

## Hearing Loss after Treatment for Childhood Cancer

Some chemotherapy drugs, other medications, or radiation needed for treatment of childhood cancer can damage hearing. Hearing loss interferes with daily living. If you received these treatments, it is important to have your hearing checked and to obtain treatment if hearing loss is found.

### How do the ears work?

It's easier to understand hearing loss if you understand how the ears work. The ear is made up of three main parts, known as the outer, middle, and inner ear.

### Outer ear

Sound waves travel through the air and first enter the body through the outer ear. The part of the ear that can be seen outside the body is called the pinna. The pinna collects and funnels sound into the auditory (ear) canal. The auditory canal is like a tunnel. It makes the sound louder and directs it toward the middle ear.

### Middle Ear

The eardrum separates the outer ear from the middle ear, a chamber that is normally filled with air. Inside the middle ear are three tiny bones (ossicles) that form a chain connecting the eardrum to the opening of the inner ear. Sound waves cause the eardrum to vibrate. These vibrations cause the three tiny bones in the middle ear to move, transmitting the sound to the inner ear.

### Inner Ear

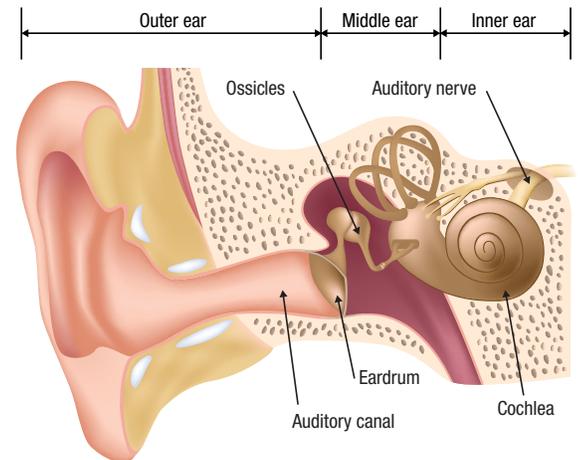
The inner ear is known as the cochlea, and it is filled with fluid. The cochlea contains thousands of tiny nerve endings, known as sensory hair cells. Sounds travel in waves through the fluid of the inner ear. The sensory hair cells change the sound waves into nerve impulses that are sent to the brain by way of the auditory nerve (also known as the eighth cranial nerve). In the cochlea, the sensory hair cells are arranged in order of pitch, from low-pitched sounds (such as a man's voice) to very high-pitched sounds (such as a bird's chirping). Each hair cell is sensitive to a specific range of pitches.

### What are the types of hearing loss?

Hearing loss that occurs in the outer or middle ear is called **conductive hearing loss**. This means that the hearing loss is due to a problem in transmission of sound from the air to the inner ear. An example of this would be changes in hearing because of fluid collection in the middle ear. Sometimes this happens when people have ear infections. The fluid "muffles" the sound when it is traveling through the middle ear.

Hearing loss that results from damage to the inner ear or auditory nerve is called **sensorineural hearing loss**. An example of this would be damage to the sensory hair cells in the inner ear from chemotherapy. Even though sound waves still move through the inner ear fluid, they can no longer be changed into nerve impulses, so the sound does not reach the brain. Sensory hair cells that process high-pitched sounds are usually damaged first, followed by damage to the sensory hair cells that process lower-pitched sounds.

Hearing loss with both conductive and sensorineural components is called **mixed hearing loss**.



### What types of cancer therapy increase the risk of hearing loss?

The following cancer treatments can potentially cause hearing loss:

- Chemotherapy from the “platinum” group, such as cisplatin or high doses of carboplatin
- Any dose of carboplatin, if given prior to one year of age
- High doses of radiation (30 Gy or 3000 cGy/rads or higher) to the head or brain, especially when the beam is directed at the brainstem or ear
- Surgery involving the brain, ear or auditory (eighth cranial) nerve
- Certain antibiotics (medicines used to treat infections) and diuretics (medicines that help the body get rid of excess water)

### What are the effects of childhood cancer treatment on hearing?

High doses of radiation to the ear or brain can cause inflammation or ear wax buildup in the outer ear, problems with fluid buildup in the middle ear, or stiffness of the eardrum or middle ear bones. Any of these problems can result in conductive hearing loss. Radiation can also damage the sensory hair cells in the inner ear, causing sensorineural hearing loss. Damage from radiation may affect one or both ears, depending on the area of radiation treatment. Conductive hearing loss may improve over time, but sensorineural hearing loss is usually permanent.

Platinum chemotherapy can cause damage to sensory hair cells in the inner ear, resulting in sensorineural hearing loss. Most often, the effect is similar in both ears and is permanent.

### What are the symptoms of hearing loss?

Symptoms of hearing loss may include:

- Ringing or tinkling sounds in the ear
- Difficulty hearing in the presence of background noises
- Not paying attention to sounds (such as voices, environmental noises)
- School problems (see related Health Link: “Educational Issues Following Treatment for Childhood Cancer”)
- Some people may have no symptoms at all

### What monitoring is recommended?

Testing should be done by an experienced audiologist (a professional trained in hearing disorders).

- Hearing is usually evaluated by a series of tests. During an audiogram, the person wears earphones and listens for sounds of different pitches and different degrees of loudness. Speech audiometry tests the person’s ability hear single words and sentences. Tympanometry tests the status of the middle ear and the movement of the eardrum in response to a puff of air.
- People who are not able to have an audiogram (such as those who are too young or who cannot understand the test instructions) can have their hearing tested using Brainstem Auditory Evoked Response (BAER). The person having this test is usually given medicine so that they go to sleep, and then their brainwave responses to various sounds are recorded.

### How often should hearing be tested?

Everyone who had cancer treatment that can affect the ears (such as cisplatin, high doses of carboplatin, any dose of carboplatin if given prior to one year of age, high doses of radiation to the brain) should have their hearing tested

at least once following completion of treatment. The need for additional testing depends on the type and dosage of cancer treatments that were used. If hearing loss is found, testing should be repeated yearly or as advised by an audiologist. In addition, hearing should be tested anytime a hearing problem is suspected.

### What can be done if hearing loss is detected?

If hearing loss is detected, it is important to have an evaluation by an audiologist or otologist (doctor who specializes in hearing disorders). Hearing loss can cause problems with a person's ability to communicate and carry out daily activities. Younger children are at higher risk for school, learning, and social difficulties, and problems with language development. It is therefore very important for a person with hearing loss to find the services that will best help to make the most of their ability to communicate well. There are many options available, and these can be used in various combinations, depending on the hearing problem.

**Hearing aids** make sounds louder. Several types are available, depending on the age and size of the person and the extent of hearing loss. Most children under 12 years of age wear a behind-the-ear model to allow for adjustments as the child grows. These are available in a variety of colors—allowing for personalization and assisting with the child's acceptance of the hearing aid. Teenagers and adults may benefit from a smaller, in-the-ear or in-the-canal model. It is very important that the hearing aid batteries are fresh and that the hearing aid is turned to the “on” position when in use.

**Auditory trainers** (also known as “FM trainers”) are devices that are particularly useful in the school setting. The person who is speaking (usually the teacher) wears a microphone that transmits sound over FM radio waves. The person with hearing loss wears a receiver that picks up the sound. This device can be worn alone or attached to the hearing aid and allows the person with hearing loss to hear the speaker clearly, even in a noisy environment.

**Other assistive devices** are also available for people with hearing loss. These include telephone amplifiers and teletypewriters (TTYs—sometimes also referred to as Telephone Devices for the Deaf or TDDs). Specialized appliances designed for people with hearing loss include alarm clocks that vibrate and smoke detectors with flashing lights. Closed captioning for television is widely available. The Internet is also a helpful communication tool for people with hearing loss, providing options such as e-mail, on-line discussions, and access to information via websites. Many cell phones now offer text messaging, instant messaging, Internet access, and photo transmission.

**Telecommunication relay services** are available in video and voice/text formats. The video relay service is internet-based and allows a person using signed language to communicate via a video interpreter, who translates the signed language into voice or text. The voice/text relay service allows a person using a teletypewriter to communicate through an operator, who then relays the message to the hearing person in spoken form.

**Cochlear implants** may be an option for people with profound hearing loss who are unable to benefit from hearing aids. These electronic devices are surgically placed behind the ear and electrodes are threaded into the inner ear. A microphone and speech processor are then used to transmit sound to the electrodes, stimulating the auditory nerve and allowing sound perception by the brain. After the cochlear implant is installed, auditory training is given for a period of time to teach the individual to recognize and interpret sounds.

**Alternate or supplementary communication methods**, including speechreading, signed language and cued speech, are available for people with significant hearing loss. Spoken language may also be an option, but usually requires an intensive educational approach with speech therapy. In the United States, healthcare organizations that receive federal funding are required to provide sign language interpreters when requested by a patient.

**Community and educational resources** in the United States include services through local public school districts or referral agencies (available under the IDEA legislation, PL 105-17), such as intensive speech therapy and auditory trainers for classroom use. Sometimes special accommodations, such as seating in the front of the classroom are all that is needed, but this usually requires that the parent request an Individualized Education Plan (IEP) for the child through the school district (see related Health Link: “Educational Issues Following Treatment for Childhood Cancer”). Many hospitals have a teacher or school liaison that can assist with arranging for the IEP and other specialized services that may be needed. The Americans with Disabilities Act (ADA, PL 101-336) guarantees people with hearing loss equal access to public events, spaces and opportunities, including text telephones and telephone amplifiers in public places, and assistive listening devices in theaters. Some theaters also offer special showings of newly released movies with captioning.

### What can I do to protect my hearing?

If you have experienced hearing loss, or have received therapy that has the potential to damage your hearing, you should discuss this with your healthcare provider. Be sure to obtain prompt evaluation and treatment for ear infections, swimmer’s ear, and earwax impaction. Whenever possible, ask your healthcare provider to consider alternatives to medications that have the potential to cause further hearing loss, including certain antibiotics (aminoglycosides such as gentamicin), certain diuretics (“loop” diuretics, such as furosemide), salicylates (such as aspirin) and medications for high iron levels. You should also take care to protect your ears from loud noises. In fact, loud noises can cause significant damage to your ears. Examples of items and activities that can be hazardous to your hearing include:

Appliances	Occupations	Recreation
Power saws	Firefighters	Hunting
Vacuum cleaners	Construction workers	Boating or water skiing
Lawn mowers	Farmers	Motorcycling or four-wheeling
Yard trimmers or leaf blowers	Airport workers	Stereo headphones
	Cab, truck, and bus drivers	Amplifiers
	Hair stylists (due to constant exposure to loud hair dryers)	

If you cannot avoid exposure to noise, you should:

- Wear hearing protectors such as ear plugs or ear muffs
- Limit periods of exposure to noise (for example, if you are at a loud concert go to a quieter area for a while to give your ears a break)
- Be aware of the noise in your environment and take control of it when you can

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Additional health information for childhood cancer survivors is available at  
[www.survivorshipguidelines.org](http://www.survivorshipguidelines.org)

**Note:** Throughout this *Health Links* series, the term “childhood cancer” is used to designate pediatric cancers that may occur during childhood, adolescence, or young adulthood. Health Links are designed to provide health information for survivors of pediatric cancer, regardless of whether the cancer occurred during childhood, adolescence, or young adulthood.

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