Parent Guide

Cochlear Implants  Hearing Loss  Options for Your Child
BabyBTE  BRIDGE to Better Communication Program
Bilateral Implantation  Audio Processors  Long-term Care
and Commitment  Complete Cochlear Coverage BabyBTE
About Arin G and Arin G Loss
Why Hearing is Important

The sense of hearing is precious. For young children, hearing is important for the development of language, social and learning skills. Hearing lets people enjoy music and gives them an awareness of the world of sound all around them.

Hearing also warns of approaching danger. The perception of warning sounds such as alarm signals, traffic sounds, or sirens helps people to react quickly and safely to many situations in the environment.

Being able to hear adequately reduces the effort required to concentrate during communication. Children that grow up with sound have greater access to educational opportunities. Later in life, good hearing is also important for a successful professional life.

Hearing means independence.
You Are Not Alone

Learning that your child has been diagnosed with hearing loss can be a challenging experience. You may be confronted with new situations and decisions. Take heart, you are not alone. Specialists including physicians, pediatric audiologists and speech therapists can give you professional advice. Support groups can give you emotional assistance as well as practical advice for daily life with a hearing loss. Use the resources in your community to help you become familiar with all of the hearing solutions and options that are available. A thorough understanding of hearing loss will help you make decisions for your child.

The aim of this booklet is to provide you with a detailed and easy-to-use guide concerning the different aspects of hearing and hearing loss.
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Important Terms to Know

In the beginning, many terms from the world of audiology and from the medical speciality of ENT (ear, nose and throat) may be new and unfamiliar to you. On the following pages, you will find explanations for the most commonly used terms to help you better understand the world of hearing.
Anatomy of the Ear

**Auditory Nerve:** Hearing nerve; the auditory nerve carries nerve impulses from the inner ear to the brain.

**Cochlea:** The snail-shaped part of the inner ear that changes sound vibrations to nerve impulses.

**Ear Canal:** The tube running from the outer ear to the eardrum that directs sound into the ear.

**Eardrum:** Also called the tympanic membrane; the eardrum is situated between the outer and the middle ear and changes sound waves into mechanical vibrations.

**Hair Cells:** The hair-like structures in the inner ear that convert the mechanical energy of sound waves into nerve impulses.

**Inner Ear:** The part of the ear that contains the hearing organ (cochlea) and the balance (vestibular) system. The cochlea contains fluid and highly sensitive cells (hair cells) that move with sound vibrations.

**Middle Ear:** The middle part of the ear that includes the eardrum and three tiny bones (ossicles). The middle ear transfers sound vibrations to the inner ear.

**Outer Ear:** The part of the ear that is normally visible is called the pinna. It collects sound waves and directs them into the ear canal.

**Ossicles:** The chain of three tiny bones in the middle ear: hammer (malleus), anvil (incus) and stirrup (stapes).

Types of Hearing Loss

**Acquired Deafness:** A severe to profound hearing loss that develops later in life.

**Conductive Hearing Loss:** Any medical condition in the outer or middle ear that prevents the ear from conducting sound. Read more about different types of hearing loss on pages 19–21.

**Congenital Hearing Loss:** A hearing loss that is present from birth.

**Neural Hearing Loss:** A problem that results in the absence of or damage to the auditory nerve.
Types of Hearing Loss (Cont.)

**Prelingual Deafness:** Deafness that occurs at birth or early in childhood, before language acquisition.

**Postlingual Deafness:** Deafness that occurs after having language acquisition.

**Sensorineural Hearing Loss:** Hearing loss caused by a problem in the cochlea; it results from missing or damaged hair cells. A sensorineural hearing loss is usually permanent and may become progressively worse over time.

Audiological Terms

**Audiogram:** A graph obtained during a hearing test that illustrates a person’s hearing for each ear, indicating the degree and type of hearing loss. It shows the amount of hearing loss (in decibels or dB) at different frequencies (250–8000 Hertz or Hz). Read more about the audiogram on page 18.

**Audiologist:** A professional who treats individuals with a hearing impairment.

**Audiology:** A science that studies hearing; the profession is concerned with assessment and rehabilitation of auditory and communication problems.

**Audiometry:** A series of tests administered by an audiologist that assess hearing and middle ear function.

**Auditory:** Relating to hearing.

**Auditory Brainstem Response (ABR):** An objective test used to check the function of auditory pathways by measuring the brain’s electrical response to sounds. ABR assessments are commonly used in newborn hearing screenings because the child does not need to react to sound signals.

**Binaural/Bilateral Hearing Loss:** Hearing loss affecting both ears.

**Decibel (dB):** The loudness of a sound is measured in units called decibel (dB).

**Frequency:** The pitch of a sound is measured in frequency. Frequency is denoted in Hertz (Hz).
**Hearing Threshold:** The softest sound that a person can hear at a specific frequency. Hearing thresholds are displayed on an audiogram to give an indication of the overall hearing loss.

**Localization:** The ability to determine where a sound originates.

**Otology:** The branch of medicine dealing with the ear.

**Otologist:** A physician who specializes in the treatment of ear problems.

**Rehabilitation:** Specialized training for people with hearing loss to help them learn to speak and understand language through listening. For children who could never hear or speak, this is sometimes called habilitation.

**Residual Hearing:** The amount of remaining measurable, usable hearing. Most individuals with hearing loss have some degree of residual hearing.

**Speech Frequencies:** The range of frequencies most important for hearing and understanding speech, within 500 to 4000 Hz.

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**Hearing Devices**

**Cochlear Implant:** An electronic device for individuals with severe to profound sensorineural hearing loss. A cochlear implant (CI) is surgically implanted under the skin behind the ear, and bypasses the damaged hair cells of the inner ear to stimulate the cochlea. Read more about cochlear implants on page 30.

**Electric Acoustic Stimulation (EAS***): EAS combines the technology of a cochlear implant (CI) and a digital hearing aid for individuals with specific hearing loss configurations.

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*The EAS Hearing System is approved in Europe.
About Hearing and Hearing Loss
How Hearing Works

Ears are extraordinary organs. Unlike eyes, they never “sleep,” and you cannot close them or give them a break. Ears pick up sound waves and change them into information that the brain can interpret. Knowing how natural hearing works can help you to better understand hearing loss.

Hearing is the perception of sound. A sound is a pressure wave that can either vibrate slowly (low frequencies reflect deep sounds) or quickly (high frequencies reflect high-pitched sounds).
How Hearing Works for Children:
Read more about the journey of the sound wave on MED-EL’s Kids’ Corner on www.medel.com
Hearing Development in Children

The most vital period for hearing development in a child’s life occurs in the first two years. Children who receive no auditory stimulation during this critical period will face difficulties learning to speak. The brain's ability to learn to process sound and develop spoken language decreases after this critical period until about age seven, when learning language becomes much more difficult (for more information see page 24). Children’s development of speech and language varies individually. There are, however, milestones for speech and language development that can serve as a guideline for normal development.1
0–3 months
Reacts to loud and sudden sounds (wakes up, scares, startles)
Recognizes a parent’s voice
Reacts in response to a familiar voice (quiets, smiles)
Looks around to see where a new sound is coming from
Smiles when spoken to
Makes pleasure sounds, coos, chuckles
Uses specific crying patterns (e.g., hunger-cry)

3–6 months
Experiments with own voice, babbles
Pays attention to music
Discriminates between sounds, friendly/angry voices
Localizes sound source/voice
Recognizes own name
Uses different cries, stops crying when spoken to

6–9 months
Babbling is more varied
Listens attentively to music/singing
React is to own name
Understands simple verbal requests
Recognizes names of some common objects

9–12 months
Uses exclamations
Speaks first words (“dada,” “mama,” “bye-bye”)
Follows simple commands
Understands simple questions (“Where is the ball?”)
12–18 months
Says one-word sentences
Says and understands up to 20 words
Understands more new words every week
Enjoys nursery rhymes
Comprehends simple questions
Uses words rather than gestures to express wants and needs

18–24 months
Uses 2–3 word sentences
Follows simple commands
Understands simple questions
Enjoys being read to
Understands more complex sentences
Points to body parts when asked

2–3 years
Speaks in simple sentences
Says and understands 200+ words
Follows simple tasks when asked
Points to the right picture in a book when asked

3–4 years
Speaks clearly enough that people outside the family usually can understand him or her
Uses sentences of four or more words in length
Speech and understanding improve considerably
Diagnosis of a Hearing Loss

In many countries, hospital Newborn Hearing Screening programs\(^2\) check the hearing of all infants. This is a short and painless examination of the auditory pathways performed a few hours after birth. If an infant was not screened in such a program, parents are usually the first to suspect a hearing problem.

If you have any concern about your child’s hearing, you should not hesitate to see an ENT specialist. It is very important to treat a hearing loss as early as possible to avoid delays in your child’s speech and language development. The sooner a hearing loss is treated, the more likely the child will be able to acquire speech and language normally.
Typical Signs of Hearing Loss Are:
- Child does not react to loud sounds
- Child is unable to detect where a sound is coming from
- Child may start to babble, but soon stops
- Babbling does not develop into understandable speech
- Child does not react to voices, especially when he or she is not being held
- Child does not follow commands or misunderstands directions
- Child may start acting frustrated

Hearing Tests
A variety of different methods are available to test your child’s hearing. The audiologist will choose a method that is best suited for your child’s age. Usually, hearing tests performed on newborns and babies use objective measuring methods to assess the baby’s hearing and do not require the active participation of the baby. All these tests are quick, simple and painless and are performed while the baby is asleep. Parents can stay with the baby while the hearing test is being carried out.

In Otoacoustic Emission (OAE) screening, the function of the hair cells in the cochlea is checked. A tiny earpiece is placed into the baby’s ears emitting clicking sounds. When the cochlea receives these sounds, it produces an echo that the screening equipment picks up. A similar screening method, the Auditory Brainstem Response (ABR), measures brain waves in response to auditory stimuli (usually a clicking sound). Older children can participate more actively in audiometry tests. The child indicates when he or she hears a sound (pure-tone audiometry) or understands speech (speech audiometry).
The Audiogram

An audiogram is a visual representation of your child’s hearing. A typical audiogram shows the softest sounds that your child can hear at different pitches (frequency). The softest sound he or she is able to hear is called the hearing threshold. The ‘speech banana’ on the audiogram is a crescent-shaped area that shows where typical speech sounds occur. It is shown on the left in the white shaded area.

The loudness level of sounds, also shown as hearing level on the audiogram, is measured in decibels (dB) from soft sounds at the top of the graph, to loud sounds at the bottom. Frequency is measured in hertz (Hz) from low pitch on the left side to high pitch on the right side of the graph.

Normal hearing ranges between 0 and 20 dB HL (dB Hearing Level). If the hearing thresholds are outside that range, the listener is considered to have hearing loss. A person with a hearing loss at 40 dB HL, for example, may not be able to hear certain speech sounds. The degree of loss is determined by the severity, e.g., mild hearing loss, moderate hearing loss, severe hearing loss, profound hearing loss (see right side of the graph). It is important to be familiar with the details of your child’s audiogram so that you can detect any changes in his or her hearing without delay. We recommend that you keep dated copies of your child’s audiograms.
Types of Hearing Loss

If any part of the ear does not function properly, hearing will be compromised. Doctors and audiologists distinguish between different types of hearing loss, depending on the part of the ear that is affected.

**Conductive Hearing Loss**

Any condition in the outer or middle ear that prevents the ear from conducting sound properly is known as a conductive hearing loss. This can be due to a blockage in the outer ear or ear canal, ear infection, or other problem. Conductive hearing loss is usually mild or moderate in nature. In some cases, conductive hearing loss is temporary and can be treated with medication or with surgery. If a conductive hearing loss is irreversible, many people can benefit from a hearing aid or a middle ear implant. Common causes of conductive hearing loss in children are: buildup of earwax or infections in the middle ear (otitis media). Earwax buildup can be removed by an ENT specialist and hearing can usually be fully restored. Middle ear infections are very common in young children. These infections are often painful and should be treated immediately to prevent damage to the eardrum. Untreated middle ear infections can cause the eardrum to rupture. Although a perforated eardrum can heal, it leaves scar tissue which can cause permanent hearing loss, especially in cases of repeated infection.
Sensorineural Hearing Loss

Sensorineural hearing loss results from missing or damaged hair cells in the cochlea; it is usually permanent and can progress over time. Also known as “nerve deafness,” sensorineural hearing loss can be mild, moderate, severe or profound. Conventional surgical procedures cannot cure sensorineural hearing loss. Treatment options for mild to severe sensorineural hearing losses are traditional hearing aids and middle ear implants. For the treatment of severe or profound sensorineural hearing loss, cochlear implants are often recommended.

A common cause of sensorineural hearing loss in children is severe infection, like meningitis or infections which require treatment with ototoxic drugs in order to save lives (ototoxic: toxic for the ear). Very often, children are born with sensorineural hearing loss called congenital hearing loss. A congenital hearing loss can be hereditary (due to genetic causes) or it can result from complications during pregnancy or birth. Prolonged exposure to excessively loud sounds may also cause sensorineural hearing loss, though this is more common in older children and adults.
**Mixed Hearing Loss**
A mixed hearing loss is a combination of sensorineural and conductive hearing loss. It results from problems in both the inner and middle ear. Treatment options may include medication, surgery, hearing aids or a middle ear implant.

**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, because the nerve is not able to pass on enough sound information to the brain. In some cases, an auditory brainstem implant may help.
Hearing Loss – What Now?

**Diagnosis and Emotions**

Maybe you already suspect that your child has a hearing loss, or maybe your child’s hearing loss was already diagnosed after a Newborn Hearing Screening. In any case, getting confirmation that your child does not hear properly evokes a variety of emotions in parents, ranging from shock to denial. These reactions are normal. **Allow yourself the time to accept the diagnosis.**

Over time, many questions will arise: How well will my child be able to hear and speak? How will the hearing loss impact my child’s future? Which assistive technology will be the best? Talk to your ENT doctor and/or audiologist to get answers to all your questions. Do not hesitate to ask them for details. Knowing as much as possible about your child’s hearing loss helps you to support your child’s development of hearing and speech.

**Support groups are a valuable source of information, too.** Families who went through the same experiences will understand your worries and can give you helpful advice. You may also wish to visit school or therapy programs in your area that teach children with hearing loss. Even if your child is far too young to enter these schools, this will help to give you perspective about the different educational methods and how they work.
Early Intervention

Early intervention means acting without delay to treat your child’s hearing loss. If your child has an irreversible hearing loss that cannot be otherwise remedied, it is vital to get hearing instrumentation as soon as possible. It is also very important to assess how well the hearing instrument(s) work(s) for the child. If hearing aids are not going to be enough to help the child to develop spoken language, it is crucial to determine this as quickly as possible so that other alternatives can be evaluated while the child is still in the critical language learning phase.
**Why is Early Intervention so Important?**

Once your child is diagnosed with a severe hearing loss, it is important to act immediately. In the 24th week of pregnancy, the inner ear is fully developed and the fetus is able to hear sounds coming from both inside and outside the mother’s body.

Newborns are already able to recognize their mother’s voice. During the first few months, infants learn to understand a variety of sounds around them. They can very quickly distinguish between human speech and other environmental sounds. **The first two years are especially important for language acquisition.** Children with hearing loss cannot develop these abilities later on.

The younger a child’s age when receiving a hearing device, the easier it will be for him/her to learn to hear and speak. A baby's brain is better able to process new information than that of older children, and when children are provided with a hearing device at a very young age, they often develop spoken language quickly and can “catch up” with other children born with normal hearing.4, 5, 6
If your child has been diagnosed with a hearing loss, your audiologist will discuss the options available for him/her. Depending on the degree and the type of the hearing loss, your child may be a candidate for a hearing aid or a cochlear implant. The following graph serves as a guideline for finding an ideal solution for your child’s hearing loss.
Technical Hearing Solutions for Children

**Hearing Aids**
Hearing aids help your child to utilize the hearing abilities that he or she still has by amplifying sounds. Hearing aids can be worn behind the ear (BTE) or in the ear (ITE) and use either analog or digital processing. If your child is a candidate for a hearing aid, your audiologist will advise you about the device that best suits your child’s individual needs.7

**Cochlear Implants**
A cochlear implant is a hearing solution that takes over the function of damaged nerve cells in the inner ear. Unlike hearing aids, cochlear implants do not amplify sounds. Instead they process the sound signal electronically and use tiny electrical pulses to stimulate the hair cells in the inner ear. Read more about cochlear implants on page 30.
Communication Options

We all communicate in different ways: through facial expressions, through gestures and body language, as well as through speech and hearing. Each child is different and there are many ways to help your child to communicate. A speech-language professional will be able to discuss these options with you in more detail.

**Auditory-Verbal Communication**
A communication mode that only uses hearing in developing speech and language. It is similar to the oral-aural approach (see below), but lip-reading is not emphasized. The auditory-verbal approach emphasizes parents as the child’s primary teacher, and the focus of therapy is to empower the parent to teach the child.

**Oral-Aural Communication**
A method that emphasizes the use of residual hearing and lip-reading to teach spoken language.

**Cued Speech**
A communication method that combines lip reading with a system of hand shapes placed near the mouth.

**Sign Language**
A visual and manual language using hand shapes and the rest of the body, including the face, to convey words and concepts, i.e. American or British Sign Language. Sign language is an independent language with a specific vocabulary and grammatical structure and may not follow the same grammatical rules as the language used by the family.

**Total Communication**
A habilitation approach consisting of the integration of oral/aural and manual communication strategies.
Although the methods mentioned above are separate ways of communicating with your child, some people choose to use them in combination. Some parents may talk to their child, while others use a combination of speech and sign, or some only use sign language. The mode of communication you use with your child may change over time, depending on how well he or she uses hearing aids or cochlear implants and what type of educational programs are available. Ask your local speech-language professional about the different communication options and resources available in your community. Be sure to visit school programs in your area that offer different communication options. Visiting programs that teach older children as they approach adulthood may also give you a good idea of the outcomes and effectiveness of various approaches.
Decisions Concerning Education

Your child’s education is important. Families are encouraged to explore their options and to seek the support of trusted professionals while making decisions. However, after diagnosis, it is essential to act quickly as it is best to begin a therapy program as soon as possible to take advantage of the critical period of language learning. Review the “Communication Options and Educational Placements” booklet from MED-EL to help you understand the various approaches and how they relate to communication development.

There will come a time when it will be appropriate to consider the best educational placement for your child. Remember that each child has unique strengths and challenges, which may change as he or she goes through school. Your CI clinic, local school district or support group members can give you specific advice on educational opportunities in your region. To help you make an informed decision once your child is old enough for a preschool program, take a look at MED-EL’s “Picture Perfect Preschool.” It is a guideline for parents to use when evaluating a potential preschool placement and helps parents keep track of how well their child is doing in that placement.

Rehabilitation following implantation is a critical component to your child’s success using a cochlear implant (see page 54 of this guide for detailed information).
Cochlear Implants
An Option to Help Your Child Hear

Cochlear implants are hearing devices that take over the function of damaged hair cells in the inner ear. MED-EL has been pioneering cochlear implant development since the 1970s. Decades of research have resulted in today’s hearing implants, which are convenient, miniaturized high-tech devices that have opened up the world of hearing to thousands of children and adults all over the world.

MED-EL’s OPUS 2 processor and SONATA100 cochlear implant.
What is a Cochlear Implant System?

A cochlear implant system is a medical option for individuals with severe to profound sensorineural hearing loss. For individuals with this type of hearing loss, hearing aids provide little or no benefit. A cochlear implant system bypasses the non-functioning part of the cochlea and delivers sound signals directly to the hearing nerve.

Cochlear implant systems can be used effectively by children who were deaf at birth or before learning to speak and children who became deaf later. Cochlear implant systems can also be used by adults who lost their hearing but are still able to speak normally.

**INTERNAL Implant**
(surgically placed under the skin) The implant consists of a housing, which contains the electronics, and the electrode array as well as the receiving antenna and a magnet that holds the coil in place behind the ear.

**EXTERNAL Audio Processor**
(worn behind the ear) The audio processor consists of a control unit, a battery pack, and a coil that transmits information through the skin to the implant.
How Does a Cochlear Implant Work?

Cochlear implant systems convert everyday sounds into coded electrical impulses. These electrical pulses stimulate the auditory (hearing) nerve(s) and the brain interprets them as sound. Because the brain receives sound information very quickly from the stimulated auditory nerve, the cochlear implant user hears sounds as they occur.

1. Sounds are picked up by the microphone of the audio processor.
2. The audio processor analyzes and codes sounds into a special pattern of electric pulses.
3. These pulses are sent to the coil and transmitted across the skin to the implant.
4. The implant sends the pulses to the electrodes in the cochlea.
5. The auditory nerve picks up the signal and sends it to the auditory center in the brain. The brain recognizes these signals as sound.
Benefits of Cochlear Implants

Cochlear implants allow people with severe to profound hearing loss to understand speech, speak more clearly, use the telephone, listen to music, communicate with their environment and enjoy the world of sound in all its aspects.

Numerous studies have proven the positive effects on users’ quality of life as well as the cost-effectiveness of cochlear implants. A US study compared children implanted with a CI for more than 2 years with their peers with profound hearing loss who did not have implants. Results showed that twice as many CI users could attend mainstream schools, were less dependent on self-contained classrooms, and required fewer hours of special education support.

A cost-benefit analysis based on conservative estimates of educational expenses for children throughout their time at school (from 5 to 18 years of age) showed a cost savings of cochlear implantation and appropriate auditory rehabilitation that ranged from $30,000 to $200,000. It is important to realize that results vary depending on a number of factors such as degree and duration of hearing loss, anatomy of the cochlea, the type and quality of rehabilitation received, and the type of educational program the child attends.
Is My Child a Candidate for a CI?

If you and your audiologist or speech-language professional consider a cochlear implant to be the best solution for your child, the next step is to contact an ENT clinic with a cochlear implant program. A list of cochlear implant centers is available from MED-EL. Your local team of CI specialists will work with you to determine whether your child is a candidate for cochlear implantation.

**Basic candidacy criteria for implantation include:**

- Your child has a profound sensorineural hearing loss in both ears.
- Your child receives little or no benefit from hearing aids.
- There are no medical reasons your child cannot undergo surgery.
- Your child has access to appropriate education and rehabilitation follow-up.
- You and your child are highly motivated to participate in required rehabilitation programs.

**Please note:** not every child with a profound hearing loss is a candidate for cochlear implantation. Here are some reasons why:

- If your child can receive a significant benefit from hearing aids, they are likely the better solution.
- If your child’s hearing loss comes from somewhere other than the inner ear, another solution might be more effective.
- If the anatomy of your child’s individual cochlea does not allow proper placement of the electrode or there is no hearing nerve, an alternative solution might be more effective.
- To gain the greatest hearing benefit from a CI, it is important for children to have full support from their family and to participate in rehabilitation programs. This is vital to ensure that your child obtains the best benefit from the implant. If a family cannot commit to participation in a rehabilitation program, other options besides a CI may need to be considered.
Receiving a Cochlear Implant

1 Assessment
To determine candidacy for a cochlear implant, your child will undergo a number of routine assessments prior to implantation. These tests allow the cochlear implant team to check for any additional factors or needs and allow them to help you know what to expect. These assessments often include medical, audiological (hearing) and radiological (x-ray) evaluations.

2 Surgery
The surgical procedure usually takes between one and three hours and is done under general anesthesia. The risks involved in cochlear implant surgery are low and comparable to other ear surgeries. Children are usually up and about the next day. The hospital stay can vary from one to several days, depending on what is typical in your area and what your child's individual needs are.

3 First Fitting
About four weeks after implantation your child will receive his or her audio processor. The audio processor is programmed, or “fitted”, for each child individually by an audiologist or other professional. This program contains settings for pitch, loudness and timing. Initially, setting up an ideal program for your individual child requires repeated fitting sessions in order to gradually fine-tune the settings.

4 Follow-up Program
While cochlear implants provide a remarkable opportunity for children with hearing loss, sounds can be confusing and overwhelming initially. Regular communication training with a speech-language professional is an essential element in learning how to understand sounds and in developing listening and speech skills. For very young children, auditory therapy may initially involve parent-directed therapy activities to help your child detect and recognize sounds. For older children, auditory therapy may focus on helping the child to recognize the new, more detailed way that things sound as opposed to the limited sound they knew with hearing aids.
Advantages of Early Cochlear Implantation

Your child may benefit from a cochlear implant regardless of his or her age, but for children who became deaf before learning to speak success is more likely.¹² This is because they receive auditory information at a time when the brain is really ready to learn language. As previously mentioned, if children with a profound hearing impairment are implanted early enough, their hearing and speech can develop much like a normal hearing child’s. Spoken language appears to emerge almost naturally.¹³,¹⁴

For children who have had hearing experience and have lost their hearing later, a similar rule applies: the shorter the time period of deafness, the more likely they will benefit from the cochlear implant. Children are being implanted younger and younger because of improved surgical procedures¹⁵ and research proving better results with children implanted at very young ages.¹⁶,¹⁷
On the Way to Success

It is important to remember that the cochlear implant is a technical tool for your child’s hearing. Success with the implant depends on many factors. Age of implantation is only one factor influencing the benefit a child will receive from a cochlear implant. A rich communication environment, effective audio processor programming, motivation, rehabilitation and realistic expectations are all important factors contributing to a child’s overall success.\(^{18}\)

It is crucial to speak to your child like you would with a child with normal hearing, even though he or she may not fully understand what you are saying. Talking to your child is the best way to encourage the development of spoken language. Facial expression and body language emphasize the meaning of words and will help your child understand you better. Structured auditory therapy goes along with what you teach your child at home. For very young children, auditory therapy may initially involve parent-directed therapy activities to help your child detect and recognize sounds in the therapeutic setting. At a later stage, your child will learn to apply these new listening skills in the real world, outside the therapeutic setting.

**MED-EL is committed to supporting children with hearing loss** and their parents with a wide variety of information and materials that are specifically developed for the needs of children of different age groups. Many of these materials are appropriate for children with hearing aids as well as for those with cochlear implants. Research has shown that wearing an audio processor for longer periods of time throughout the day positively affects children’s performance with their implant.\(^ {19}\) The reason for this is that children with a cochlear implant can often acquire language skills and auditory skills incidentally, the same way that typically-developing children learn. This
means that even when you or your child’s teachers are not there explaining things or working on learning, the child learns just by listening and playing. Therefore, maximal use of the cochlear implant leads to better results. On the other hand, after extended periods of time not wearing the audio processor, your child’s brain must take time to readjust to incoming sounds from the cochlear implant. This can delay your child’s hearing development.

Learning language is just one goal of cochlear implantation. Making your child’s speech intelligible for other people, even for those who do not know your child, is another goal. A well programmed audio processor that is worn during all waking hours, along with appropriate rehabilitation, will help your child to achieve this goal.

Finally, your expectations play an important part in your child’s success with the CI. Children implanted very young typically make early and steady progress, especially with effective therapy and support. In most cases, it is realistic to expect your child to eventually understand spoken language and to develop speech skills, assuming that no other learning issues exist. Most cochlear implant users are also able to use telephones, some learn second languages, and many enjoy music – auditory tasks that are considered highly complex. It is important for you to help your child to reach his or her full potential. Because every child is different, your child’s ultimate level of success will depend on a number of factors which cannot be predicted before implantation. For this reason, it is important that expectations are realistic. Your audiologist and speech-language professional are there to help you decide on realistic goals and mindset for each stage your child may be going through.
Ideal for Infants and Toddlers

The decision to get a cochlear implant is one that will affect you and your child’s life for many years to come. For decades, the majority of MED-EL cochlear implant users have been children. As a result, MED-EL has been able to develop its CI system to ideally match children’s needs, offering uncompromising safety, performance and convenience. At the same time, MED-EL products are designed to be future-ready, ensuring that children can benefit from future technological and medical advances as they come along.

MAESTRO™ CI System offers two choices of implant housings and audio processor designs. (left to right) PULSAR CI, SONATA, OPUS 2 with FineTuner, OPUS 1
MAESTRO™ Cochlear Implants: PULSARCI\textsuperscript{100} and SONATA\textsuperscript{T1}{100}

The future-ready design of the PULSARCI\textsuperscript{100} implant and the SONATA\textsuperscript{T1}{100} implant means that your child can benefit from the very latest advances in hearing implant technology from one of the pioneers in the industry – today AND tomorrow.
**Thinnest Implant Package**
At approximately 4 mm (0.157 in), PULSARCl100 is the thinnest cochlear implant available today, a particularly important factor for infants and small children.

**New Titanium Housing**
The SONATA\textsubscript{Ti}100 has a compact, lightweight titanium housing. Its exceptionally small size makes it ideal for infants and toddlers as well as adults. The SONATA\textsubscript{Ti}100 is also designed to aid minimally invasive surgical techniques which can enable faster recovery.

**Soft Electrode Arrays for Every Cochlea**
The cochlea of a child is already adult size at birth. MED-EL’s philosophy is that the delicate inner ear structures need to be specially protected so that they can be preserved in the event of future technological and medical advances. Therefore, the electrodes must be especially soft and flexible ("atraumatic") to cause little or no trauma when they are inserted into the cochlea. MED-EL offers a variety of soft electrode options to ensure an ideal match with every child’s cochlea, even if a child’s cochlea is malformed or ossified (covered in bony growth).

**Reliability and Safety**
MED-EL hearing implants are designed according to the highest safety standards for long-term reliability, durability and performance. MED-EL’s safe and effective technology incorporates a variety of additional safety features particularly important for children. For up-to-date, transparent data on the reliability of MED-EL implants, please visit our website at [www.medel.com/reliability](http://www.medel.com/reliability).
Complete Cochlear Coverage

MED-EL offers the longest electrode array (approximately 31 mm/1.22 in) for the deepest electrode insertion in the cochlear implant industry. A deep insertion and optimized spacing of electrode contacts – Complete Cochlear Coverage – provides stimulation of all available nerve fibers along the entire length of the cochlea, particularly the low-frequency region. Low-pitched sounds contain important speech cues that contribute to intonation, rhythm and vowel discrimination. By accessing this otherwise ignored low-frequency region, MED-EL implant recipients report more natural sound quality and improved speech understanding.

Without stimulation, auditory nerve fibers lose their ability to function; therefore, it is important to stimulate all areas of the cochlea. In children, this stimulation ensures that they learn to effectively use sound information now and in the future.

Like the keys of a piano, the cochlea is arranged in order of pitch (frequency). One end of the cochlea sends high-pitched information to the brain, while the other end sends low-pitched information.
MAESTRO™ Audio Processors: OPUS 1 and OPUS 2

MED-EL has worked closely with parents and cochlear implant professionals to develop an audio processor design that is ideal for children. The unique modular design of the OPUS 1 and OPUS 2 allows them to be adapted easily to meet children’s changing needs as they grow.

**Choose from Two Processor Designs**
While the OPUS 1 features easy to operate switches for selecting programs and making adjustments, the OPUS 2 introduces, as a worldwide first, a completely switch-free design. It is comfortably operated by the FineTuner, a wireless remote control unit (see page 50 for more details).

**Clear Hearing in All Listening Situations**
In everyday life, your child is surrounded by a lot of background noise, which may distract him or her from important speech information. Sophisticated processor features, such as the Automatic Sound Management technology, automatically adapt to changing listening environments and help your child to hear the sounds that are most important. Both soft and loud sounds are heard clearly and comfortably in all listening situations. While some cochlear implant systems require special switches or settings for difficult listening environments, the OPUS audio processors make all adjustments automatically. This is particularly beneficial for children who are too young to change audio processor settings to adapt to different listening situations.
A Processor that Grows with Your Child

OPUS audio processors offer a variety of wearing options appropriate for each stage of your child’s life. Among them are the unique BabyBTE™ and Children’s Battery Pack configurations.

**BabyBTE**

As more and more infants and young children are receiving cochlear implants, MED-EL’s BabyBTE wearing configuration has been developed to address their special needs. The entire processor is worn on the baby’s clothing, with no equipment worn on the ear. Then, when the child is old enough to wear the processor at ear-level, the BabyBTE is easily converted to a more traditional ear-level wearing configuration without the need to switch to a different processor. The BabyBTE is tamperproof and features a status light to allow parents to easily check that the processor is functioning correctly.
**Children’s Battery Pack**
The Children’s Battery Pack wearing option is ideal for small children because only the small, ultralight (2 g/0.07 oz) control unit is worn on the ear. The battery pack is clipped securely to the collar or other clothing. This design provides additional security: if the control unit is brushed off the ear while a child is playing, the attached battery pack ensures that the processor will not fall to the ground.

**Exceptionally Long Battery Life**
MED-EL's patented power-efficient technology provides exceptionally long battery life at full performance. Most MED-EL recipients enjoy 3–5 days of use with a single set of batteries, making the OPUS audio processors both cost-effective and convenient. MED-EL also offers users the DaCapo™ rechargeable battery system (only available for use with the standard battery pack).

**Lightweight and Compact**
In order for a child to make the most out of a cochlear implant, consistent use (wearing it all day, every day) are imperative. Therefore an audio processor needs to be so comfortable that the child does not even notice he or she is wearing it. While bulky bodyworn audio processors for children are still on the market, both OPUS processors are worn behind the ear (BTE). They are extremely thin and lightweight, making them comfortable to wear, even for infants and toddlers. The small profile and lightweight design ensures that the processor does not bend or irritate a baby’s small ears.

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You can choose from six different colors for your child’s OPUS 1 or OPUS 2.

- Anthracite
- Beige
- Bordeaux Red
- Nordic Grey
- Pacific Blue
- Sienna Brown
Quick and Easy Access
The FM battery pack cover of the OPUS 2 features a standard input jack as used in hearing aids. This provides convenient access to mobile telephones, FM systems, MP3 players, televisions, etc.

Safe and Secure
MED-EL puts a lot of effort into making its products safe and secure for the youngest users. MED-EL audio processors are equipped with a variety of safety features specially geared to children’s needs:

- Tamper-resistant battery packs and lockable parts.
- SoundGuard to protect against program loss in the case of exposure to electrostatic discharge (ESD).
- Status light that flashes a series of patterns to indicate various error conditions.
- The FineTuner remote control unit permits the OPUS 2 to be adjusted without any switches. The child is not able to change audio processor settings unintentionally.
**Comprehensive Diagnostic Toolkit**

Infants and toddlers cannot usually tell how well they are hearing sounds. For this reason, MED-EL has developed a Comprehensive Diagnostic Toolkit, designed to provide objective measurements to audiologists for fitting and checking the implant function.

**Quick Fitting**

Because infants and children may not be able to sit through long fitting sessions, MED-EL's CI system allows quick fitting while still obtaining ideal results. This reduces stress and fatigue on both you and your child.
Bilateral Implantation

Bilateral implantation is implantation of both ears. Hearing with two ears, also called binaural hearing, has distinct advantages such as precise localization of sounds, better hearing in noisy environments, and improved understanding of speech. In general, “stereo” hearing (with two ears) is less strenuous. MED-EL pioneered bilateral cochlear implantation in 1996 and has since accumulated leading experience in this field.
In a retrospective study using a parent questionnaire, hearing quality in children was found to be significantly better following bilateral implantation. Bilaterally implanted children respond much faster in group situations; they react more quickly and appropriately in everyday situations and acquire language spontaneously. Auditory effort is reduced and, according to parents, the children are less tired after school or kindergarten. Parents often report the clear benefits in speech understanding and an increase in their child’s self-confidence.

A variety of technical features make MED-EL cochlear implant systems especially well suited for bilateral implantation. In particular, the combination of high-rate stimulation and specially designed flexible electrodes that allow deep insertion into the cochlea provides users a maximum amount of acoustic information. High-rate stimulation refers to the speed and amount of information that the implant can deliver to the ear. High rates of stimulation more closely represent the function of the normal cochlea and have been found to be beneficial in speech understanding.

Another innovative feature is the ability to use one FineTuner for both implants. This makes it very user-friendly for parents.
Long-term Care and Commitment

At MED-EL, we don’t consider our job finished once your child has been fitted with a cochlear implant. Rehabilitation following implantation is a crucial component to your child’s success. For your child, learning to use his or her “new ear” is a process. MED-EL is there to help you every step of the way offering a line of rehabilitation materials to assist you and your child.
The **BRIDGE to better communication program** is a comprehensive support program developed by MED-EL in cooperation with leading experts worldwide. This program was specially designed for education and rehabilitation to help “bridge” the gap between implantation and the development of improved listening skills and spoken communication. The BRIDGE program offers a wide variety of communication packages for clinical and home use as well as materials that facilitate access to and understanding of music. The BRIDGE materials cover a broad range of abilities and needs with one goal in mind: to ensure the best possible results for our family of cochlear implant users.

Among the BRIDGE materials is **My LittlEARS Diary**, which gathers information about early auditory speech and language development. It is both a record book and an assessment tool for parents and therapists to document early development of hearing impaired children fitted either with a hearing aid or a cochlear implant.

**SoundScape**, a new online activities section, is available on soundscape.medel.com. It includes different interactive listening activities for different age groups from two years to adult age as well as follow-up activities.
Kids’ Corners and Children’s Kits

In addition to the activities offered on SoundScape, two other “MED-EL for Children” sections are available online at www.medel.com. The “Kids’ Corner” for preschool children offers simple explanations about hearing, hearing loss and cochlear implantation. Created for children aged 3–6 years, it is written in an easy-to-understand way with mascot Mellie, the MEDElephant, guiding the children through the pages.

The “Kids’ Corner” for school children is an informative and fun section for children aged 6 years and older. It provides the same information in a more comprehensive way. It also includes personal stories about children with implants as well as online games and activities.

The Kids’ Corners are complemented by two Children's Kits, targeted at children aged 0–3 years and 4+ years. The kits have been developed with rehabilitation specialists and aim to prepare children for their life with the cochlear implant in a playful way. They include sound-making toys, story books and mascot Mellie.
MEDELEPHANT Mellie and her little friend guide children through their journey to hearing.
Life with a Cochlear Implant

The life of a child with a cochlear implant is not very different from the life of a hearing child. Your child will be able to do most of the things that other children can do. To ensure proper functioning of the device for many years, a few rules should be observed:

- Avoid dropping the audio processor.
- The audio processor should not get wet, so take it off before swimming or taking a shower or bath.
- Avoid contact sports and activities that may result in head injuries because this might damage the implant. Your child should always use a helmet for head protection.
- Take the audio processor off at night and dry it in the special drying kit.
**Communication Tips**

Regardless of whether your child wears hearing aids or uses cochlear implants, there are some basic guidelines that you should observe when communicating with your child to help him or her understand you better:

- Always turn towards your child when speaking so that he or she can see your face properly. This makes it easier for your child to read your lips. If possible, make sure your face is well lit.

- Try not to talk to your child while chewing food or hiding your face behind your hands, newspaper or other objects. These situations make lip-reading more difficult.

- Speak clearly and at a normal pace. Remember, there is no need to speak very slowly or to shout. If your child does not understand a sentence, try rephrasing it.

- Avoid background noise whenever possible. If background noise is too loud, even people with normal hearing have difficulty understanding speech. For children with hearing problems, this is even more difficult. Turn off the television or radio and move closer to your child so that your speech becomes louder than the background noise.
Real People,
Real Experiences

Although scientific results and technical details tell us a great deal, “real life” experiences of CI users can express even more. Below you can read what parents of children using MED-EL implants have said about the benefits and advantages of cochlear implants in everyday life!

Raquel, age 4

“When our daughter Raquel was born, we were thrilled to have a beautiful baby girl. Her hearing test at birth showed normal results, as did the second one at the age of 7 months. Raquel had always been a very happy and communicative baby. At the age of 9 months she started saying her first word, “mama.” Then, as months passed, she improved her vocabulary and seemed to understand what she was told. But later, at about the age of 20 months, she seemed to have fallen behind her peers as far as her speech and comprehension skills were concerned.

We decided to have a special hearing test done when she was about two and a half years old. My husband and I were shocked by the results: she had become profoundly deaf in both ears. Fortunately, the doctor was very nice and professional. She immediately informed us of what turned out to be a wonderful solution: the cochlear implant.”
Raquel was fitted with bilateral hearing aids and started regular speech therapy to prepare her hearing skills. The process had begun: diagnosing her deafness, having the preliminary tests done, and finding the right center and the right surgeon for the implant.

None of the tests revealed any anatomical or physiological abnormalities, so it may be that Raquel lost her hearing due to drug therapy she was given as an infant (a side effect that resulted in loss of hearing). Raquel was implanted shortly before her third birthday, with a PULSARCi100, which was activated a month later, and the new OPUS 2. She loves it and she is very eager to hear everything going on around her. In the morning, as soon as she gets up she asks for it to be put on.

It’s hard to believe that Raquel has the implant for just under a year. I could write pages telling you stories about things we have accomplished in this short time: Seeing the wonder in her eyes as she listened to the sound of her favorite “tip-tap” shoes on the floor the same evening she was activated or her repeating the word “baby” the next morning at breakfast. Seeing her looking in awe at birds chirping. Listening to her sing and play instruments with her older brother and observing her as she also starts to learn and speak in two languages.

At the risk of sounding rhetorical, I have to tell you that the MED-EL implant has been a godsend and has changed our lives forever. Raquel now has a chance for a normal future. The shock of discovering that our beautiful and healthy baby girl suddenly, and seemingly for no rational reason at all, was profoundly deaf is still a strong memory. But the MED-EL device has offered us a glimpse of a better future for Raquel. She remains a very happy and exuberant girl; she loves life. A day does not pass without my husband and I being reminded of what a miracle this is.
When our son Johannes was born, routine newborn hearing screening carried out in the hospital 2 days after his birth indicated that deafness in both ears was suspected. *This first diagnosis was a shock.*

However, since none of our relatives were hearing impaired, we hoped this was a mistake and that the next screening would have a better outcome. More hearing tests and an ABR measurement were carried out when he was four and six weeks old, confirming that our little Johannes was severely hearing impaired. At first we could not and would not believe it. Johannes was immediately fitted with hearing aids, which unfortunately were completely unsuccessful. He did not respond to sound no matter how loud they were. He only responded to visual stimuli. An examination confirmed that Johannes showed no hearing response at 120 dB.

Immediately after the first hearing screening, my husband and I found out everything we could about deafness. During our research, we came across cochlear implants. We had close contact with parents of hearing-impaired children who had also been treated with cochlear implants and they gave us invaluable information about their experiences. *Soon we decided on an implant.*
The preliminary examinations were promising; the CI team at Würzburg, Germany, recommended immediate implantation. Following consultation with the pediatrician, the anesthetist and the ENT doctor, who encouraged prompt treatment, we decided on a MED-EL cochlear implant. Johannes got through the operation without any problems. During the short stay in hospital, his first tooth came in, and he learned to turn over. The whole CI team were a great support to us emotionally.

The first fitting took place 6 weeks later. We had longed for this day but we were fearful, too. Would our little boy respond? Would he be able to hear? The audiologist in attendance played with a triangle. When Johannes heard the first sound he looked astonished and began to laugh. We were really shocked by this intense reaction from our little boy. We were overjoyed! The game repeated with each sound. When the sound of triangle could no longer be heard, Johannes also stopped laughing. Since Johannes was still so young, we had decided to space the first fitting over 3 days and the next 2 days were just as successful as the first.

**We watched, full of joy as Johannes was able to hear sounds in his environment.** Even after only a few weeks we could see his progress. Johannes dozed off and would be awoken by a loud noise and he would immediately look for the source of the noise. In the meantime Johannes has started to make sounds and babble. However, without the CI he does not make a sound.

**We work intensively with Johannes and speak to him a lot.** Early stimulation also has made a considerable contribution to his success. His progress with the CI has taken away our fear of deafness. We are leading quite a normal life with Johannes and taking part in lots of activities. Children with normal hearing accept him with his CI. They just want to know what Johannes is wearing on his ear and after it is explained, they play with Johannes just like they would with a child with normal hearing.

I can only report that I am very enthusiastic about our MED-EL CI and would like to encourage other parents who are facing the same decision as we did then to have the courage to take the step and let their child be implanted.”
Hayley, age 3

“Hayley was deafened due to meningitis, which was caused by an undiagnosed birth defect. I realized about ten days into the meningitis that Hayley wasn’t responding to sound. We had a consult with Hayley’s surgeon, and Hayley was implanted five days later.

**We were amazed at Hayley’s progress.** Hayley was deafened at a very critical time in her speech and language development; she only had about 15 words before the onset of the meningitis. It is only 2 ½ weeks after her first fitting and we cannot begin to tell you how thrilled we are with the progress she has made in this short amount of time. She responds to questions, and appears to hear and understand much of what I said. To be able to have my daughter start to call me “Mommy” two months after she became deaf and two weeks after she had her initial stimulation was the single greatest gift ever.

My husband and I liked the MED-EL CI system very much because of the options for children. When it was hot, Hayley often ran around in just a diaper with the BabyBTE on her hairclip!

I think that as a parent, you have to give your child all opportunities available, whether they have special needs or are normally developing in all areas. **We felt as parents that we owed it to Hayley to give her the ability to hear.** And I think that Hayley, if you can drag her away from singing and dancing to her Wiggles videos with her twin sister April long enough to ask her, would tell you exactly the same thing.”
References

1 Veekmans K et al. My LittleARS Diary, Therapist Book. MED-EL, 2005.


WORLDWIDE LEADER
IN HEARING IMPLANTS

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