



Understanding Cochlear Implants



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



If you have any questions or would like further 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

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How We Hear

Anatomy of the Ear

There are three main parts of the ear:

A The outer ear

Ear (pinna) – collects and funnels sound into the ear, and helps us to tell where the sound is coming from.

Ear canal (external auditory meatus) – acts as a channel for sound.

B The middle ear

Ear drum (tympanic membrane) – is like the skin of a drum, turns sounds into vibrations.

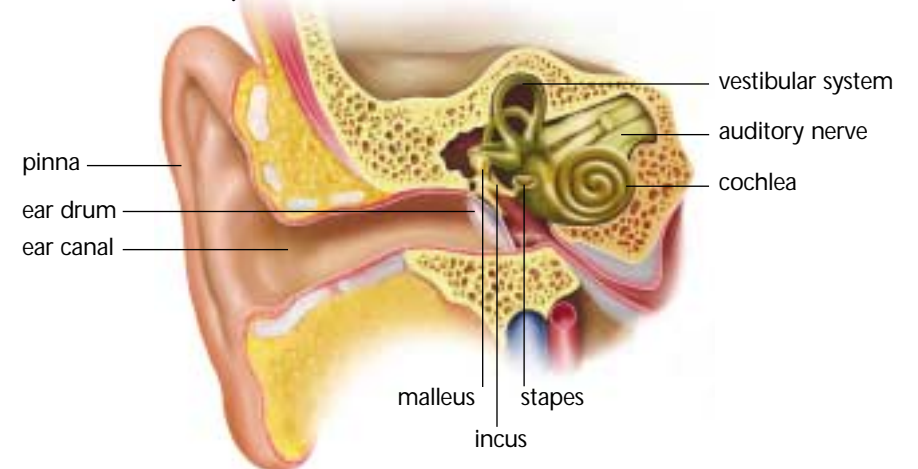
A chain of 3 small bones (ossicles) – the hammer, anvil and stirrup (also known as malleus, incus and stapes) – these bones pass vibrations on to the inner ear.

C The inner ear

The inner ear (cochlea) – is snail-shaped and filled with fluid. It contains highly sensitive cells, known as hair cells, which have a tiny hairlike structure on the top of each cell. These hair cells play a very important part in enabling us to hear.

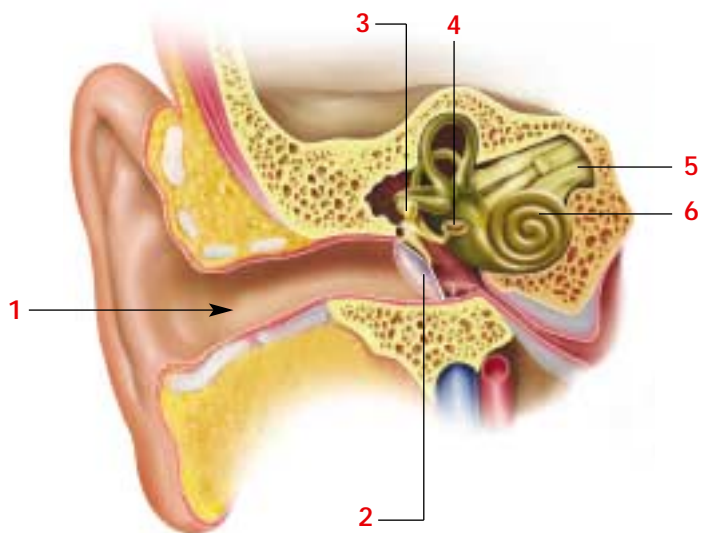
The vestibular system – contains delicate cells that control our sense of balance.

The auditory nerve – leads from the cochlea to the brain.



The Hearing Process

- 1 Sound travels down the ear canal and hits the eardrum.
- 2 Like the skin of a real drum, the eardrum vibrates when sound hits it.
- 3 Vibrations are passed down the chain of bones to the cochlea.
- 4 These vibrations cause the fluid in the cochlea to move.
- 5 This movement causes the hair cells to move. When this happens, the hair cells create electrical 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 electrical signals as sounds.



HOW WE HEAR



Why people have hearing difficulties

Conductive hearing loss

Any problem in the outer or middle ear can block sound to the ear and cause a conductive hearing loss (so called as it stops the ear from conducting sound properly).

Conductive losses are usually mild or moderate in nature, causing hearing loss of up to about 60 or 70 decibels.

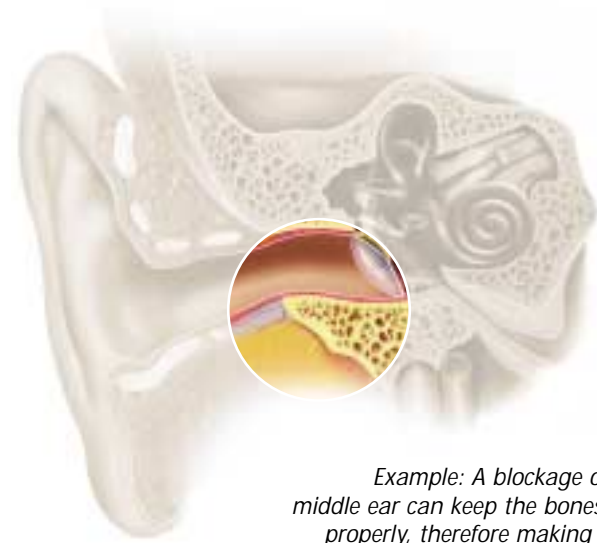
Conductive hearing losses can be temporary in some cases.

In many cases, medication or surgery can help, depending on the cause of the problem.

This type of hearing loss can usually be helped very well with hearing aids.

Conductive hearing loss is due to:

a problem in the outer or middle ear



Example: A blockage or deformity in the middle ear can keep the bones from functioning properly, therefore making it difficult to hear.

Sensorineural hearing loss

A problem in the inner ear can cause a sensorineural hearing loss.

This can be a mild, moderate, severe, or profound hearing loss.

Sensorineural losses are usually permanent.

There is no surgical procedure to cure problems in this part of the ear. Depending on the cause, medication may be helpful in some cases.

Hearing aids can usually help in mild to severe hearing loss.

Cochlear implants can be a very effective option for persons with severe, or profound hearing loss.



The cochlea does not function properly and is unable to change sounds into the electrical pulses that the auditory nerve needs.

Neural hearing loss

In very rare cases, hearing loss may be caused by the absence of or damage to the auditory nerve, resulting in a neural hearing loss.

Hearing aids will provide little benefit, because the nerve is not able to pass on enough information to the brain.

Without sufficient auditory nerve function, a cochlear implant will not help.

An auditory brainstem implant may help in some cases.



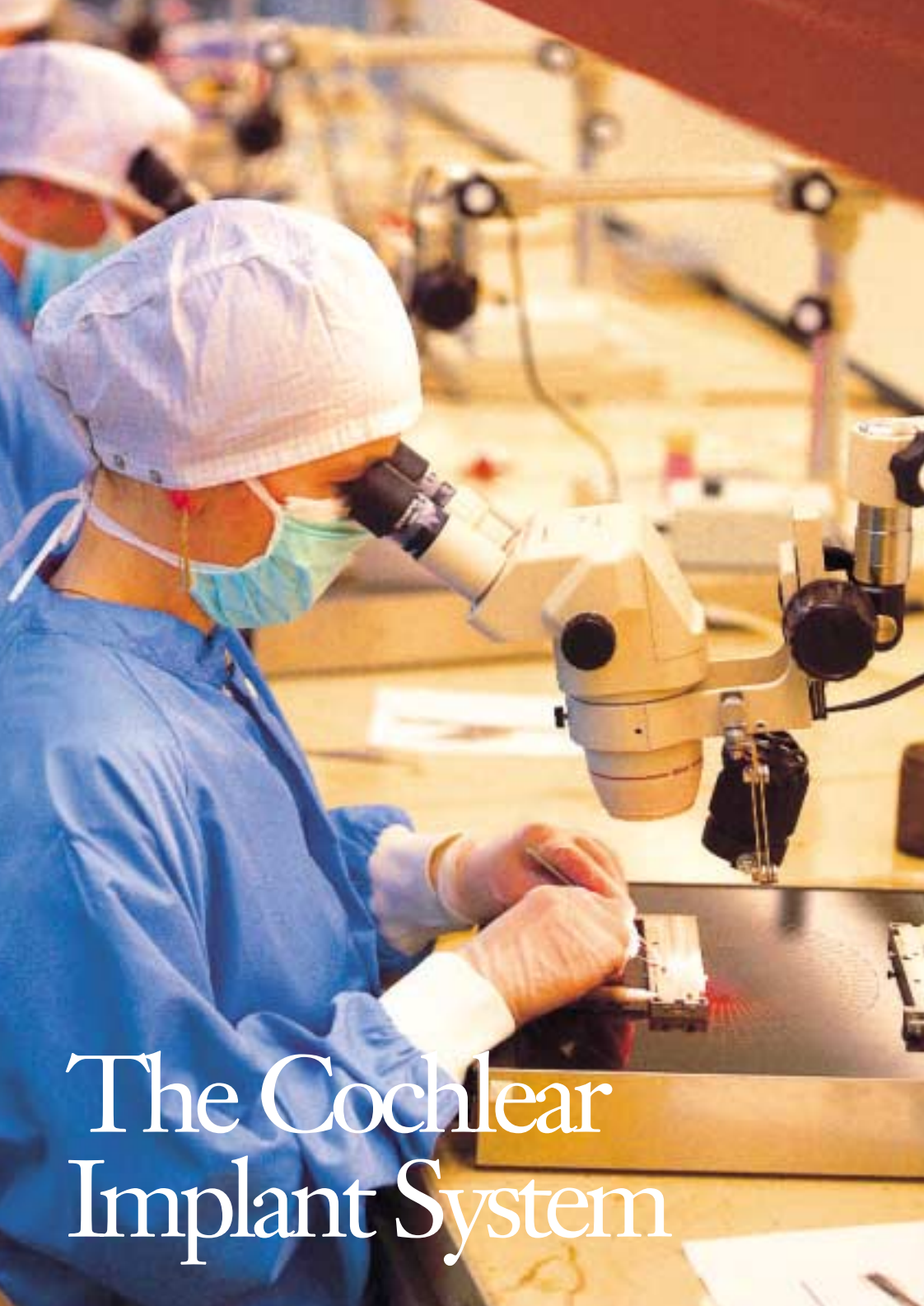
The auditory nerve is damaged or missing. Electrical signals cannot be passed along to the brain.

Neural hearing loss is due to:

a problem in the neural pathway

Sensorineural hearing loss is due to:

a problem in the inner ear (cochlea)



The Cochlear Implant System

What is a cochlear implant?

A cochlear implant is an electronic device designed to help individuals with severe to profound hearing loss who gain little or no benefit from hearing aids.

Cochlear implant systems convert everyday sounds into coded electrical impulses. These electrical pulses stimulate the hearing nerve, and the brain interprets them as sound.

A cochlear implant system consists of two main parts:

- The part that is surgically placed under the skin is called the **implant**.

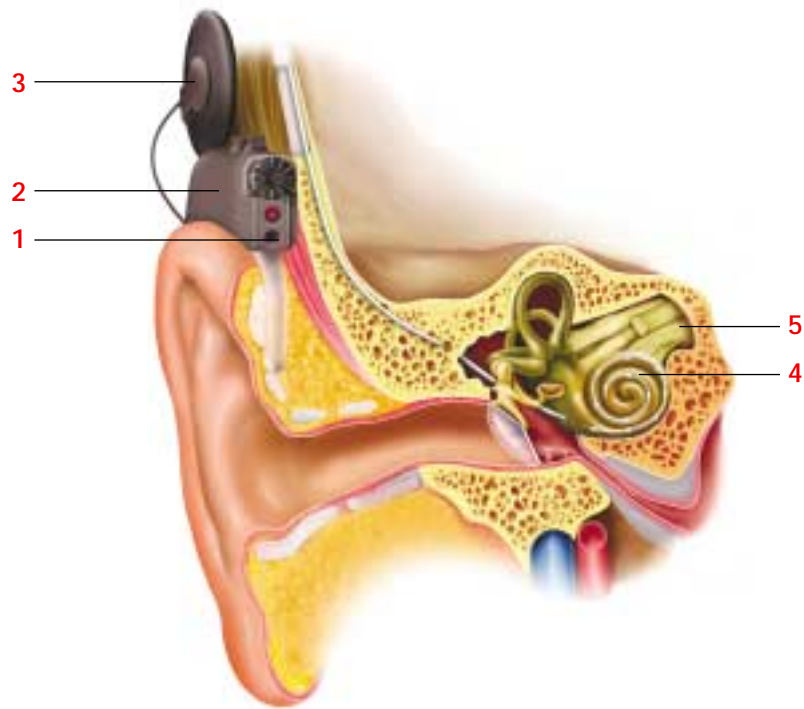


- The external part known as the **speech processor**.



How a cochlear implant works

- 1 Sounds are picked up by the microphone transmitted to the speech processor via the cable.
- 2 The signal is then “coded” (turned into a special pattern of electrical pulses).
- 3 These pulses are sent to the coil and are then transmitted across the skin to the implant.
- 4 The implant sends a pattern of electrical pulses to the electrodes in the cochlea.
- 5 The auditory nerve picks up these electrical pulses and sends them to the brain. The brain recognizes these signals as sound.



Who can benefit from a cochlear implant?

Both children and adults can use cochlear implants effectively, regardless of whether they are born with a severe or profound hearing loss or experience hearing loss later in life.

It is not possible to predict how beneficial a cochlear implant will be for each individual, but the following points are widely recognized:

- Because hearing is important for children’s language development, implantation at a young age is preferred.
- Persons with memory of speech and language may receive more benefit from a cochlear implant.
- The longer the period of profound hearing loss, the more limited the benefits are likely to be.

What are the benefits of cochlear implants?

Results reported with today’s cochlear implants consistently indicate speech understanding for the majority of implanted patients. Benefit from a cochlear implant is most readily measured within the scientific community by the percentage of speech a cochlear implant user can understand in a laboratory setting without lip-reading. Although open-set speech understanding is a very important measure of hearing ability, it is by no means the only benefit cochlear implant users report. The perception of environmental sounds, door bells, music, birds or alarm signals of various kinds can make a substantial difference in the life of a severely hard-of-hearing person.

Why might a cochlear implant not be suitable?

While cochlear implant systems have been used successfully by thousands of people worldwide, there are a number of situations which may make a cochlear implant (CI) system inappropriate for a particular individual. Some of these factors include:

Hearing is “too good”

If well-fitting hearing aids provide a person with enough speech understanding, then this is likely a better option than a CI system.

Profound hearing loss for a very long time

If the auditory nerve has never been stimulated or has not been stimulated for a very long time, it may not be able to pass sound information to the brain very well.

The cochlea is not the main cause of hearing loss

A cochlear implant cannot help if the main problem lies elsewhere than in the inner ear. (see p. 11)

Surgery is not likely to be successful

If the cochlea is in poor condition and cannot receive the electrode, or the auditory nerve is damaged or absent, a cochlear implant is unlikely to provide benefit.

Medical problems

A patient needs to be healthy enough to tolerate the anesthetic and recover from the surgery. It is also essential that the patient is able to undergo the necessary follow-up programs and wear the external parts of the device.

Inappropriate expectations

It is essential for patients and their families to have realistic expectations of the likely benefits of the CI system.

Lack of support from family or care-givers

Support from family and care-givers is a very important factor in the success of a CI system. In the case of children with cochlear implants, such support is vital.

Other considerations

Prediction of benefit

There is no method yet available to predict precisely how much benefit a person will attain. This is discussed in "Who can benefit from a CI?" (see p. 15).

Everyday precautions

While CI systems are generally easy to use, certain precautions should be taken:

- Keep the external parts of the device dry
- Reduce exposure to static electricity
- Radio waves (e.g. mobile phones) can cause some temporary interference with the sound for some users
- Sports such as boxing and others that may result in severe blows to the head are not advised

Risk of device failure

Like any electronic device, there is a small risk that the implant could eventually stop working. This occurs very rarely. In such cases, re-implantation with a new implant has been highly successful.

Enhancing Quality of Life

With a research heritage spanning over 25 years, MED-EL is pioneering cochlear implant technology and research worldwide. Users in over 60 countries are already benefiting from the advanced technology of the MED-EL COMBI 40+ Cochlear Implant System. Designed according to the highest safety and reliability standards, the COMBI 40+ integrates the latest technological advancements while leaving options open for future technologies.

COMBI 40+ Implant

Thinnest implant available

Not noticeable, does not protrude – especially important for small children.

Preserves options for future technologies

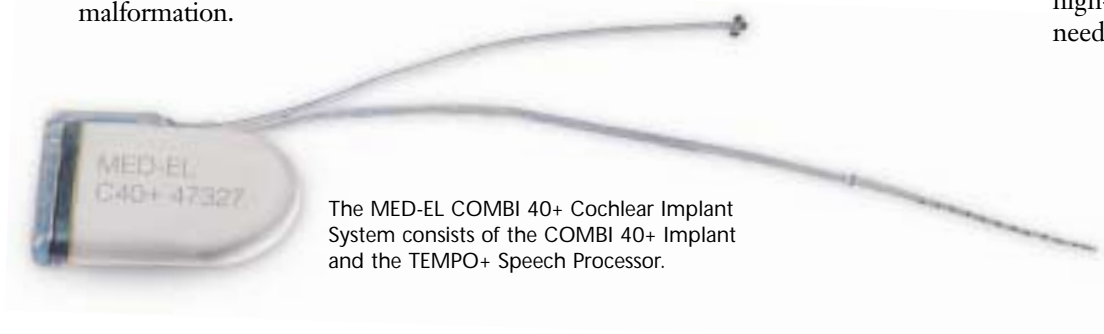
Small-diameter, soft and flexible electrode is designed to minimize trauma to the delicate structures of the cochlea. This is critically important because trauma to the cochlea may increase the potential for future problems and restrict access to future technological upgrades.

More natural range of sound

Deep electrode placement provides access to a wide range of high and low frequency sounds important for optimal speech understanding.

Electrode options for special cases

MED-EL provides electrodes for cochlear ossification or malformation.



The MED-EL COMBI 40+ Cochlear Implant System consists of the COMBI 40+ Implant and the TEMPO+ Speech Processor.

TEMPO+ BTE Speech Processor

The TEMPO+ is a compact BTE (behind-the-ear) speech processor that achieves superior results while providing users maximum comfort and convenience in daily life.

For all candidates

Candidates know before surgery that they can use a BTE.

Unique flexible wearing options for all ages

MED-EL provides a wide variety of wearing options that are lightweight and secure enough for babies but robust enough for even the most active user. Unique wearing options for children, such as the Baby BTE, are available to meet children's special needs.

Child-friendly features

The TEMPO+ includes special safety features for children such as lockable earhooks, battery packs and a status light.

Never without sound

Med-El provides the option of a second TEMPO+ speech processor to each user as a backup system. In addition, a battery pack that can be powered by either rechargeable batteries or readily available AA batteries is included.

Less expensive to operate

The TEMPO+ is the most power-efficient and cost-effective high-rate BTE available. Users enjoy 3-5 days of use before needing to replace batteries.



CIS+ Speech Processing Strategy

Speech processing strategies are complex programs that convert the sounds picked up by the speech processor into electrical signals to be sent to the implant. A correct implementation of speech processing strategies is essential for optimal results.

The TEMPO+ implements the CIS+ speech processing strategy and includes the **Hilbert Transformation**, an advanced technical feature that provides a more accurate representation of incoming sound.

The philosophy behind CIS+ is to give users access to a wide range of auditory stimulation – much like the auditory perceptual process of the normal hearing ear. Instead of limiting the amount of information as in other strategies, CIS+ provides all the incoming information to the auditory nerve. The result is an expanded frequency range and a more accurate representation of the very rapid and often subtle changes in spoken language and music. CIS+ is also fully flexible. Stimulation parameters can be adapted to each patient's individual needs.

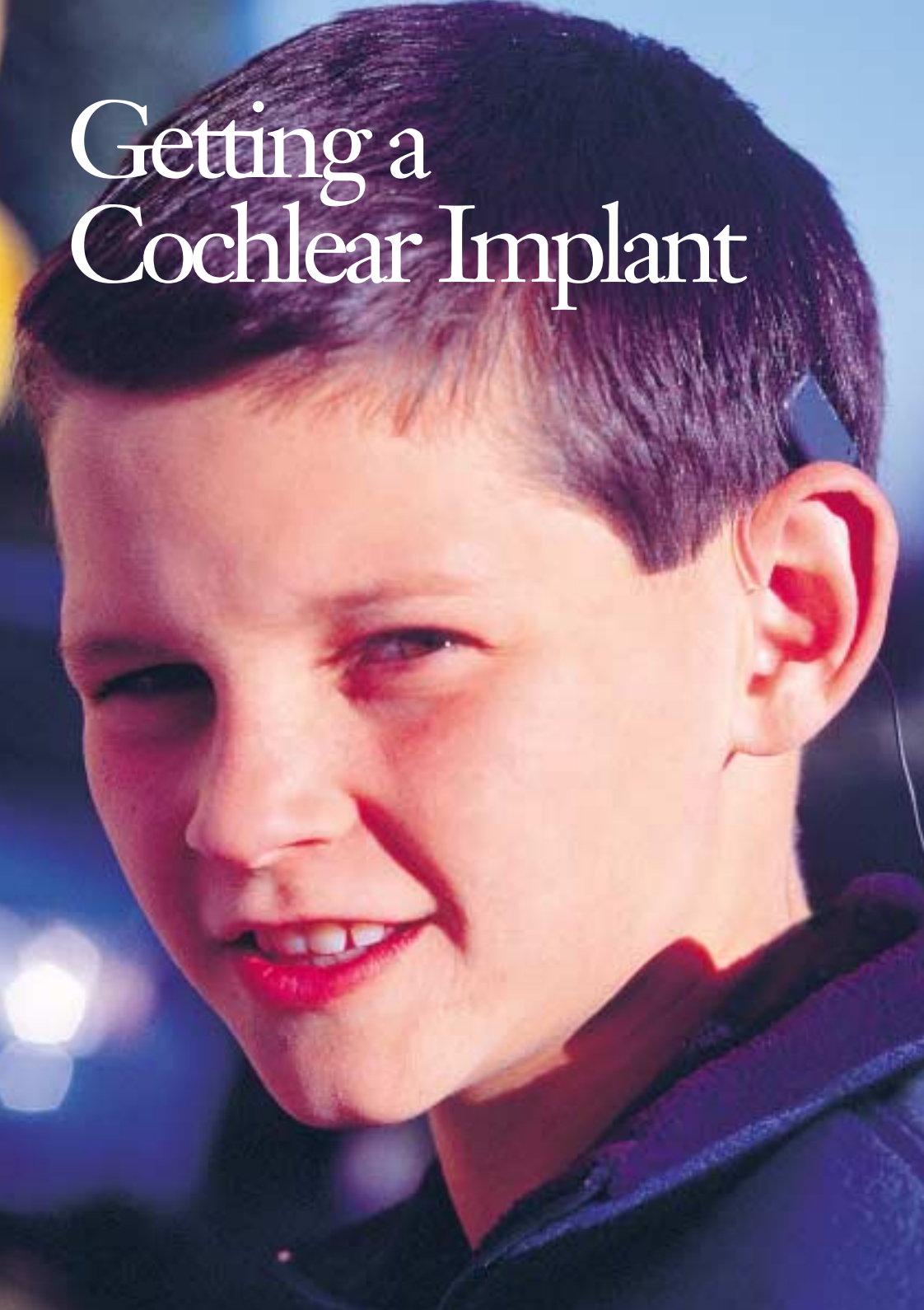
Superior Results

A recent clinical study demonstrated superior results with the COMBI 40+ Cochlear Implant System:

- **100%** of children demonstrated improvements in their MAIS score.
- **95%** of children ages 5-18 frequently or always responded to their name in quiet.
- **84%** of adult subjects reported that the system has 'quite positively' or 'very positively' affected their lifestyle.
- After only six months, adults with hearing losses of up to 25 years demonstrated a mean score of **86%** on CUNY in quiet.



Getting a Cochlear Implant



Contacting a CI Team

Cochlear implantation is performed at special cochlear implant (CI) centers. Patients are commonly referred to a CI center by their local physician or ENT (Ear, Nose and Throat) doctor.

Cochlear Implant Team members may include:

| | |
|------------------------------|---|
| ENT specialist | <i>Medical evaluation</i> |
| Audiologists | <i>Evaluation of hearing abilities, processor fitting, programming and follow-up</i> |
| Surgeons | <i>Medical evaluation, surgery, post-op care</i> |
| Speech & Language Therapists | <i>Evaluation of speech and language status, rehabilitation and support</i> |
| Educators/Teachers | <i>Evaluation of educational environment, learning style and rehabilitation options</i> |
| Educational Psychologist | <i>Evaluation of psychological status, family expectations and support system</i> |
| Social Worker | <i>Family and patient expectations</i> |
| Implant Team Coordinator | <i>Coordinates evaluations and other activities of the team</i> |
| Administrative Staff | <i>Oversees insurance billing and provides insurance reimbursement assistance</i> |

Assessments

Cochlear implant candidates undergo a number of routine assessments prior to surgery. These enable the Cochlear Implant Team to:

- Identify any additional conditions or needs
- Help the candidate establish appropriate expectations

Audiological

- Evaluation of hearing levels with and without hearing aids, for tones and for speech
- Test of auditory nerve function

Medical

- Evaluation of cause of hearing loss
- General health
- Condition of the ears

Radiological

- CT and/or MRI scan of the ears

Psychological

- Psychological ability to cope with operation
- Ability to cope with follow-up program

Speech & Language

- Assessment of stage of speech and language development

Educational

- Assessment of educational needs

Surgery

The operation usually takes between 2 and 4 hours. The risks involved in cochlear implant surgery are small and compare well with other ear surgeries.

- 1 A general anesthetic is normally given.
- 2 The hair is shaved in the area where the incision is to be made.
- 3 Incision is made.
- 4 A bed is made in the mastoid, the bone behind the ear, for the implant.
- 5 An opening is made into the cochlea.
- 6 The electrode array is inserted into the cochlea.
- 7 The electrode array and the implant are secured in place.
- 8 Electrode function is tested before the incision is closed.
- 9 There is usually mild discomfort when the patient wakes up. Pain medication can be given if required.
- 10 Patients are usually up and about the next day. The length of stay in the hospital depends upon local practice and can be as short as one day.

First sounds

The speech processor is fitted 3 to 6 weeks after surgery, and is set up individually for each user.

To program the processor for the user:

- The user wears the processor
- The processor is attached to the clinic computer
- The clinic computer generates signals at carefully controlled levels
- The user indicates:
 - The quietest signal heard (**threshold** level)
 - The loudest comfortable signal heard (**most comfortable** level)
- These two levels are measured for all electrodes in the cochlea
- Using this information, a program is created which allocates sounds between these two levels and ensures that sounds are loud enough to hear but not uncomfortably loud
- The program is fine-tuned during following clinic sessions



MED-EL DIB (Diagnostic Interface Box)
used for fitting sessions

Follow-up program

In order to attain the greatest benefit, CI users need to be fully committed to the follow-up program designed by the Cochlear Implant Team. The follow-up program will depend on local practices but may include:

Help, advice and support

Assistance should be available not only for technical matters which may arise, but also for general questions. The team can also give you information on support groups for cochlear implant users and their families.

Regular medical check-ups

The implant site should be checked regularly by a physician.

Regular re-programming of the speech processor

CI users should visit their clinic regularly for re-programming of the speech processor. This allows the audiologist to ensure that the implant is continuing to function properly. The audiologist can also make any small modifications or improvements to the program so that the user will continue to attain the greatest benefit.

Speech and language therapy

Regular speech and language therapy is usually recommended, especially for children.

Educational advice and support (for children)

Children using cochlear implants usually have regular contact with an educational specialist qualified to work with the deaf or hard-of-hearing. An educational specialist can offer advice and support as well as monitor the child's process.

Dedicated, Professional Customer Support Team

MED-EL is committed to enhancing quality of life by providing outstanding support.

Our dedicated team of support staff is available to cochlear implant recipients, audiologists and surgeons



Technology for Life

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