children with all degrees of hearing loss. The goal is to maximize the hearing that a child does have. There are many different brands and styles of hearing aids available for different types of hearing loss. Typically, young children are fit with behind-the-ear (BTE) hearing aids. This style of hearing aid sits behind the ear and is attached to a custom earmold which sits in the ear.

Cochlear Implants

A cochlear implant is a sensory aid or device for adults and children with severe to profound hearing loss who get only limited benefit from hearing aids. Cochlear implants work by changing sound waves into electrical signals that can be processed by the brain. Cochlear implant systems include external parts, those worn on the outside of the body, and internal parts, those that are surgically implanted into the inner ear. The internal components include a receiver/ stimulator anchored to the temporal bone and an electrode array that is surgically placed inside the cochlea (inner ear). The external components may include a behind the ear microphone, a speech processor, and a transmitter coil worn on the scalp behind the ear. The external microphone of the cochlear implant picks up sound and changes it into electrical signals that are then converted into specially coded electrical signals by the speech processor. The transmitter coil then sends the coded signal to the internal electrodes in the cochlea, which stimulate the auditory nerve and send the signals to the brain.



Source: <http://www.babyhearing.org>

Cochlear implant surgery is conducted at a specially designated hospital by a specially trained otologist. The surgery to place the internal components is generally done on an outpatient basis. Three to four weeks after the surgery the external components are programmed and the cochlear implant is stimulated. Not every child is a candidate for the cochlear implant. A team of professionals will conduct a series of formal evaluations to determine if a child meets the criteria for cochlear implantation. Age, type and degree of hearing loss, and potential to benefit from conventional hearing aids are some of the things considered.

Similar to hearing aids, a cochlear implant is not a cure for deafness. Aural habilitation is necessary for children to obtain optimal performance with a cochlear implant. Children with cochlear implants demonstrate a wide range of performance based on many factors.

Follow this link for more specific information about cochlear implants:

[Boys Town National Hospital website](#)

FM/DM Systems

Children who use hearing aids or cochlear implants often have difficulty hearing speech in the presence of background noise or when the speaker is at a distance greater than three feet away. FM/DM (frequency or digital modulation) systems are commonly used in conjunction with hearing aids and cochlear implants, allowing children to hear the speaker's voice better over a distance and in background noise. An FM/DM system consists of a microphone connected to a transmitter, worn by the speaker (e.g. a teacher or parent), and a receiver worn by the child, attached to the hearing aid or cochlear implant. As with other assistive devices, there has been significant improvement in these devices in recent years. A soundfield FM/DM system consists of a microphone/transmitter worn by a person talking (i.e. teacher) and a receiver is housed within or connected to loudspeakers that are placed throughout a room; these systems are typically used in classrooms.



Source: <http://www.babyhearing.org>

Early Intervention

Early intervention means getting started as early as possible to address the individual needs of a child with hearing loss, to enhance the infant or toddler's development, to minimize the potential for developmental delay, and to enhance the family's capacity to meet the child's needs. Early intervention is a system of services to help eligible children from birth until their third birthday.

Two federal laws - PL 105-17, Part C, and the **Individuals with Disabilities Education Act (IDEA)** - regulate early intervention services. Together, these laws encourage states to develop coordinated programs of early intervention services for children with disabilities from birth to age three, and require that these children and their parents have the same legal right to a free and appropriate education as children without disabilities.

Individuals with Disabilities Education Act (IDEA) - The Individuals with Disabilities Education Act, known as "IDEA," is a federal law that requires states to provide a "free, appropriate public education" to children with disabilities so that they can be educated to the greatest extent possible along with all other children. School districts are required to follow specific procedures to determine a child's eligibility for special education, to develop the child's IEP, and to resolve conflicts. Parents of children with disabilities must be afforded a meaningful opportunity to participate in the development of their child's IEP

Early intervention programs typically have both home-based and center-based services. Home-based services include a weekly visit to the family's home from an infant specialist. Center-based services include playgroups, parent groups, and sign language classes.

early intervention services – established by Part H of P.L. 97-457 of 1986 (now Part C of the IDEA of 1997); community-based therapeutic and educational services for infants and children under 3 years of age with developmental delays

Communication Choices

When families enroll in intervention programs and educational programs for children with hearing loss, they will make decisions about the type of communication mode they will use with their child. Below is a

full list of communication choices used in the United States, though not all methods are represented in all communities.

American Sign Language (ASL)

American Sign Language (ASL) is a fully developed, autonomous, natural language with distinct grammar, syntax, and art forms. Sign language can perform the same range of functions as a spoken language. "Listeners" use their eyes instead of their ears to process linguistic information. "Speakers" use their hands, arms, eyes, face, head, and body. These movements and shapes function as the "word" and "intonation" of the language. If parents are not deaf, intensive ASL training is necessary in order for the family to become proficient in the language.

Auditory/Oral and Auditory/Verbal

These methods of teaching spoken language stresses the use of amplified residual hearing, speech and oral language development. These methods emphasize teaching the child to use his or her amplified residual hearing and audition from listening devices (like hearing aids or cochlear implants) to the fullest extent possible. A high degree of parent involvement is necessary as parents learn methods to integrate listening and language throughout daily routines.

Total communication

The term Total Communication was first defined as a philosophy which included use of all modes of communication (i.e. Speech, sign language, auditory training speech, speech reading and finger spelling). Today the term Total Communication is commonly interpreted as Simultaneous Communication (signing while talking). This philosophy led to the formation of manual systems (e.g. Signing Exact English Signed English) that attempt to represent spoken English.

Cued Speech

This system is designed to clarify lip reading by using simple hand movements (cues) around the face to indicate the exact pronunciation of any spoken word. Since many spoken words look exactly alike on the mouth (e.g. pan, man), cues allow the child to see the difference between them. Cued speech can be learned through classes taught by trained teachers or therapists. A significant amount of time must be spent using and practicing cues to become proficient.

Case Study #1: Joe

History

Joe is a 2 year 3 month old child who has been referred for an interdisciplinary evaluation in the Child Development Clinic. Joe's parents are both developmentally delayed and there are concerns that Joe is exhibiting similar delays. Joe has not had any previous evaluations and did not have a newborn hearing screening.

Findings

Audiology

Joe was tested with visual reinforcement audiometry under earphones and bone conduction and provided reliable responses so that hearing thresholds could be established. Joe shows a moderate bilateral sensorineural hearing loss with hearing thresholds of 50 to 65 dB in both ears.

Speech and language

Joe demonstrates significant delays in both his expressive and receptive language.

Psychology

Joe demonstrates mild delays on psychological testing. However, an examination of the subtests shows that in non-language based psychological measures Joe is above age-level, but on language subtests he shows moderate delays.

Summary

Joe demonstrates a moderate sensorineural hearing loss and associated language delays consistent with a likely congenital hearing loss of unknown etiology. He does not demonstrate global developmental delays despite the family history.

Follow-up

Joe returned within a month for fitting with binaural behind-the-ear hearing aids. He was referred to an early intervention program in his community.

Case Study #2: John

History

John was born premature and was a graduate of the UW Medical Center NICU (neonatal intensive care unit). John was born at 25 weeks gestation, 685 grams. His neonatal course was significant for chronic lung disease treated with extended ventilation for 4 weeks, grade II intraventricular hemorrhage, and stage II retinopathy of prematurity. John did not pass his neonatal BAER newborn hearing screening.

Findings

Audiology

John was seen in the Pediatric Audiology Clinic at CHDD at 3 weeks corrected age for a comprehensive evaluation using the BAER, OAE and tympanometry tests. Testing determined that John had a severe sensorineural hearing loss in both ears. His parents were counseled regarding the impact of a significant hearing loss and recommendations for treatment, including hearing aids and early intervention.

Physical therapy

Due to his extreme prematurity, John was followed by the High Risk Infant Follow-up Clinic to monitor his development. A physical therapy evaluation at 4 months corrected age showed that John was developing appropriately in both his motor and mental skills.

Psychology

As part of the High Risk clinic, John had a developmental assessment at 12 and 24 months corrected age that showed that he was at age level for his cognitive skills.

Summary

John was diagnosed with a bilateral severe sensorineural hearing loss shortly after his discharge from the hospital. The etiology of his hearing loss is likely associated with his severe prematurity. Newborn hearing screening, early fitting of hearing aids, and enrollment in an early intervention program are all factors in John's development.

Follow-up

Audiology

John returned in one month for fitting with binaural hearing aids and the audiologist assisted the family in evaluating the early intervention services available in their community. By 3 months of age, John and his family were enrolled in an early intervention program, receiving weekly home visits. When John graduated from the program at age 3, he was at age-level for his language skills.

Resources

Counseling

Strong counseling skills help the audiologist build a positive relationship with a family with a child with hearing loss. Families appreciate clear, honest presentation of information so that they can make informed decisions. The relationship between the family and the audiologist can last throughout the child's life so, building and maintaining a strong relationship is crucial in working with families.

- The [A.C.E. \(Audiologic Counseling Evaluation\)](#) is a tool to evaluate a clinician's counseling skills.
- [Giving Bad News to Parents](#) by the Medical Staff by Royal Children's Hospital, Melbourne. A 2-page guide to help with delivering bad news to parents.
- [Personal Adjustment Counseling: It's an Essential Skill](#) by Kris English (2000). Addresses counseling skills specific to audiology.
- [Reflections on Counseling: Families and Hearing Loss](#) by Carolyn Edwards . Addresses counseling in pediatric audiology. Suggestions for empowering both the parents and the child are provided.
- [Empowering Parents to Help Their Newly Diagnosed Child Gain Communication Skills](#) by Amy McConkey-Robbins. Describes how the audiologist's role changes from diagnosis to early intervention.

Early Hearing Loss Detection, Diagnosis and Intervention (EHDI)

- **CDC Hearing Loss** main page:
<http://www.cdc.gov/ncbddd/hearingloss/index.html>
- **CDC Hearing Loss in Children - Free materials** page:
<http://www.cdc.gov/ncbddd/hearingloss/freematerials.html>
- Download CDC Materials
 - [Hearing Loss Info for Primary Care Providers](#)
 - [Questions to Ask Your Child's Audiologist](#)
 - [Questions to Ask Your Child's ENT](#)
 - [Questions to Ask Your Child's Geneticist](#)
 - [Questions to Ask Your Child's Speech-Language Pathologist](#)
- Washington State Dept. of Health - Early Hearing Loss page:
<http://www.doh.wa.gov/YouandYourFamily/InfantsChildrenandTeens/HealthandSafety/EarlyHearingLoss>

Professional Associations

American Speech-Language and Hearing Association

Comprehensive information about hearing loss and communication disorders designed for the public or professionals. <http://asha.org/>

American Academy of Audiology

For professionals: www.audiology.org

For the general public: www.howsyourhearing.org/

Joint Committee on Infant Hearing

A detailed history of the Joint Committee on Infant Hearing and the process of creating Universal Newborn Hearing Screening www.icih.org/

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Other Resources

Amplification and FM

- [Phonak](#) e-school desk is an interactive resource to learn about FM.
- Phonak maintains an [FM configurator](#) as part of the e-school desk. This tool provides support for programming and using Phonak FM systems with various brands of hearing aids.

Developmental Milestones

LinguiSystems: A complete and easy to navigate [resource for communication milestones](#) (pdf).

Books/Pamphlets/Posters for Audiologists

<http://www.cdc.gov/ncbddd/hearingloss/freematerials.html>

Early Intervention

Handout about available EI programs for families in Seattle, Washington:

- [Deaf and Hard of Hearing Services](#) - English Version
- [Deaf and Hard of Hearing Services](#) - Spanish Version
- [Communication Choices and Decision Making](#) an essay by Mary Pat Moeller published by Hands & Voices on choosing a communication method, suitable for parents and audiologists.
- [Decision Guide to Communication Choices](#), a guide for parents in choosing communication options.

Recommended Websites for Families with Deaf/ Hard of Hearing Children

- [My Baby's Hearing – First Steps](#)
- [National Resource Center for Early Hearing Detection and Intervention \(EHDI\) systems](#)
- [Help Kids Hear](#)

[Return to UW LEND Modules webpage](#)