

How we hear

- :: Anatomy of the ear 4
- :: Hearing process 5

Explaining hearing loss

- :: Audiogram 6
- :: Conductive hearing loss 7
- :: Sensorineural hearing loss 8
- :: Neural hearing loss 9

Understanding the cochlear implant

- :: Cochlear implant systems 10
- :: How a cochlear implant works 11
- :: Benefits of cochlear implant systems 12
- :: Candidates for cochlear implant systems 13
- :: Conditions limiting cochlear implant success 14

Enhancing the Quality of Life

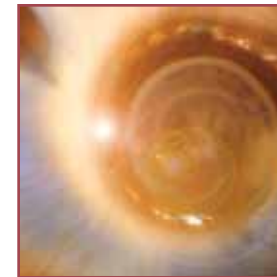
- :: MED-EL Cochlear Implant 16
- :: MED-EL Speech Processor 17
- :: Understanding speech coding strategies 18
- :: Successful results 19

The cochlear implant process

- :: Contacting a cochlear implant team 20
- :: Assessments 21
- :: Surgery 22
- :: First sounds 22
- :: Follow-up program 23

You may be wondering if a cochlear implant is the best choice for you or someone in your life. This booklet is designed to address questions you may have and offer basic information about hearing, hearing loss and the stages of the cochlear implant journey.

If you have questions or would like additional information, please contact your local cochlear implant center or MED-EL. A list of cochlear implant centers can be found on our website at www.medel.com.



How we hear

Anatomy of the Ear

Outer ear

Pinna (auricle) – collects and funnels sound into the ear canal.

Ear canal (external auditory meatus) – directs sound into the ear.

Middle ear

Eardrum (tympanic membrane) – changes sound into vibrations.

Chain of three small bones (ossicles) – hammer, anvil and stirrup (malleus, incus and stapes) – transfers vibrations to the inner ear.

Inner ear

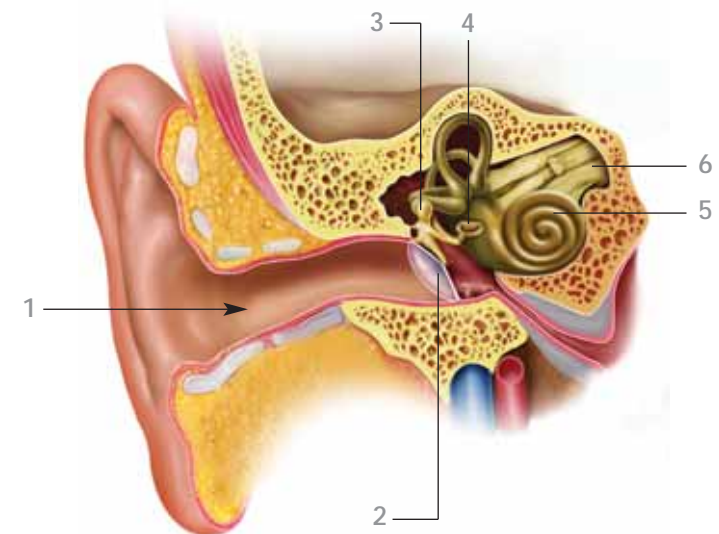
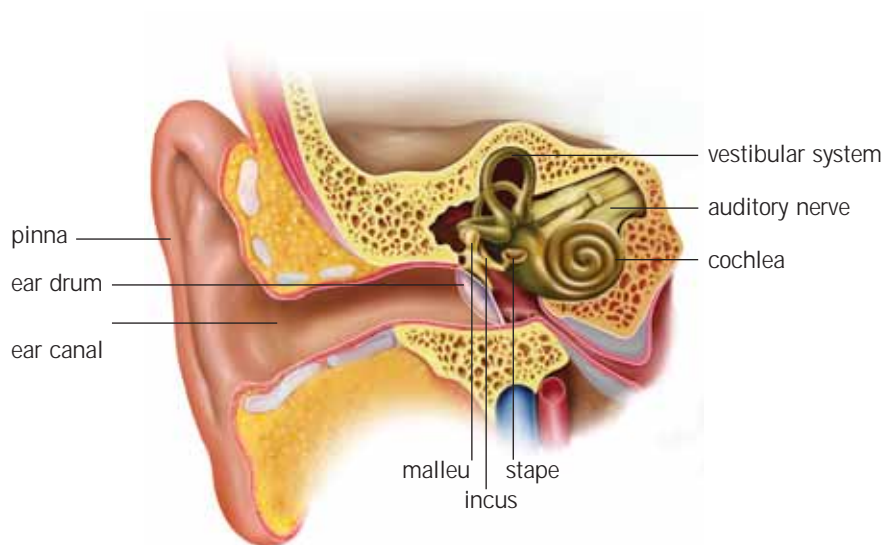
Inner ear (cochlea) – contains fluid and highly sensitive cells (hair cells), with tiny hairlike structures that move with sound vibrations.

Vestibular system – contains cells that control balance.

Auditory nerve – leads from the cochlea to the brain.

The Hearing Process

- 1 Sound funnels into the ear canal and causes the eardrum to move.
- 2 The eardrum vibrates with sound.
- 3 Sound vibrations move through the ossicles to the cochlea.
- 4 Sound vibrations cause the fluid in the cochlea to move.
- 5 Fluid movement causes the hair cells to bend. Hair cells create neural signals, which are picked up by the auditory nerve. Hair cells at one end of the cochlea send low pitch sound information, and hair cells at the other end send high pitch sound information.
- 6 The brain interprets the neural signals as sounds.



Explaining Hearing Loss

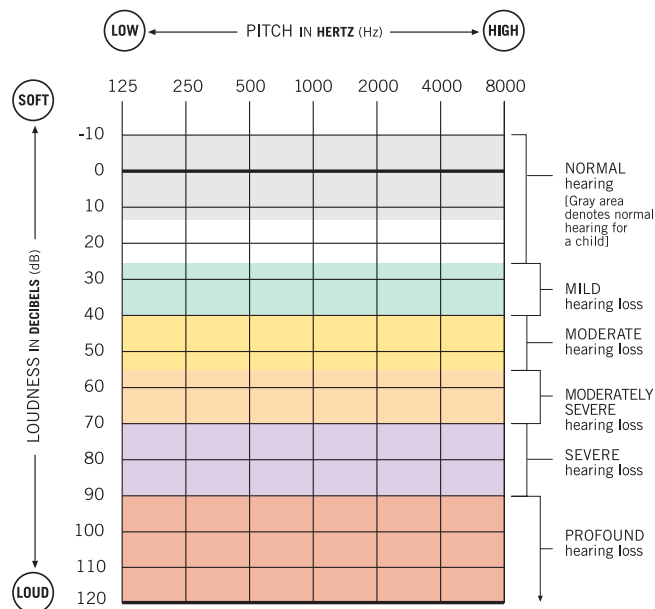
The Audiogram

Each sound has a certain pitch or frequency. Frequency is measured by the number of waves or cycles that a sound makes in a single second. The scale used to designate cycles per second (cps) is called hertz (Hz). Loudness of a sound, or intensity, is measured in units called decibels (dB).

An **audiogram** is a graph that helps illustrate usable hearing and the amount of hearing loss for each ear.

On the audiogram below, pitch or frequency of the sounds is charted from left to right (low to high pitch) by numbers at the top of the grid. Loudness or intensity of the sounds is measured from top to bottom (soft to loud).

The audiologist presents tones one frequency at a time. The softest tone a person can hear at each frequency is marked on the audiogram. This is called a hearing threshold.



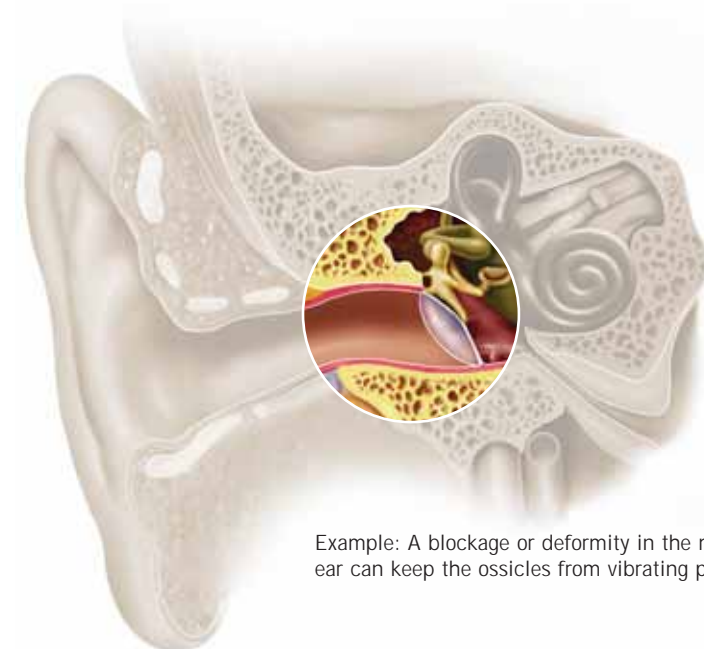
Conductive Hearing Loss

A problem in the outer or middle ear can prevent sound from moving to the inner ear and, potentially, cause a conductive hearing loss. A conductive hearing loss limits the ear from conducting sound properly.

Conductive hearing loss is usually mild or moderate (hearing loss up to 60 decibels) and can be temporary or permanent.

Conductive hearing loss may be helped by medication or surgery, depending on the cause of the problem.

Conductive hearing loss can usually be helped with hearing aids.



Example: A blockage or deformity in the middle ear can keep the ossicles from vibrating properly.

Sensorineural Hearing Loss

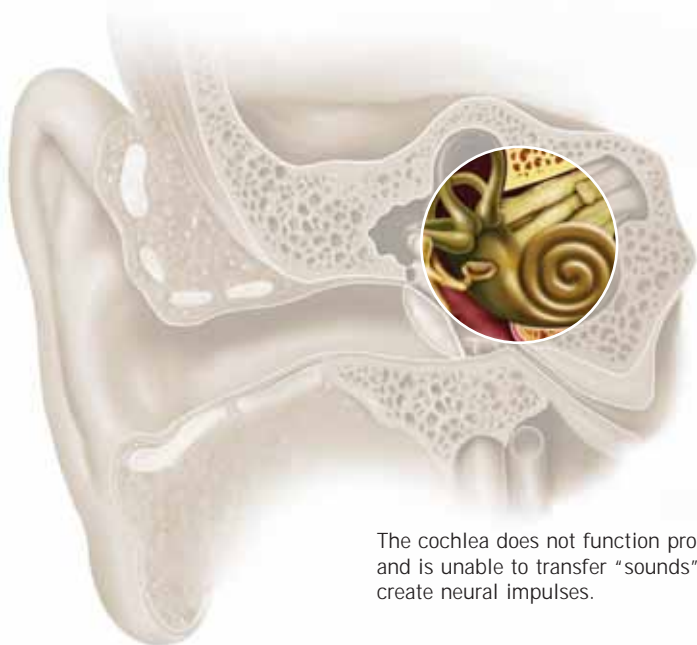
A problem in the cochlea can cause sensorineural hearing loss.

Sensorineural hearing loss can be mild, moderate, severe, or profound and is usually permanent.

Surgical procedures cannot **cure** sensorineural hearing loss. Medication may be helpful in some cases.

Mild to severe sensorineural hearing loss can usually be helped with hearing aids.

Severe or profound hearing loss can usually be helped with cochlear implants.



The cochlea does not function properly and is unable to transfer "sounds" to create neural impulses.

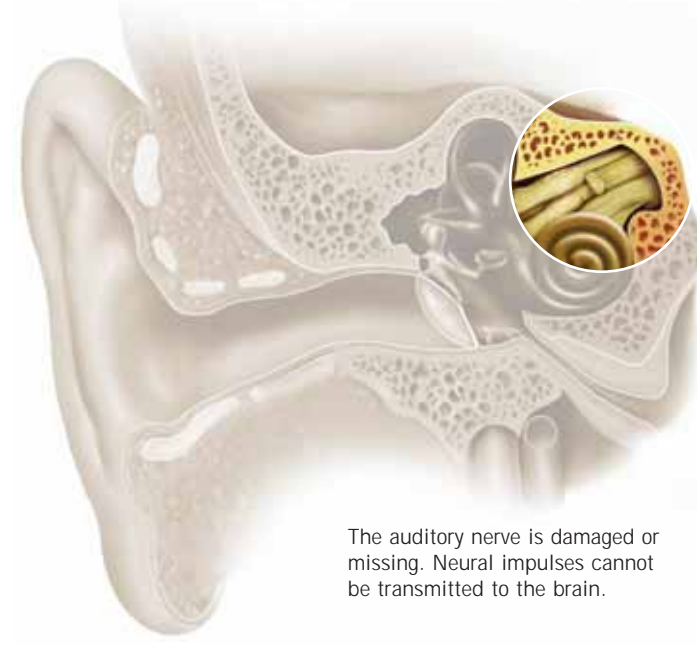
Neural Hearing Loss

A problem that results in the absence of or damage to the auditory nerve can cause a neural hearing loss.

Neural hearing loss is a profound hearing loss and is permanent.

Hearing aids and cochlear implants cannot help neural hearing loss, because the auditory nerve is not able to pass on enough sound information to the brain.

Auditory brainstem implants may help in some cases.



The auditory nerve is damaged or missing. Neural impulses cannot be transmitted to the brain.

Understanding the Cochlear Implant

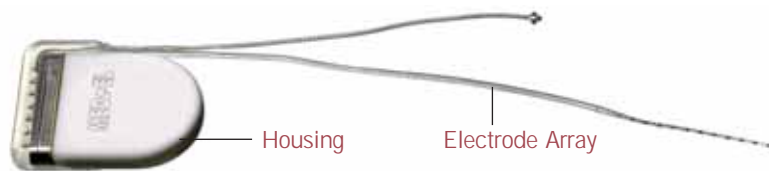
Cochlear Implant System

A cochlear implant system is a medical option for individuals with severe to profound sensorineural hearing loss, when hearing aids provide limited or no benefit.

A cochlear implant system has two main parts:

INTERNAL

- **Implant*** - (surgically placed under the skin)
Consists of the electronics housing and the electrode array



EXTERNAL

- **Speech processor** - (worn behind the ear)
Contains the microphone, loudness and sensitivity controls
- **Cable and Transmitting Coil**
- **Battery Pack**

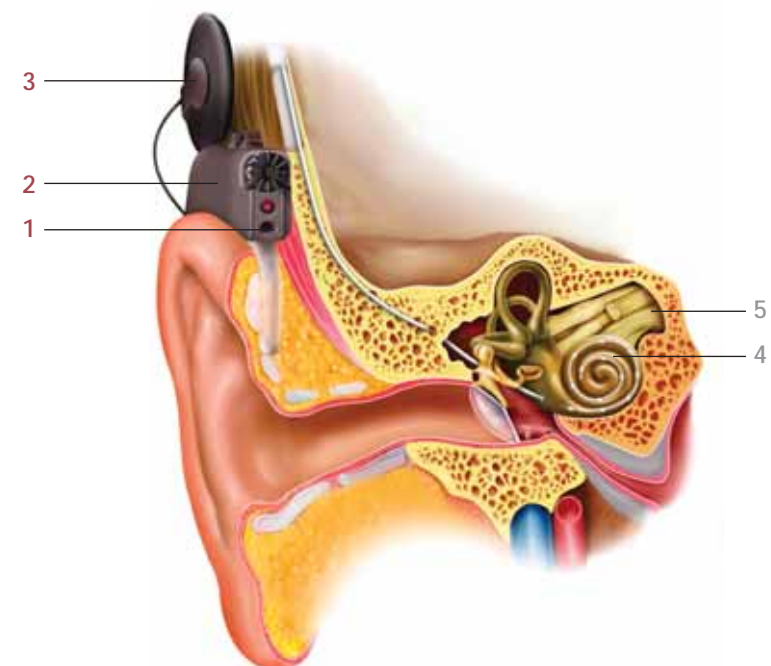


A speech processor program (**map**) controls pitch, loudness and timing. Maps are customized for each cochlear implant user's listening needs during "fitting sessions" with an audiologist.

How a Cochlear Implant Works

Cochlear implant systems convert everyday sounds into coded electrical pulses. These electrical pulses stimulate the auditory nerve, and the brain interprets the pulses as sound (see diagram). The brain receives sound information within microseconds, so sounds are heard as they occur.

- 1 Sound is picked up by the microphone of the speech processor.
- 2 The speech processor analyzes and converts sounds into a special code.
- 3 This code is sent to the coil and transmitted across the skin to the implant.
- 4 The implant interprets the code and sends electrical pulses to the electrodes in the cochlea.
- 5 The auditory nerve picks up this signal and sends it to the auditory center in the brain. The brain recognizes these signals as sound.



*Rx only

Benefits of a Cochlear Implant

Cochlear implants enhance auditory information, including speech, environmental sounds and music. Current studies indicate successful speech understanding for the majority of cochlear implant users.

Hearing everyday sounds

Nearly all cochlear implant users hear environmental sounds, keeping them in touch with their surroundings – including traffic, sirens, alarms, etc.

Hearing speech

The majority of cochlear implant users hear speech sounds. With time and an effective follow-up program (see p.22), they learn to understand these sounds. Many cochlear implant users understand speech without speechreading.

Improving speech skills

Hearing speech sounds helps refine a cochlear implant user's own speech skills.

Phone use

Many cochlear implant users effectively use standard and cell phones.

Factors affecting benefit

Maximum benefit from a cochlear implant depends on a variety of factors, including age, duration of hearing loss, status of the cochlea, and other medical and personal issues.



Candidates for Cochlear Implant Systems

Cochlear implants* are an accepted medical option for children and adults.

General candidacy criteria

- :: For children, a profound sensorineural hearing loss in both ears
- :: For adults, a severe to profound sensorineural hearing loss in both ears
- :: Age 12 months and older
- :: Receive little or no benefit from hearing aids
- :: No medical contraindications
- :: High motivation and appropriate expectations
- :: Access to education and rehabilitation follow-up

Conditions Limiting Cochlear Implant Success

Cochlear implant systems have been used successfully by thousands of people worldwide, but there are situations when a cochlear implant system may not be appropriate. Some factors include:

Hearing is "too good"

If hearing aids provide good speech understanding, they may be a better option.

Profound hearing loss for a very long time

If an individual is born with a profound hearing loss or has been deaf for many years, the auditory nerve may not effectively carry sound information to the brain. Optimal benefit of a cochlear implant may not be possible.

Neural hearing loss

If the site of hearing loss is the auditory nerve, a cochlear implant cannot help.

Cochlear malformations

If the cochlea is absent or not fully formed, it may not be possible to surgically place a cochlear implant.

Medical problems

If an individual is not healthy enough to tolerate anesthesia and surgery or participate in the follow-up programs, a cochlear implant may not be advisable.

Inappropriate expectations

If individuals and families have unrealistic expectations, results may be disappointing.

Lack of support from family or caregivers

If support from family and caregivers is not available, success with a cochlear implant system may be compromised.

*Rx only

Enhancing the Quality of Life

MED-EL offers a research heritage spanning 30 years, and is currently pioneering cochlear implant technology and research worldwide. Cochlear implant users in over 70 countries benefit from the advanced technology of MED-EL Cochlear Implant Systems. These systems are designed according to the highest safety and reliability standards and integrate the latest technological advancements.

PULSAR_{CI}¹⁰⁰ Cochlear Implant

Thin implant profile

This is especially important for young children.

Soft electrode array

The small diameter and soft, flexible electrode minimizes trauma to the delicate structures of the cochlea.

Deep electrode placement

Deep electrode insertion provides a range of sounds that are important for optimal speech understanding.

Electrode options

MED-EL offers electrodes designed for special conditions – such as ossification or cochlear malformations to meet the special needs of many cochlear implant users.



MED-EL's assortment of electrode arrays:
(L-R) Standard, Medium, Compressed, and Split

UNDERSTANDING COCHLEAR IMPLANTS

TEMPO+ BTE Speech Processor

MED-EL's TEMPO+ Speech Processor is a compact BTE (behind-the-ear) unit that provides excellent performance with maximum comfort and convenience during daily activities.



Unique flexible wearing options for all ages

All five wearing options are lightweight and secure enough for babies and robust enough for the most active user.

Unique wearing options for children, such as the BabyBTE™, are available to meet young children's special needs.

Child-friendly features

Special safety features for children – such as lockable earhooks, tamper-proof battery packs and an indicator light – give parents a peace of mind.

Never without sound

With battery pack options for use with readily available disposable or rechargeable batteries, the TEMPO+ can be powered anywhere, any time.

Less expensive to operate

MED-EL TEMPO+ Speech Processor is the most power-efficient and cost-effective BTE available. Batteries usually last 3 to 5 days.

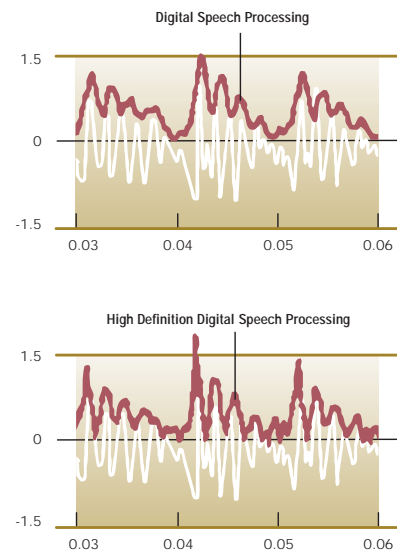
Understanding Speech Coding Strategies

A speech processing strategy, or speech coding strategy, is a code that converts sound waves into patterns of electrical pulses. These electrical pulses are generated by the implant to stimulate the auditory nerve via an electrode array within the cochlea. There are two ways to process sound, analog stimulation and digital stimulation.

Analog stimulation uses waveforms to activate electrodes at the same time. Digital stimulation uses a series of pulses to represent sound. In general, digital stimulation is more power-efficient, more flexible, and is less likely to result in sound distortion.

Most of today's electronic devices – from cellular telephones to televisions – use digital technology. For the most part, today's cochlear implant systems also use digital technology to process sound.

The TEMPO+ BTE speech processor uses an advanced mathematic algorithm – the **Hilbert Transform** – to provide High Definition Digital Signal Processing. The Hilbert Transform tracks incoming sounds more closely than other processes and allows more accurate representation of sound.



Successful Results

Recent clinical studies report successful results with the MED-EL Cochlear Implant System:

A comparative study with various cochlear implant systems indicates that the MED-EL TEMPO+ provides excellent performance on measures of speech perception in quiet and in noise.¹

In a "Quality of Life" survey, **84%** of adult MED-EL cochlear implant users report that their cochlear implant 'quite positively' or 'very positively' affects their lifestyle.

A recent telephone study indicates that the majority of MED-EL cochlear implant users (**85%**) are able to use a standard or cellular telephone.²



¹ Spahr AJ, Dorman MF. (2003). A comparison of performance among patients fit with the CII HI-Resolution, 3G and TEMPO+ processors. Poster presentation at the Conference on Implantable Auditory Prostheses, August 17-22, Pacific Grove, CA.

² Adams JS, Hasenstab MS, Pippin GW, Sismanis A. (2004). Telephone use and understanding in patients with cochlear implants. *Ear Nose Throat J.*;83(2):96, 99-100, 102-3.

Cochlear Implant Process

Contacting a Cochlear Implant Team

Cochlear implant surgery and follow-up takes place at special cochlear implant centers. Cochlear implant candidates may be referred to a center by primary care physicians (PCP) or Ear, Nose and Throat specialists (ENT). Cochlear Implant Team members may include:

Audiologists	Hearing evaluation, processor fitting, programming and follow-up
ENT Specialists/Surgeons	Medical evaluation, surgery, post-op care
Speech & Language Therapists	Speech and language evaluation, rehabilitation and support
Educational Specialists/Teachers	Educational environment evaluation, learning style and rehabilitation options
Educational Psychologist	Psychological evaluation, family expectations and support system
Social Worker	Family and patient expectations, guidance
Implant Team Coordinator	Coordinates evaluations and other activities of the team
Administrative Staff	Insurance, billing, reimbursement assistance

Assessment

Cochlear implant candidates undergo tests before surgery that help the Cochlear Implant Team:

- ∴ Identify specific conditions or needs of the candidate and family
- ∴ Explain benefits and set appropriate expectations for the candidate and family

Assessment includes evaluation and testing in the following areas:

Audiological

- ∴ Hearing levels with and without hearing aids
- ∴ Auditory nerve function

Medical

- ∴ Cause of hearing loss
- ∴ Ear health
- ∴ General health

Radiological

- ∴ CT and/or MRI studies

Psychological

- ∴ Attitudes and concerns about surgery
- ∴ Attitudes and concerns about follow-up
- ∴ Expectations

Speech & Language

- ∴ Speech and language development and performance

Educational

- ∴ Educational needs and rehabilitation

Surgery

Surgery usually takes between 2 and 4 hours. The risks of cochlear implant surgery are small and are similar to other ear surgeries.

- ∴ A general anesthetic is usually given.
- ∴ The hair is shaved in the area where the incision is to be made.
- ∴ An incision is made. (Fig. A)
- ∴ A "bed" is made in the mastoid bone behind the ear. The implant will be placed in this bed.
- ∴ An opening is made into the cochlea.
- ∴ The electrode array is inserted into the cochlea.
- ∴ The electrode array and the implant are secured in place.
- ∴ The electrode function is tested.
- ∴ The incision is closed.
- ∴ There is usually some discomfort after surgery. Pain medication can be given if necessary. Patients are usually up and about the next day. The hospital stay depends upon local practice and can be as short as one day.

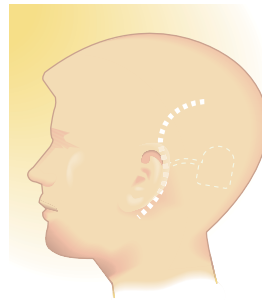


Fig. A ∴ An example of an incision site. Procedures may vary among surgeons.

First Sounds - Initial Programming

The speech processor is programmed 3 to 6 weeks after surgery. Special software is used to create unique programs (maps) for each cochlear implant user.

To program the speech processor:

- ∴ The speech processor and coil are correctly placed on the cochlear implant user's ear and head.
- ∴ The speech processor is linked to the clinic computer.
- ∴ The audiologist uses the clinic computer software to generate sound signals at carefully controlled levels.
- ∴ The cochlear implant user indicates **1**) the quietest sound heard (**threshold** level) and, **2**) the loudest comfortable sound heard (**most comfortable** level).
- ∴ These two levels are measured for all electrodes in the cochlea.
- ∴ The audiologist adjusts other auditory parameters for comfort and effective listening.
- ∴ A program (**map**) is created.



Child wearing the Remote Battery Pack option, one of the five wearing options with MED-EL's Speech Processor

Follow-up Programming

During follow-up programming, the audiologist makes modifications and improvements to the program (map) to provide the greatest listening benefit.

Cochlear implant users must be committed to the follow-up program in order to attain optimal performance. The follow-up schedule depends on local practices. Services may include:

Help, advice and support

Assistance for technical issues, answers to questions, and information on support groups for cochlear implant users and their families

Regular medical follow-up

Implant site checks by a physician and medical care if problems arise

Regular re-programming of the speech processor

Scheduled re-programming of the speech processor to ensure that the implant is functioning properly and that the map remains optimal

Speech and language therapy

Speech and language therapy options and aural rehabilitation, especially for children

Educational advice and support (for children)

Contact with educational specialists qualified to work with deaf or hard-of-hearing children

hearLIFE

At MED-EL, a commitment to research, innovative technology and superior customer service are some of the details that have defined our mission for the past three decades.

By providing a new world of hearing, MED-EL cochlear implants are helping to enrich the lives of children and adults in over 70 countries worldwide.

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Understanding Cochlear Implants



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