



# Handbook for Educators

Teaching Children Who Listen  
With a Cochlear Implant





## DEDICATION

MED-EL would like to dedicate this Handbook for Educators to **Dr. Daniel Ling** (1926-2003). Dr. Ling was a pioneer in developing methods for teaching, listening and spoken language to children with hearing loss. His several books and over 250 publications promoted the ability for children with hearing loss to learn to listen using whatever technologies were at their disposal. His techniques are just as applicable today, for children with cochlear implants, as they were when originally written. His contribution to this field is immeasurable, and his work will continue to guide and inspire those who serve children with hearing loss for many years to come.

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## INTRODUCTION

If you are reading this guide, you are probably working with, or planning to work with, a child who has a MED-EL Cochlear Implant System, or you might be wondering if a child is eligible to receive a cochlear implant. As an educator given the opportunity to work with a child using a cochlear implant, you may feel excited, overwhelmed, apprehensive, energized, tentative...or all of the above. Rest assured that you are not alone on this journey. Most classroom teachers do not have training or experience with children who are deaf or hard of hearing. Therefore, professionals in the field of deafness are eager to answer your questions. With access to the right resources (including this guide), you have every reason to trust that you will provide your child with many enriching and valuable learning experiences.

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The *MED-EL Handbook for Educators* is designed to enhance your current teaching practices as you work with the child who is learning to listen with a cochlear implant. It will provide an introduction to the system, and information to help you understand the workings of the implant, the implant process, what to expect, and how you can participate as fully as possible in the habilitation of the child.

Although we refer throughout the guide to “educators,” this resource is intended for all professionals who provide services to children with cochlear implants. Most children are served by a variety of professionals meeting an array of different needs – but all of those caregivers and service providers share the common goal of working together with the child’s family to create the best possible environment in which the child will learn. While it takes extensive training to become expert in the field of hearing loss, education and cochlear implants, please use this guide as an introduction to the myriad of teaching possibilities that exist for you and your child(ren). You will find additional avenues to further your skills in the Resource section.

The MED-EL cochlear implant represents today’s most exciting and innovative technology available for children with hearing loss. Enjoy the journey!

WITH ACCESS TO THE  
RIGHT RESOURCES,  
YOU HAVE EVERY REASON  
TO TRUST THAT YOU WILL  
PROVIDE YOUR CHILD  
WITH MANY ENRICHING  
AND VALUABLE  
LEARNING EXPERIENCES.



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## CHILDREN WITH COCHLEAR IMPLANTS IN THE CLASSROOM

The age at which children receive cochlear implants varies. As an educator, a child may come into your classroom as a new cochlear implant user or with several years' experience. Regardless of the amount of time the child has been listening with the device, there are general themes and concerns that apply to most classrooms. We would like to address some common concerns here:

### What will I need to know about the child's equipment?

The MED-EL cochlear implants are designed to be sturdy and stand to up to a child's active lifestyle. It is important to recognize that all technology is susceptible to malfunctions. Therefore, educators will need to monitor the equipment and employ some troubleshooting techniques if a problem is identified. In addition, many children who listen with a cochlear implant also use an assistive listening device, such as an **FM system**. These devices improve the child's access to spoken language. It is critical that these are functioning properly and used consistently in the classroom. Please refer to the specific manuals to learn more about the system used in your classroom. Educators are encouraged to use all of the people and resources at your disposal. These include but are not limited to: books, journals, the internet, The HearSay newsletters, the child's family, the educational team, the cochlear implant center, MED-EL, and the school's audiologist, etc.

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## I'm not comfortable with technology and would rather not handle the speech processor.

This is a common concern for many teachers. The most important thing to remember is that the child's success is dependent on consistent and meaningful access to sound, especially speech. If the child cannot hear (even temporarily), he will be unable to participate in class, to learn the day's materials or to have conversations with his peers. More often than not, the "maintenance" chores that will fall on the teacher or classroom staff include replacing **batteries** or cables. If the problem persists after the troubleshooting steps are completed, contact the child's parents. The parents will then contact the child's cochlear implant center, and that staff will address the problem. The best way to deal with any anxiety surrounding the handling of the device is to schedule an appointment with the child's parents or a member of the cochlear implant team. A hands-on "tutoring" session will help you feel comfortable with this responsibility and further ensure the child's constant access to sound while at school.



THE BEST WAY TO DEAL WITH ANY ANXIETY SURROUNDING THE HANDLING OF THE DEVICE IS TO SCHEDULE AN APPOINTMENT WITH THE CHILD'S PARENTS OR A MEMBER OF THE COCHLEAR IMPLANT TEAM.

## How can I meet the needs of a child with a cochlear implant while I have 25 other children who need attention?

Children with cochlear implants do their best when:

- :: Listening in an environment with little or no background noise.
- :: Fellow children only speak one at a time and do not interrupt one another.
- :: Instructions are presented clearly, in advance and when the class is quiet.
- :: Spoken information is given with clear language and in an audible voice.
- :: Curriculum and lessons are presented with structure and predictability.

The key issue here is that all of the above factors are critical to the success of ALL children in the class – whether they have a hearing loss or not. In other words, the majority of adjustments made for a child with a cochlear implant are of benefit to his or her classmates as well.

Many children with cochlear implants will require additional accommodations to reach his or her maximum academic potential. These will be specified in the child's Individual Education Plan (IEP).

I'm not used to working with such a large team of professionals.  
How can I trust that I will still be in charge of my classroom?

The child with a cochlear implant does generally enter the educational system with an entourage of professionals from a variety of disciplines. This group may include, but is not limited to: the child's parents and/or caregivers, a **speech/language pathologist**, a teacher of the deaf, an audiologist, an interpreter or transliterator, a motor therapist, an auditory therapist, or a personal aide. Obviously, they do not all attend class with the child, but it is not uncommon for a teacher to feel a bit invaded by the process. You may be asked to welcome observers into your room at various times of the school year. There may be a professional interpreter as a full time member of the class. You may be asked to adapt your teaching approach. The key to working effectively and harmoniously with a varied group of professionals is to maintain communication. It helps when all the members of the team share one another's email addresses, phone numbers and the most convenient times to be reached by phone. It is sometimes helpful if one team member is identified as "the point person" to ensure the flow of information within and between agencies as well as scheduling appointments as necessary.

How much should my child use the interpreter and how much should she talk and listen for herself?

Although many children who receive a cochlear implant rely on spoken communication, some children who have cochlear implants rely on visual language in addition to their hearing and speech. This is especially true for older children who had an established sign language base prior to receiving the cochlear implant. Other children may require an oral interpreter; a professional who provides lip reading assistance during instruction. Some school districts utilize a notetaker, so that the child may focus all of her attention on the teacher during lectures. It may be part of the child's IEP to have a sign language or oral interpreter in the classroom for all or part of the school day.

For those children who utilize a sign language interpreter, it will be necessary to balance the child's need for auditory demands and challenges while respecting her existing reliance on visual language. All the team members, especially the parents, teacher, interpreter, speech/language pathologist and/or auditory therapist need to monitor the child's developing auditory skills. It's important to keep auditory expectations high with these children and help them to trust and use their new listening skills. A good practice to follow in the early stages of learning to listen is to allow the child full visual access to language (i.e. use the interpreter) during academic discussions, and challenge the child's listening during less stressful conversations

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with the interpreter there as a back-up. Even so, ensuring that main concepts and vocabulary are introduced and/or reinforced auditorally will help the child integrate hearing into his or her communication system.

## COMMUNICATION OPTIONS AND EDUCATIONAL PLACEMENTS

Today, many children function successfully with cochlear implants in the mainstream, where they are expected to compete academically alongside their peers with normal hearing. Some schools provide inclusion classes, where the child is placed in a mainstream classroom, but may not be expected to compete academically at grade level. Regardless, the debate over the best way to educate a child with hearing loss continues. Historically, the opposing viewpoints focus on one primary issue to varying degrees. That issue is whether to utilize visual language (i.e. sign language) or to focus entirely on auditory language with children who are deaf or hard of hearing. Please see the chart on the next page to learn more about each type of communication mode and educational philosophy. There is no single approach that works well with all children and their families. The universal truth that does exist is that all children with cochlear implants must be provided with an environment that emphasizes hearing. To that end, it is important for educators to monitor their teaching practices and ensure they are supplying their children with an enriched listening environment. You will find a comprehensive list of effective teaching strategies in the section “Teaching Style,” but here is a list of questions you can ask yourself to help you stay on track:

- :: Am I sensitive to the background noise in my classroom, and do I make efforts to eliminate/reduce it?
- :: Do I continually monitor the child’s responses to speech/sound, and do I know where to go for help if the speech processor or FM needs repairs that are beyond my means?
- :: Am I sensitive to the child’s seating placement in group settings, and their distance from the speaker?
- :: Do I expect the child to listen and speak for herself? Or do I merely encourage it and accept skills that are below the child’s capabilities?
- :: Do I maintain ongoing communication with the child’s family, individual therapist(s), and cochlear implant center?
- :: Do I actively create situations in which the child’s listening and speech skills will be challenged?
- :: Do I periodically review the list of effective teaching strategies and add my own as I discover them throughout the school year?

COMMUNICATION OPTIONS CHART

Source: BEGINNINGS for Parents of Children Who are Deaf or Hard-of-Hearing, Inc. :: www.ncbegin.org

AMERICAN SIGN LANGUAGE  
ENGLISH AS A SECOND LANGUAGE (ASL/ESL) BILINGUAL/BICULTURAL

	AUDITORY VERBAL UNISENSORY	ORAL AUDITORY-ORAL	CUED SPEECH	TOTAL COMMUNICATION	AMERICAN SIGN LANGUAGE ENGLISH AS A SECOND LANGUAGE (ASL/ESL) BILINGUAL/BICULTURAL
DEFINITION	A program emphasizing auditory skills. Teaches a child to develop listening skills through one-on-one therapy that focuses attention on use of remaining hearing (with the aid of amplification). Since this method strives to make the most of a child's listening abilities, no manual communication is used and the child is discouraged from relying on visual cues.	Program that teaches a child to make maximum use of his/her remaining hearing through amplification (hearing aids, cochlear implant, FM system). This program also stresses the use of speech reading to aid the child's communication. Use of any form of manual communication (sign language) is not encouraged although natural gestures may be supported.	A visual communication system of eight handshapes (cues) that represent different sounds of speech. These cues are used while talking to make the spoken language clear through vision. This system allows the child to distinguish sounds that look the same on the lips.	Philosophy of using every and all means to communicate with deaf children. The child is exposed to a formal sign-language system (based on English), finger spelling (manual alphabet), natural gestures, speech reading, body language, oral speech and use of amplification. The idea is to communicate and teach vocabulary and language in any manner that works.	A manual language that is distinct from spoken English (ASL is not based on English grammar/ syntax). Extensively used within and among the deaf community. English is taught as a second language.
PRIMARY GOALS	To develop speech, primarily through the use of aided hearing alone, and communication skills necessary for integration into the hearing community.	To develop speech and communication skills necessary for integration into the hearing community.	To develop speech and communication skills necessary for integration into the hearing community.	To provide an easy, least restrictive communication method between the deaf child and his/her family, teachers and school-mates. The child's simultaneous use of speech and sign language is encouraged as is use of all other visual and contextual cues.	To be the deaf child's primary language and allow him/her to communicate before learning to speak or even if the child never learns to speak effectively. Since ASL is commonly referred to as "the language of the deaf", it prepares the child for social access to the deaf community.
LANGUAGE	Child learns to speak through the early, consistent and successful use of a personal amplification system (hearing aids, cochlear implant, FM system).	Child learns to speak through a combination of early, consistent and successful use of amplification and speechreading.	Child learns to speak through the use of amplification, speech reading and use of "cues" which represent different sounds.	Language (be it spoken or sign or a combination of the two) is developed through exposure to oral speech, a formal sign language system, speech reading and the use of an amplification system.	Language is developed through the use of ASL. English is taught as a second language after the child has mastered ASL.
EXPRESSIVE LANGUAGE	Spoken and written English	Spoken and written English	Spoken English (sometimes with the use of cues) and written English.	Spoken English and/or sign language and finger spelling and written English	ASL is child's primary expressive language in addition to written English.
HEARING	Early, consistent and successful use of amplification (hearing aids, cochlear implant, FM system) is critical to this approach.	Early and consistent use of amplification (hearing aids, cochlear implant, FM system) is critical to this method.	Use of amplification is strongly encouraged to maximize the use of remaining hearing.	Use of a personal amplification system (hearing aids, cochlear implant, FM system) is strongly encouraged to allow child to make the most of his/her remaining hearing.	Use of amplification is not a requirement for success with ASL.
FAMILY	Since the family is primarily responsible for the child's language development, parents are expected to incorporate on-going training into the child's daily routine and play activities. They must provide a language-rich environment, make hearing a meaningful part of all the child's experiences and ensure full-time use of amplification.	Since the family is primarily responsible for the child's language development, parents are expected to incorporate training and practice sessions (learned from therapists) into the child's daily routine and play activities. In addition, the family is responsible for ensuring consistent use of amplification.	Parents are the primary teachers of cued speech to their child. They are expected to cue at all times while they speak; consequently, at least one parent and preferably both must learn to cue fluently for the child to develop age-appropriate speech & language.	At least one, but preferably all family members, should learn the chosen sign language system in order for the child to develop age-appropriate language and communicate fully with his/her family. (See NOTE below.)	Child must have access to deaf and/or hearing adults who are fluent in ASL in order to develop this as a primary language. If the parents choose this method they will need to become fluent to communicate with their child fully.
PARENT TRAINING	Parents need to be highly involved with child's teacher and/or therapists (speech, auditory-verbal, etc.) in order to learn training methods and carry them over to the home environment.	Parents need to be highly involved with child's teacher and/or therapists (speech, aural habilitation, etc) to carry over training activities to the home and create an optimal "oral" learning environment. These training activities would emphasize development of listening, speech reading and speech skills.	Cued speech can be learned through classes taught by trained teachers or therapists. A significant amount of time must be spent using and practicing cues to become proficient.	Parents must consistently sign while they speak to their child (simultaneous communication). Sign language courses are routinely offered through the community, local colleges, adult education, etc. Additionally, many books and videos are widely available. To become fluent, signing must be used consistently and become a routine part of your communication.	If parents are not deaf, intensive ASL training and education about deaf culture is desired in order for the family to become proficient in the language.

**NOTE FOR TOTAL COMMUNICATION:** It should be noted that a parent's acquisition of sign vocabulary and language is a long term, ongoing process. As the child's expressive sign language broadens and becomes more complex, so too should the parents' in order to provide the child with a stimulating language learning environment. The family is also responsible for encouraging consistent use of amplification.

**NOTE FOR ASL:** Although American Sign Language is the accepted language of the Deaf community in the USA, other countries and cultures have similar signed languages, such as British Sign Language in the UK.





# 2

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## FAMILIES FIRST AND FOREMOST

Do not read any further until you absorb this fact: the child with hearing loss learns and expands language skills at home, within the context of family life. The school is a place where the child needs to apply those skills and incorporate them into academic demands. As the child's current educator, you are asked to challenge his skills while providing an effective learning environment. Whether you are working with a family whose child is an infant or a teenager, it is essential to acknowledge yourself as a partner with the child's primary teachers – his family.

Here are some suggestions for maintaining partnerships with families. Expand these suggestions and individualize them to meet your needs and those of your child's family.

**Actively pursue the family's insights into their child's learning style and strengths.** Initiate an informal meeting before or early in the school year so you can assure the child's family that you will seek their input.

**Maintain communication on a regular basis.** Some teachers and parents opt to share a communication book that travels with the child between school and home. Family members, teachers, therapists and – when appropriate – the child can write important information on a daily or weekly basis. Email is another option, or regularly scheduled phone calls. Establish phone appointments so families are able to reach you without disrupting class time.

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**Keep the family informed about any changes you notice at school.** Don't forget to celebrate positive progress – especially if the conversations between home and school are typically weighted in problem solving.

**Invite the parent or guardian to observe your classroom.** Since parents know their children better than anyone, they may be able to suggest effective strategies to assist in listening. While some teachers may feel uncomfortable with this option at first, it has the potential to yield excellent results and lead to a mutually respectful relationship.

**Seek out a relationship with the child's cochlear implant center.** If you have not been contacted by the cochlear implant team, obtain permission from the family to call yourself. Ask the family to identify the best contact person on the team and introduce yourself as a professional eager to contribute to the child's success with a cochlear implant.

WHETHER YOU ARE  
WORKING WITH A FAMILY  
WHOSE CHILD IS AN  
INFANT OR A TEENAGER,  
IT IS ESSENTIAL TO  
ACKNOWLEDGE YOURSELF  
AS A PARTNER WITH  
THE CHILD'S PRIMARY  
TEACHERS – HIS FAMILY



# 3

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## THE IMPORTANCE OF AUDITORY SKILLS

Why is the development of auditory skills so critical?

In order to understand why reduced hearing creates a potential problem for spoken language development, it is helpful to understand the function of hearing. Please refer to this guide's section on "The anatomy and physiology of hearing and hearing loss" to become familiar with the physiology of hearing.

In terms of the function of hearing, we need to respect how valuable it is for language development. Newborn babies with normal hearing are exposed to a myriad of sound stimulation. In the first days and weeks of a newborn's life, she is able to hear many sounds – but is not able to understand them. It is only through months of listening to all kinds of talking, singing and "cooing" that the baby even begins to comprehend the basic meaning of spoken language. It may be helpful to recognize that a baby with normal hearing has ears that take sound in, but her brain has not yet developed the ability to make any sense of those sounds. Listen to the way most people speak to babies and you will hear:

- :: **lots of inflection:** ("Oooh! Look at the beautiful baby! I just want to squeeeeeeeze you!");
- :: **lots of repetition:** ("Where are your toes? Give me those toes! I'm gonna tickle those toes! Oh, you have the cutest little toes!");
- :: **variety of speech patterns** ("Here comes the bunny. Watch it hop, hop, hop! Wheeeee – it jumped down!");
- :: **and a variety of emotions:** ("Oh, you have a boo-boo."  
"Let's go find Daddy!" "Don't touch that! It's hot!").

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Babies with normal hearing begin to get the idea that different types of speech patterns have unique meanings. These concepts are reinforced through the experiences the baby has when listening to those patterns. For example, when she hears “Oooh! Look at the beautiful baby!” that pattern is typically accompanied by smiles, perhaps hugs and a general feeling of comfort and happiness. Therefore, that pattern – not the individual words, yet – becomes something the child hears and recognizes as fun and comfortable. These different patterns and the use of vocal pitch changes are referred to as the **suprasegmentals** of spoken language. They carry a great deal of meaning, help clarify our spoken messages and give the newborn baby her beginning understanding of spoken language. The language a child is able to understand is commonly referred to as **receptive language**, or language the child receives.

While the baby is listening and starting to comprehend the meaning of speech, she is also playing with the sounds of her own voice. Typically, babies coo, laugh, gurgle, yell, sigh – they make all sorts of sounds with their voices and mouths. Most parents and caregivers imitate those sounds back to the baby and make a game out of it. This is one way the baby learns to “take turns” while communicating. The baby is also learning to match the sounds she hears with the sounds she makes. It takes lots of practice playing with all those sounds, feeling what their mouth needs to do and checking it with their own hearing, before the baby produces them well. Over the first several years of the baby’s life, all that listening and talking practice results in the ability to understand spoken language, say words, make sentences and express her wants, ideas and humor.

This natural progression is precisely what we strive to provide for the child with hearing loss. More babies with hearing loss are being helped at earlier ages than ever before with the progression of **newborn hearing screening**. With properly fitted hearing aids during infancy, early cochlear implantation when appropriate, and effective auditory intervention, we can maintain high expectations for deaf children to develop excellent listening and spoken language skills. In the early months of the cochlear implant journey, professionals are patiently leading the child through the same early developmental stages of audition that babies with normal hearing seem to pass through effortlessly. Our challenge is to lay this developmental foundation in ways that are interesting and valuable for the child, regardless of their age or previous experience.

IN TERMS OF THE  
FUNCTION OF HEARING  
– WE NEED TO RESPECT  
HOW VALUABLE IT IS FOR  
LANGUAGE DEVELOPMENT.



# 4

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## THE ROLE OF THE EDUCATOR

Children with hearing loss are, with few exceptions, enrolled in some type of educational setting. The person or persons providing intervention for the child with a cochlear implant may be: a teacher of the deaf, a regular education teacher, a speech language pathologist, an audiologist or a parent-infant specialist. Whether in a classroom or participating in an individual therapy session, the professional who consistently strives to maximize the child's auditory skills will go far towards contributing to the success of the cochlear implant.

### DEFINING "SUCCESS"

Before we begin to discuss expectations and what you can do to maximize the child's auditory experience, it is important to emphasize the wide variability of performance among children who receive cochlear implants. There are many children who are outstanding performers and who achieve levels of communicative competence that astound even the most seasoned professionals. And, there are children who, despite all efforts, don't seem to be destined to be auditory learners. However, even those children will most likely experience successes of some kind with their implants. If a child isn't making realistic progress, in light of his or her own individual set of strengths and challenges, try another approach that makes the most of what they CAN accomplish. Remember that children have to start where they are, and move forward from there. The cochlear implant will not change where they started, but can change the rate and degree of their progress.

## FACTORS THAT INFLUENCE SUCCESS

Researchers have tried valiantly to analyze populations of children with cochlear implants to determine what factors will give the child the best chance for success with a cochlear implant. Different studies in different populations point to different factors, but in general, it is agreed that the following factors can have an effect, either positive or negative, on a child's prognosis:

POSITIVE FACTORS	NEGATIVE FACTORS
Young age at time of implant.	Poor or inconsistent hearing aid use prior to implant.
Strong family support, where family members share a common goal for communication development and dedicate significant time and attention to communicating constructively with their child.	Other learning challenges not related to hearing loss, or the presence of an inner ear anomaly.
All professionals, family and caregivers share common goals for communication development and expectations for success.	Poor communication between caregivers and professionals.
Best possible use of <b>residual hearing</b> prior to receiving the implant.	Inconsistent device use.
Short length of deafness.	Child spends significant time in an environment where there is little spoken interaction or little opportunity to associate sound with meaning.
Educational environment that is supportive of learning through hearing and the use of the implant. Listening is expected and valued.	Expectations too high or too low.
All providers support the parent's choice of communication method, with language development being of paramount importance.	The child is in an environment where there are few, if any, reasons to listen.



# 5

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## WHAT TO EXPECT AND HOW YOU CAN HELP AT EACH STAGE

### STAGE I: IN THE PRE-IMPLANT PROCESS

Many implant teams welcome input from the educational professionals who have been working with the child. Open communication with the implant center is encouraged. You may be able to provide important insight into the child's communication and learning style that can't be duplicated in the clinic. Important information might include:

- :: Insight into the child's ability to maintain attention.
- :: Carryover of skills from one activity or environment to another.
- :: Consistency of communication between home and school.
- :: Insight into the child's learning style.
- :: Consistency of hearing aid/FM use in the classroom.
- :: Degree to which the child is able to use **residual hearing**.
- :: Insight into any communication frustration the child is experiencing.
- :: Assessment of the child's interactions with adults and peers.

The child will experience a variety of evaluations as part of the candidacy process towards potential cochlear implantation. If an implant is eventually recommended, he or she will be asked to make global judgments about the quality of sound presented. You can help the child participate in this process by teaching the following concepts at an age-appropriate level, if the child has not already learned them: okay, little, big, too much, stop, nothing, more, like/don't like.

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## STAGE 2: AFTER THE IMPLANT HAS BEEN NEWLY ACTIVATED

Ideally, it is desirable to have consistent communication among the child's family, cochlear implant audiologist, caregivers and educators. There are many reasons for this (i.e. the need to share effective teaching strategies; keeping all parties aware of any concerns; and sharing one another's expertise) and one issue is especially important as it relates to the child's maps. As the child develops listening skills, there will be changes to the maps programmed into the **speech processor**. As changes are made to the programs in the speech processor, it is of the utmost importance that all who are involved in the care of the child understand which is the primary map to be used daily, and when other settings should be applied. Many implant centers send some type of report or form home with the parents after a **mapping session** so that pertinent information can be disseminated among the child's team of professionals. Important information might include: the child's recommended daily use settings, whether significant changes were made to the map that may require a brief adjustment period, or whether certain maps were made for specific listening environments.

### What to expect

Generally, children who are new to the experience of listening with a cochlear implant will exhibit a broad spectrum of skills and behaviors. Even children who may have had normal hearing at one point, or had been successful hearing aid users will require time to adjust to the new sensation provided by the cochlear implant. Please note that every child will have his or her own unique set of responses. Any questions or concerns regarding a specific child should be directed to the family and the cochlear implant center.

When first wearing the speech processor, the child may or may not:

- :: Become quiet and reserved.
- :: Show excitement when new sounds are introduced.
- :: Become agitated or clingy.
- :: Become upset when new sounds are introduced.
- :: Increase the use of her voice (for **vocal play**, not words).
- :: Seek out sources of sounds and voices.
- :: Frustrate her caregivers by repeatedly taking the coil off her head.
- :: Become more tired than usual throughout the day.
- :: Have more energy than usual.

During the early weeks of cochlear implant experience, the following skills and behaviors are NOT expected:

The child will most likely not:

- :: Understand speech when adults or other children talk to him.
- :: Have the ability to use the telephone.
- :: Acknowledge new sounds (even simple communication), especially in environments where numerous auditory or visual distractions are present.
- :: Use clear speech.
- :: Understand conversation in the classroom or in social situations.

As you can see, there are no right or wrong responses – only a variety of experiences that could arise. The family, friends and educators interacting with the child who is a new listener are responsible for providing a rich auditory environment while observing the child's behavior. It can be very tempting to constantly "test" the child's hearing with the new cochlear implant (i.e. calling the child's name without any need to do so, clapping or making other noises – just to see if the child reacts). This will only result in the child's loss of interest in the sound source. After all, how often would you continue to turn around to your name if your only reward was a nod from the speaker? It cannot be stressed enough that the adult's role during these early weeks and months is to build the listening foundation upon which spoken language rests. In other words, talk to the child and observe progress in terms of the child's increasing ability to pay attention to sound, tolerate and seek new sounds and show interest in spoken conversation. Don't demand progress in terms of the child's ability to talk more or follow directions yet. Those skills will come in time, but only when the adults have the patience and commitment to build that natural listening foundation first.

IT CANNOT BE STRESSED  
ENOUGH THAT THE  
ADULT'S ROLE DURING  
THESE EARLY WEEKS AND  
MONTHS IS TO BUILD THE  
LISTENING FOUNDATION  
UPON WHICH SPOKEN  
LANGUAGE RESTS.

### **Important feedback to the team following activation**

Early maps are usually not precisely fit – just as the child is learning about sound, he is also learning how to give specific feedback during mapping sessions. Over time, the map will be fine-tuned to fit his needs (see the Mapping section of this guide). In

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these early stages, the map may become too loud or too soft in just a day or two as the body continues to adjust to the new stimulation. At this point, information about how the child is adjusting to this new life change can help the implant center determine whether the map is appropriately set or whether adjustments should be made. Helpful information to provide to the implant team includes the following:

- :: Does the child come to school with the device in place and in working order?
- :: Does he or she wear the device consistently throughout the day?
- :: Does the child tend to pull the device off during the day?
- :: If the coil comes off, does the child reposition it, or indicate a problem and ask for help in putting it back on?
- :: Is the child vocalizing more frequently while the device is on?
- :: Does the child seem to be more attentive?
- :: Is the child easily agitated or emotional?
- :: Any other notable changes in behavior/communication/attitude?

### **Important information to receive from the team following activation**

It is usually beneficial to have some basic information from the implant team that will help you know what to look for during these first days and weeks. Things may be changing very quickly during this phase. Helpful information to receive from the team includes:

- :: Which processor settings should the child use, and how will I know if they should be changed?
- :: Who will make the decision to change settings?
- :: How accurate are the settings? Remember at initial sessions the maps are often not very precise.
- :: What responses should I be looking for and encouraging?
- :: When is the next appointment?

STAGE 3:  
AFTER THE CHILD HAS USED THE  
IMPLANT FOR SEVERAL MONTHS

**What to expect**

Children vary significantly in the type of progress that they make with the cochlear implant; this depends greatly on the skills they started with in the beginning. However, in general, progress should be steady over time. Children should be wearing the speech processor consistently within a very short time after initial hook-up.

In clinical studies with the MED-EL implant system, auditory skill development was measured over time on 77 children ranging in age from 18 months to 18 years<sup>1</sup>. After six months of implant use, statistically significant trends for improvement were seen in the following skill areas (all responses were elicited using hearing alone, without visual cues):

CHILDREN SHOULD BE  
WEARING THE IMPLANT  
CONSISTENTLY WITHIN A  
VERY SHORT TIME AFTER  
INITIAL HOOK-UP.

- :: **Awareness of sound:** The child nonverbally or verbally indicates the presence or absence of sound. Example: The child's eyes widen when he/she hears mother's voice; child vocalizes in response to initiation or cessation of a sound.
- :: **Attention to sound:** The child attends to what he/she hears for an extended period of time (a few seconds or longer). Example: The child pauses and listens to mother's voice.
- :: **Searching for a sound source:** The child looks around, but may not necessarily find the sound source. Example: The child glances or moves in search of the sound.
- :: **Indicating when sound starts and stops:** The child is able to indicate when sounds stop and start. Example: The child moves a toy while the adult is vocalizing, stopping when the adult's voice stops, or plays musical chairs appropriately.
- :: **Identifying a sound source:** The child turns to the source of a sound. The child may turn the wrong way initially but continues to search until the correct source is found.
- :: **Imitating the duration of a sound or speech:** Example: The child imitates, through babbling or jargon, a long vs. short string of syllables or "sentence," or imitates a rhythmical pattern with a toy.

REFERENCE :: (1) Franz DC, Caleffe-Schenck N, Kirk K. (2004) A tool for assessing functional use of audition in children: Results in children with the MED-EL COMBI 40+ Cochlear Implant System. The Volta Review 104(3), pp 175-196.

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- :: **Imitating the pitch of a sound or speech:** The child imitates vocal inflection for common utterances, such as falling pitch in “uh oh,” or imitates rising inflection for a question such as “more?”
  - :: **Imitating the intensity of a sound or speech:** Example: The child imitates loud vs. quiet sounds such as using a loud voice to wake up a doll vs. a quiet voice when the doll is sleeping.
  - :: **Modifying his or her own utterance to more closely match an adult model using hearing alone:** The child modifies his/her speech to more closely match an adult model, without benefit of speechreading, visual or tactile cues. Examples: The child lowers pitch of voice after listening to adult produce a lower-pitched sound, approximates articulation (such as producing “mmm” in response to “moo”), or modifies speech from “pour” to “more” to match a spoken cue. Acquisition of this skill indicates that the child is able to use audition to improve speech production.
  - :: **Identification of simple phrases or directions:** The child responds to simple phrases or predictable directions, such as “uh-oh!,” “open the door.” Alternatively, the child identifies sounds for objects, such as looking at a toy duck when mom says “quack quack.”
  - :: **Remembering and repeating 3 or more critical elements in an utterance:** The child remembers groups of words that contain varying numbers of critical (differing) elements. Example: The child finds “little green ball” versus “big red ball” (two critical or differing elements).
  - :: **Identifying words or phrases in noisy settings:** The child identifies and comprehends the primary speaker from a background of noise or competing messages, such as a crowded waiting room, a noisy restaurant, or while music is playing in the therapy room.

Children in the study<sup>1</sup> had a wide range of ages and educational backgrounds, and had a variety of different skill levels pre-operatively. Children who made the most of their **residual hearing** with hearing aids prior to receiving an implant may progress more quickly in these initial months. Although it is important to keep individual differences in mind, to remain positive even if progress seems to be slow, and to be realistic about each child’s potential, it is also important not to underestimate the possible benefits that can and have been attained by many children who use cochlear implants - namely to develop meaningful communication skills through audition.

Even though listening skills should be improving, progress in speech production skills may or may not be very apparent, even after several months of implant use. Children need to be exposed to spoken communication in a positive and supportive environment before they are able to begin to use it expressively. For suggestions, see “Creating a positive communication environment.”

Early signs that speech production is developing are:

- :: Increased vocalization when the implant is on.
- :: Attempts to use a core vocabulary of functional words and phrases that may not be fully intelligible.
- :: Improved imitation of speech sounds.
- :: The child’s phonemic repertoire begins to include sounds that he or she could not detect or discriminate with hearing aids, such as ‘s’.

### **Important feedback to the team after months of listening**

Your feedback can assist the implant team in evaluating the effectiveness of mapping visits and tracking overall progress. A lack of overall progress is also important to communicate. See “What to expect” for information on establishing realistic expectations for progress. During this stage, important feedback to the implant center might include:

- :: Any significant progress in communication skills.
- :: Whether any skills have regressed that were previously learned.
- :: The child’s speech has improved/deteriorated from a previous level.
- :: The child has become more (or less) attentive or easily frustrated.
- :: The child is asking “what?” more frequently than usual.
- :: There has been a change in a child’s ability to detect or discriminate sounds after a period of consistent responses (see the *Equipment Guide* for the child’s speech processor for information on quick methods for assessing detection and discrimination skills).

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### What to do if your expectations are low

It is generally understood that expectations play an important role in a child's performance. Having expectations that are too high or not allowing adequate developmental time can lead to disappointment. At the other end of the spectrum is the belief that cochlear implants do not provide sound stimulation effectively enough to promote spoken language development. Educators acting on this belief system will surely create an ineffective listening environment where children are not expected to participate in spoken language or the world of sound. It has already been established that, in order for a child to develop functional spoken communication skills, he or she needs consistent experience listening to and using spoken language. For example, a child who is only expected to listen during individual therapy sessions and not throughout the school day will not reach his or her full listening potential. Please see the resource lists at the end of this guide for further reading that will help families and educators create a listening environment that is exciting and enriching for children.

A CHILD WHO IS ONLY  
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DURING INDIVIDUAL  
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REACH HIS OR HER FULL  
LISTENING POTENTIAL



# 6

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## THE CHILD WITH A HEARING LOSS IN THE CLASSROOM: ISSUES TO CONSIDER

### DAILY LISTENING CHECKS

Probably the most important component that helps a child to be successful with the cochlear implant is consistent use of a working **speech processor**. It is important to encourage use of the processor during all waking hours, unless otherwise instructed by the cochlear implant center. It is also important to be sure the speech processor is providing the best signal possible for the child. A method for doing a simple daily listening check is described in detail **Equipment Guide** for the child's speech processor. Get into the habit of checking the child's ability to detect and discriminate sound each day. Not only does it help you to be sure your teaching will be effective, but it also teaches the child the importance of monitoring the quality of his or her own hearing. Ideally, we want the child to eventually learn to report when equipment is malfunctioning or when a new **map** is needed. However, until he or she learns to self-advocate, a daily listening check verifies equipment function and reinforces the importance of consistent and good-quality hearing. Remember that prior to having an implant, the child's hearing acuity was simply something with which he or she had to cope, and was unable to change. Once implanted, the child can begin to realize that mapping can change sound quality in many different ways, providing a way for hearing to be customized to each user's preferences.

For more specific guidance about how to establish a daily listening check routine, please see "Daily Listening Checks" in the **Handling and Troubleshooting Guide** for the child's speech processor.

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## PREPARING THE CLASSROOM

There are a number of simple strategies you can use that will improve the physical environment and give the child the best possible opportunity to hear well in the classroom. These strategies often help typically developing children as well, so they are good habits to adopt. Remember that, even though the child has a cochlear implant, he or she still will function to some degree as a child with a hearing loss. This is particularly important to keep in mind with high-performing children; when communication goes smoothly for the most part, it is easy to forget that the classroom is often a challenging environment for a person with a hearing loss.

### **Some strategies to consider:**

**Reduce background noise and reverberation as much as possible.** Carpets, wall hangings, and curtains will help reduce sound reflection from the hard surfaces of walls, floors and windows. A carpet remnant should be placed in the block area of younger classrooms. Even textured wallpaper will provide some dampening effect.

The movement of chairs and tables on hard floors generates a tremendous amount of classroom noise. Full carpets are not always feasible. One solution is to **place rubber tips on the bottoms of each chair and table leg**. A fun and inexpensive alternative is to solicit contributions from a local tennis club and get a supply of used tennis balls. Slice an "X" on each ball using a utility knife. Place one ball on the bottom of each chair or table leg. It may be necessary to treat the classroom directly above your room if their floor noise comes through your ceiling. Many teachers enjoy the noise suppression benefits achieved by this method so much, they continue to use it long after the child with hearing loss has graduated from their classes.

Classrooms should ideally have **four full walls and a door** to reduce noise.

Arrange the classroom so that **visual distractions are limited** in the area where the teacher provides the majority of instruction. Visual distractions include light or glare, or less than optimal lighting on the speaker's face.

PROBABLY THE MOST  
IMPORTANT COMPONENT  
THAT HELPS A CHILD TO  
BE SUCCESSFUL WITH  
THE COCHLEAR IMPLANT  
IS CONSISTENT USE OF  
A WORKING SPEECH  
PROCESSOR.

**Place the child in a preferential spot** (i.e., close to the teacher), if possible, and away from other noise sources. Some noise sources include, but are not limited to:

- :: Ventilation or heating unit
- :: Fish tank with a filter
- :: Printer
- :: Class pet that makes chirping or squeaking sounds
- :: Door to the classroom
- :: Lavatory

### CREATING A POSITIVE EDUCATIONAL ENVIRONMENT

Most cochlear implant team members would agree that a positive educational environment is one of the most important ingredients in a child's success with a cochlear implant. Regardless of the child's **communication methodology** (using speech only, a combination of speech and sign language, or cued speech), an environment that supports the consistent use of the implant, provides rich opportunities to relate listening to all aspects of learning, and expects the child to use sound for meaningful communication is crucial for the child to make fullest possible use of the implant. Let's take a look at some general parameters for professionals working with these children and their families.

#### **DO's and DON'T's for educators:**

DO maintain expectations that the child will develop auditory skills.

DON'T restrict the child's listening development by having low expectations.

DO attend workshops and meetings that explore cochlear implant technology, research and pediatric (re)habilitation.

DON'T expect good speech production from the child unless you are committed to providing intensive auditory work first.

DO expect the child to use his or her voice for communication. While he or she may not have clear speech early in the process, remember that one of the best ways to improve speech is by speaking.

DO adapt the physical environment of the classroom, home or therapy room as much as possible so that background or interfering noise is minimized.

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DO respect the relationship that exists between a family and their cochlear implant center. If a difference of opinion arises between you and the cochlear implant team, DO resolve it in a professional and responsible manner.

DO initiate conversations with cochlear implant centers that may not be sensitive to a child's educational and therapeutic needs. Remember to get written permission from the child's parent or legal guardian before sharing information either over the phone or in writing.

DO understand that a family needs clear and unbiased information. Whether you strongly support or are strongly opposed to pediatric cochlear implantation, DON'T deluge a family with rhetoric and rumor. Opinions should be expressed only in the context of current and accurate information.

## TEACHING STYLE

Just as there are simple environmental strategies, there are also a number of things you can do as you are teaching that will greatly increase the child's chances of success.

**Provide as much context as possible.** Many newly implanted children need to feel successful in the beginning.

**Call attention to new or unusual sounds** when appropriate. This helps encourage the child to be aware of what is happening in the environment.

**Repetition is good.**

**Provide activities** that are appropriate to the age and interest of the child.

**Provide opportunities** to emphasize and practice new vocabulary.

**Model good listening behavior.**

Provide parents, therapists, and other caregivers with **important concepts and vocabulary** prior to teaching, so they can pre-acquaint the child.

When a child asks a question or gives an answer, **repeat it for the benefit of the whole class.** Children with hearing loss have particular difficulty determining where the speaker is in a group. By the time they find the speaker, they have often missed the answer.

If **using an FM system**, be sure to turn it off during times when your spoken communication is not the primary focus of the child using the FM.

ADAPT THE PHYSICAL ENVIRONMENT OF THE CLASSROOM, HOME OR THERAPY ROOM AS MUCH AS POSSIBLE SO THAT BACKGROUND OR INTERFERING NOISE IS MINIMIZED.

**Make use of visual supports** as much as possible: demonstrations, outlines, writing important words or phrases on the board, handouts. In doing this, avoid forcing the child to share attention between your face and the visual support, if possible. When visual supports are used, be sure to continue to reinforce the auditory component (i.e., repeat the key word or phrase) so that the child has an opportunity to reinforce auditory learning of the new concept.

When a discussion begins, make a habit of **identifying the speaker** so the child with a hearing loss has a chance to cue in before the speaker starts. Having the children use a play microphone (even an eraser, ruler or other item will do the job) can help the child with an implant orient more quickly to where the speaker is located in the room and will encourage children to take turns speaking.

**Avoid turning your back** and lecturing directly at the chalkboard. The child with a hearing loss will need to see your face. Similarly, avoid obstructing the child's view of your face with papers or books. Note that some therapy methodologies advocate removing all visual cues in specific therapy situations in order to focus the child's attention on auditory information only. Removing visual cues is also important during the daily listening check. However, this is not typically recommended during academic teaching.

**Change topics with a short summary** of what you just discussed, and outline the next topic you will talk about to provide context.

**Be aware** that the child with a hearing loss may miss a change of topic without realizing it until much later (or not at all).

**Speak normally;** over-enunciating makes speech reading more difficult.

Plan activities that support goals and objectives through **modalities other than listening**, such as hands-on, experiential opportunities that reinforce concepts.

Remember that the child can't see your face when taking notes or reading assignments. **Be sure that major points are understood.**

**Allow adequate processing time.** Children with hearing loss may require additional processing time, sometimes as much as seven seconds. Allow sufficient time before repeating or rephrasing the question.

**Be aware of lighting.** If you are standing in front of a sunny window or bright light, the child must look directly into the light, making it difficult to speechread. Your face will also be "backlit," increasing the difficulty. Sometimes the easiest solution is to seat the child with his or her back to the windows.

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**Watch for signs of confusion.** If they don't understand, children with hearing loss often answer based on their best guess of what you may have asked. If the answer doesn't make any sense, the question was probably not understood. Frequent “yes” answers are a coping mechanism and also may indicate a lack of understanding.

The child with hearing loss may be significantly more tired at the end of the day than other children, due to the increased effort of communication. The cochlear implant seems to help this, but children may still be less attentive toward the end of the day.

Most children prefer not to draw attention to themselves in the classroom. This may prevent a child with hearing loss from notifying the teacher if he or she is confused or did not hear a part of the discussion. It is a good idea to **meet with the child individually** and develop a simple code that will discretely notify the teacher of any difficulty experienced by the child. One example is the child can gently tap his forehead with a pen or pencil until the teacher notices and makes eye contact.

## DIRECTIONALITY AND NOISE

MED-EL speech processors have an omni-directional microphone, which means that they are able to pick up sounds that are not necessarily generated directly in front of the microphone. That being said, however, it is important to understand some of the ramifications of unilateral hearing – with only one ear – if the child has only one cochlear implant. The brain needs input from two ears (both sides of the head) in order to **localize** a sound and in order to filter out background noise. Children with unilateral cochlear implants quite often demonstrate a surprising ability to guess the general direction of a sound source, but it is important to remember that localization is a guess. It is also important to consider the environment, and be aware of any competing sounds that may interfere with the primary message. Sometimes it is helpful to identify the competing sound source and give the child an opportunity to note it – this sometimes seems to help the child place the sound “in the background” and pay less attention to it. For example, if a fan is on in the room, showing the child the source of the noise and taking a moment to listen to it together may help him or her to better disregard it.

Background noise is a classic problem for all people with hearing loss. Noise masks out the teacher's voice, especially if the child is close to the noise source (such as a heater or fan) and far away from the teacher. People with hearing loss find that small amounts of noise that aren't especially noticeable to others can be a significant obstacle to communication.

Children with bilateral cochlear implants may have somewhat less difficulty with speech understanding in noise and localization abilities, since these are skills that require the use of “two ears” to achieve. If you want specific information regarding these abilities in your child you can contact his implant center to determine if specific testing has been conducted.

### TEACHING THE EXPERIENCED IMPLANT USER IN THE MAINSTREAM

There are many implant users who are outstanding performers and who achieve levels of communicative competence that astound even the most seasoned professionals. Some of these children are ready to enter the typical school setting during the pre-school years, particularly if they received their implants at an early age. These children are experienced implant users and demonstrate skills that appear commensurate with their peer group. Parents as well as educators may be asking questions about the child’s readiness and the school’s ability to meet the needs of these children. As the child moves from a pre-school setting into kindergarten and primary school these issues become even more important, and as he approaches the upper grades, teaching strategies must evolve to help the child cope with increasing academic demands. The skills that a child with hearing loss needs for educational advancement through the years change as the demands for learning change throughout the years. Yearly IEP’s (Individual Education Plan) are important to identify strengths and weaknesses and ensure a positive educational placement. Periodic multidisciplinary testing for each child should be considered. The ***Mainstream Assessment of Readiness for Children Over Five (MARCOF)*** is an excellent tool for families and educators. It is intended to help evaluate the strengths and needs of children with hearing loss who are being considered or are already placed in the mainstream classroom. The MARCOF is a part of MED-EL’s BRIDGE to Better Communication program, listed in the “Resources” section.

It is important to remember that, even though the child has a cochlear implant, he or she still will function to some degree as a child with a hearing loss. This is particularly important to keep in mind with these high-performing children; when communication goes smoothly for the most part, it is easy to forget that the classroom is often a challenging environment for a person with a hearing loss.

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The strategies, teaching style and issues discussed in the earlier sections of this chapter are still relevant and very important for this group of high performing children. Please refer back to those sections as you prepare for a child with a cochlear implant in your classroom. Some strategies to review and remember:

- :: Daily listening checks
- :: Preparing the classroom
- :: Creating a positive educational environment
- :: Teaching style
- :: Do's and don'ts for educators

With experienced implant users, it is easy to become complacent about issues like regular communication between service providers and the family, or the importance of a working processor all the time. Especially once children and teens have begun to advocate for themselves, it is a challenge for the classroom teacher to empower the child toward independence on the one hand, while closely monitoring progress on the other. If a child's hearing acuity changes very gradually, he may not notice and report a problem until the changes are beginning to affect academic performance. It is imperative that he has the best access to sound through his cochlear implant throughout the school day. Daily listening and equipment checks are still important to ensure consistent working equipment, although these activities may need to be modified to be age-appropriate for older, more experienced children. Please refer to the **Equipment Guide** for the child's speech processor for more information about listening and equipment checks.

The high performing cochlear implant user will have some difficulties that affect learning that his peers with normal hearing will not. Some of these difficulties may include:

- :: Understanding in background noise and at a distance
- :: Following and understanding the responses and answers of his classmates
- :: Understanding the fast rate and complexity of the language of the classroom
- :: Awareness that a topic change has occurred
- :: Following group discussions with multiple talkers
- :: Need for additional processing time to respond
- :: Additional effort for a child with hearing loss to listen than for the child with normal hearing. He may experience some fatigue and lose his focus or attention because of fatigue.

The following strategies can be helpful to assist the learning of the child with a cochlear implant in the regular classroom setting:

As children move into school settings that involve changing classrooms and teachers throughout the day, it is even more important that a “**point person**” is identified to check in periodically with teachers and the child and to facilitate communication among service providers. Often this is the school audiologist or an itinerant support professional, such as a teacher of the hearing impaired. All of the child’s instructors will need information about helpful teaching strategies and managing the classroom environment. If the child uses an FM system, it will be important to ensure that all teachers understand how to use the transmitter appropriately and whether it is necessary to monitor the child’s use of the FM. Self-advocacy skills need to be developed by this time, although they will continue to be refined throughout the child’s academic career.

Communication and/or auditory comprehension breakdown is natural. The young child will benefit from **teacher-initiated comprehension checks** and opportunities/encouragement to develop and use strategies to request repetition or ask for clarification. The older child may have developed better self-advocacy strategies and won’t need as much support for comprehension checks as the younger child.

The child with a cochlear implant will benefit from **repetition and rephrasing** of information presented auditorally. The classroom comprehension technique related to “making connections” is beneficial for both the child with a cochlear implant and the child with normal hearing. These techniques are typically part of elementary content and reading instruction and encourage a child to connect new information to their own experiences to facilitate comprehension. “Making connections” will also help the child’s teacher monitor comprehension.

**A variety of visual supports** are an added benefit in the classroom and are even more important as course content and academic demands increase in the later grades. Face-to-face communication and/or obtaining visual attention before presenting important instructions and content information will help to ensure understanding. The use of visual supports such as pictures, graphs, posters and print benefit the child. Visual supports in the classroom are useful to indicate a change in topic or lesson by referring to that visual aid. As a child with a cochlear implant progresses through school he will benefit from other technologies that might include use of PowerPoint and/or overhead projectors (this allows the teacher to face the class rather than turning his back to write on the board), and smart board technology.

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**Pre-teaching vocabulary and new content** can provide great benefit for learning during classroom instruction. This can be accomplished through use of the parent, itinerant teacher of the hearing impaired, tutor or the speech pathologist. Although the child with hearing loss may score well on traditional vocabulary tests which indicate the child recognizes and is familiar with the words presented, he may experience more difficulty when asked to formulate and provide definitions of word meanings for the vocabulary items. Some postulate that these vocabulary issues are related to less “incidental language learning” or learning through overhearing others than their hearing peers (although incidental language learning is one benefit of cochlear implantation). When the child is familiar with new or difficult vocabulary which has been pre-taught, it becomes easier to understand the fast rate and complexity of the language of the classroom.

When breaking off into small groups for instructional support and projects, a **group of no more than two or three other children is ideal**. Since this is a time that an FM system is not advisable, a quiet location as far as possible from other groups is also ideal.

**Captioning on all TV and videos** or DVDs is helpful. Captioned educational media is available to school districts through a federally funded free-loan program, the Described and Captioned Media Program administered through the National Association of the Deaf. See the “Resources” section for details.

In the older grades, a **note-taker or peer** that provides good notes can greatly assist the child with a cochlear implant. It is more difficult to listen and take notes at the same time since the child can not take as much advantage of visual information during note-taking.

**Timely repetition of announcements** made via the PA system assists in understanding important messages.

It is truly exciting to see so many children with cochlear implants experiencing success in the typical education classroom even as early as pre-school. However, it is important to remember that these children are “deaf” and depend on the cochlear implant to function in the classroom. Their job, learning in the classroom, is harder than it is for the child with normal hearing. Additional support may be needed for the child to meet educational standards each year. Each child is an individual, so a set recipe for learning is not possible, but we trust that the suggestions presented here will support you in meeting each child’s needs more easily.

IT IS IMPERATIVE THAT  
THE CHILD HAS THE  
BEST ACCESS TO SOUND  
THROUGH HIS COCHLEAR  
IMPLANT THROUGHOUT  
THE SCHOOL DAY

## CHILDREN WITH BILATERAL COCHLEAR IMPLANTS

The age at which children receive bilateral cochlear implants varies. As an educator, you could have a child come into your classroom with several years of bilateral cochlear implant use or as a new bilateral user. Or, a child with a single cochlear implant in your class may receive a second implant during the school year.

Regardless of the length of time of bilateral use, as the child's teacher you need as much information as possible to assist you with preparing for the child with bilateral cochlear implants. Open communication with the parents and the child's implant center will provide you with valuable information regarding the type of bilateral surgery, recommended wearing time if the second device is new, the length of time of bilateral implantation and the auditory skills of the child.

### **The Newly Implanted Child**

You may have a child entering your classroom who has just received a 2nd (bilateral) implant or one that is to have this surgery during the school year. Although these children may be excellent listeners with their single implant, they will need to start over with the development of auditory sensitivity with the newly implanted side. Children receiving sequential bilateral cochlear implants will need additional auditory and/or speech therapy following the surgery, the same as children who receive one implant. The length of time and intensity of additional therapy will vary with the individual child. Most children with sequential bilateral implants make faster progress with adjustment and the development of listening skills with their second implant than they did for the first. However, this too will vary with the individual.

### **Wearing Time**

Some implant audiologists may recommend using the 2nd implanted side by itself for a period of a month to six weeks to assist with adjustment and the development of auditory or listening skills. Others may recommend special times during the day for the child to use the newly implanted side alone. After school, while watching TV or videos and during therapy sessions are examples of special times. If you find that the recommended wearing time is interfering with the child's educational progress it is important to notify the parents and/or the implant center regarding your concerns. If you have a child in your class who will undergo a second implant surgery during the year, establishing communication with the parent and the child's

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implant center prior to the surgery can make the transition back into the classroom easier. As the child's classroom teacher you have valuable knowledge regarding the child's learning style and classroom needs that are important for the implant team to know prior to this procedure.

### **The Experienced Bilateral User**

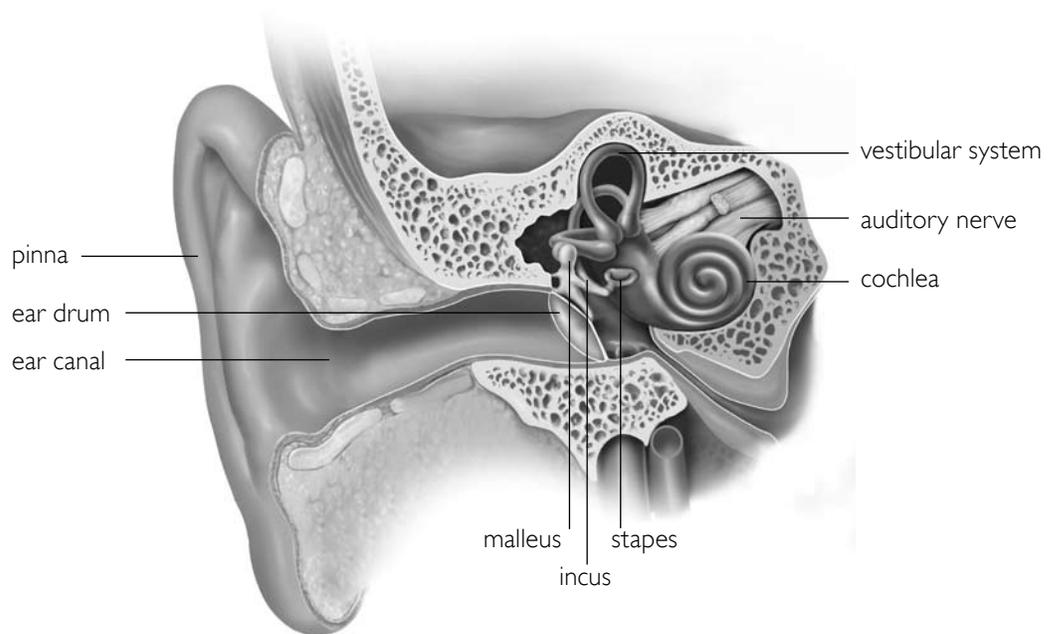
The experienced bilateral user in your classroom will most likely use both implants during the day. The strategies, teaching style and issues discussed in the previous sections of this chapter are still relevant and very important for the child using bilateral implants. As with the child using only one implant, the most important factor that helps a child to be successful with his cochlear implants is consistent use of working speech processors. Daily equipment and listening checks are important to consider, ensuring the most favorable listening conditions. You will find detailed information in the **Equipment Guide** for the child's speech processor. During daily listening checks, the best procedure for the child with bilateral implants is to use an acoustic screen to assess listening in the best condition, both implants together. You will want to check the settings for program, volume and sensitivity for each processor.



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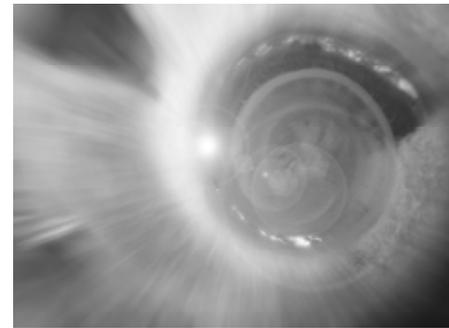
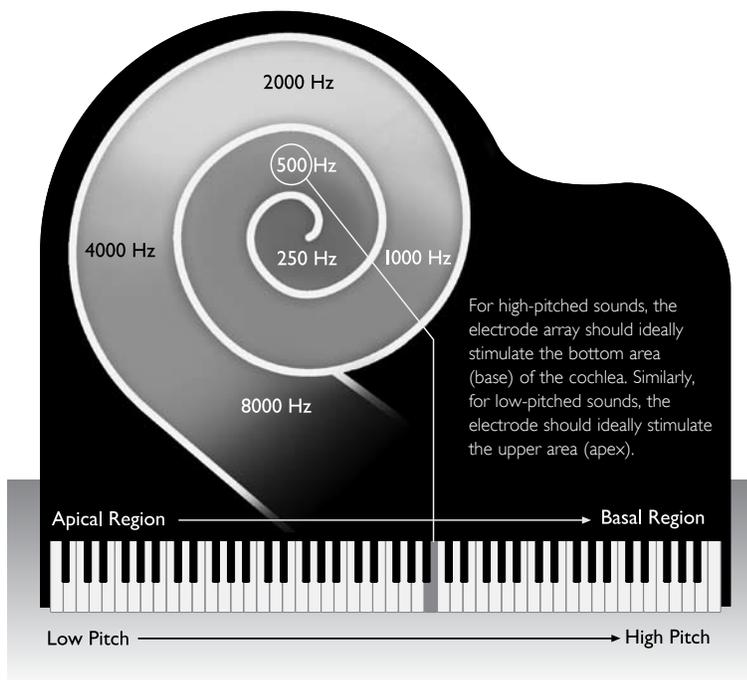
## WHAT IS A COCHLEAR IMPLANT?

### THE ANATOMY AND PHYSIOLOGY OF HEARING AND HEARING LOSS



The human ear has three distinct sections: the outer ear, the middle ear, and the inner ear. The outer ear is made up of the pinna (the part you can see, that we commonly call 'the ear'), the ear canal, and the tympanic membrane (also commonly called 'the eardrum'). The middle ear is made up of the three small bones of hearing, called the malleus, incus and stapes. The inner ear consists of the cochlea, a snail-shaped organ that contains the nerve endings that sense sounds, the semicircular canals that control balance, and the nerves that carry these hearing and balance messages to the brain. The inner ear is very organized; the nerve endings (also called "hair cells") are arranged by pitch, just like the keys to a piano keyboard. This arrangement is called tonotopic organization – which simply means, "arranged by tone." The highest pitched hair cells are located just inside the opening of the

cochlea (the base or **basal region**), and the lowest are at the top (the apex or **apical region**) of the spiral. The hearing nerve and the brain are also organized tonotopically; so the whole system is designed to analyze sound by pitch.



THE COCHLEAR IMPLANT  
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ELECTRICAL SIGNAL  
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CORRECT PLACES IN  
THE COCHLEA.

All sounds are made up of energy that moves through the air in the form of sound waves. These sound waves travel into our ear through the outer ear. The outer most parts of the ear (pinna and ear canal), direct sound towards the eardrum (tympanic membrane). Since the three bones of the **middle ear** are connected to the eardrum, they vibrate in direct relation to the sound waves. Their movement then activates the fluid inside the cochlea, which stimulates the nerve endings. The nerve endings, called hair cells, create tiny electrical pulses that travel along the auditory nerve to the brain. It is the brain's job to interpret all the individual sound messages and to give them meaning to the child.

For most children who are profoundly deaf, the outer and middle ear sections of the ear function normally. However, for some reason, the inner ear nerve endings are unable to sense sound, or unable to translate sound sensations into the electrical impulses for the brain. The job of these inner ear nerve endings is to initiate a chemical-electrical signal that will travel down the nerve. Since these nerve endings aren't doing their job, the cochlear implant simply tries to supply the missing electrical signal using very fast, yet tiny, electrical pulses at the correct places in the cochlea.

## AUDIOLOGICAL TESTING AND THE AUDIOGRAM

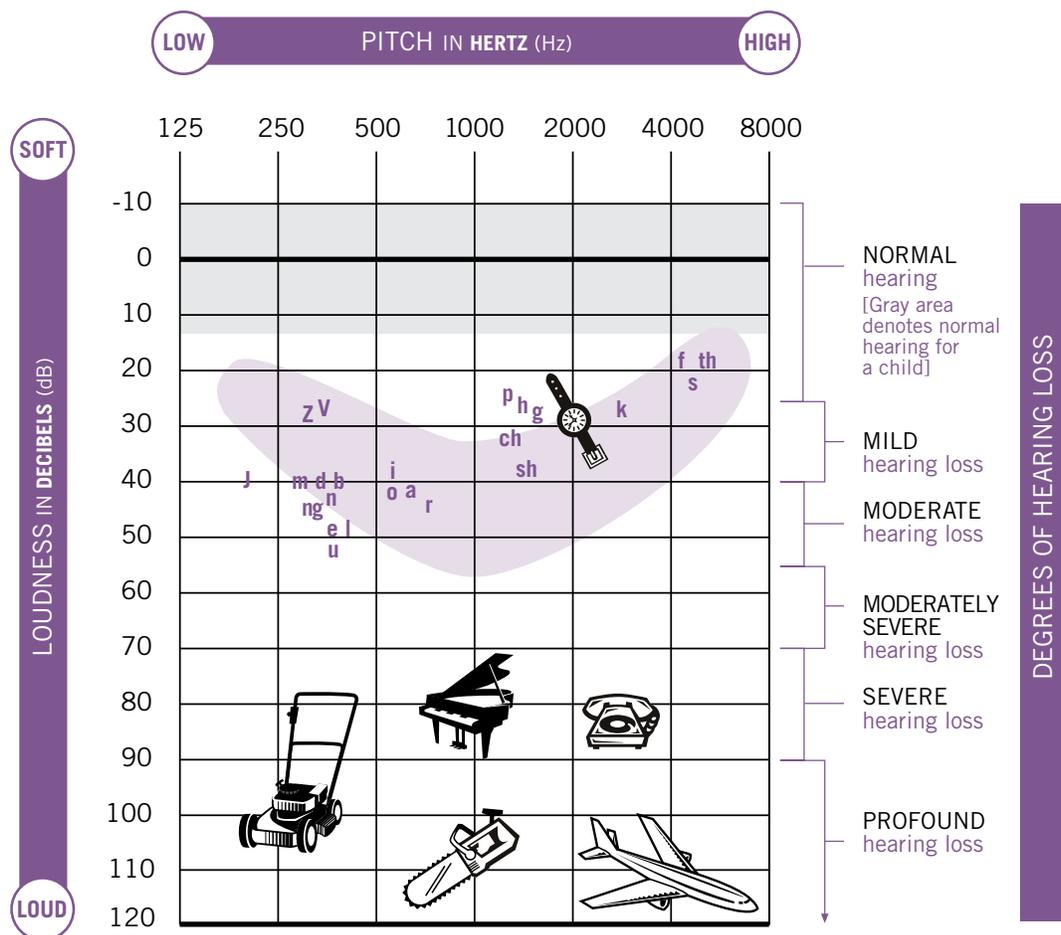
An **audiogram** is the most common method of documenting a person's hearing levels and function. Hearing loss can manifest in a myriad of degrees, and it is probably safe to assume that no two children hear exactly the same way, even though their hearing losses may look identical on paper. But for the purposes of understanding the effects of a profound hearing loss upon speech and language learning, it is worth briefly delving into the audiogram and learning how hearing is quantified.

Hearing acuity is evaluated by audiometric testing. An **audiologist** presents stimuli of varying pitch and loudness to obtain an overall picture of the softest sounds a person can detect at low, mid and high pitches. The main pitches tested are those that are important for the understanding of speech, although the range of normal human hearing is much wider. These levels of softest detection are called **thresholds**, and the results are charted on a graph called an audiogram.

The audiogram plots sound from low pitch on the left, to high pitch on the right, and from soft sounds at the top, to loud sounds at the bottom. **Pitch** (also called "frequency") is referenced in a unit of measurement called **Hertz (Hz)** and **loudness** levels are referenced in **decibels (dB)**. For convenience, several generic hearing ranges have been defined and are used to quickly describe hearing acuity. However, not all people with the same range of hearing loss perform at the same level in terms of their ability to understand speech.

Normal conversational speech falls somewhere in the middle of the audiogram, between 200-4000 Hz, and at roughly 50 dB. Of course, simply hearing at this level is not enough to understand conversational speech. If a person has a moderate hearing loss, they would hear sounds that are presented at the 50 dB level as if they were whispers. A certain amount of volume above the person's hearing threshold is needed for optimal speech understanding. As you can see in the audiogram on the following page, some speech sounds carry much more energy, and are therefore louder than others. And, given the **speed of conversational speech**, it is important that the brain can accurately discriminate pitch and loudness from one instant in time to the next, in order to decode the complex picture of signals that makes up spoken communication.

If hearing levels are not within the “normal range,” whatever hearing does exist is referred to as residual hearing. It is very difficult for a person without a hearing impairment to understand what residual hearing might be like. For some individuals, amplification of the sound with a hearing aid can be very useful. For others, even though we can make the sound loud enough with hearing aids, it isn't very clear, and they struggle to understand. For some individuals, the hearing loss is so great that we can't adequately amplify the sound. In adults, it is a bit easier to arrive at an understanding of the quality of their residual hearing. Adults can repeat back words and sentences in quiet and noisy situations, and that gives us a way to measure how useful their residual hearing is. But most children who have hearing loss are unable to give us much information about the quality of their hearing. That is why it is very difficult to look at two children's audiograms and try to understand why one of them may perform well with hearing aids or a cochlear implant and the other may not – the audiogram only gives us a surface-level glimpse into the complex process of hearing.



Adapted from Northern JL & Downs MP. Hearing in Children 4th Ed. (1991). Williams & Wilkins: Baltimore, MD.

COCHLEAR IMPLANTS AND HEARING AIDS:  
HOW ARE THEY DIFFERENT?

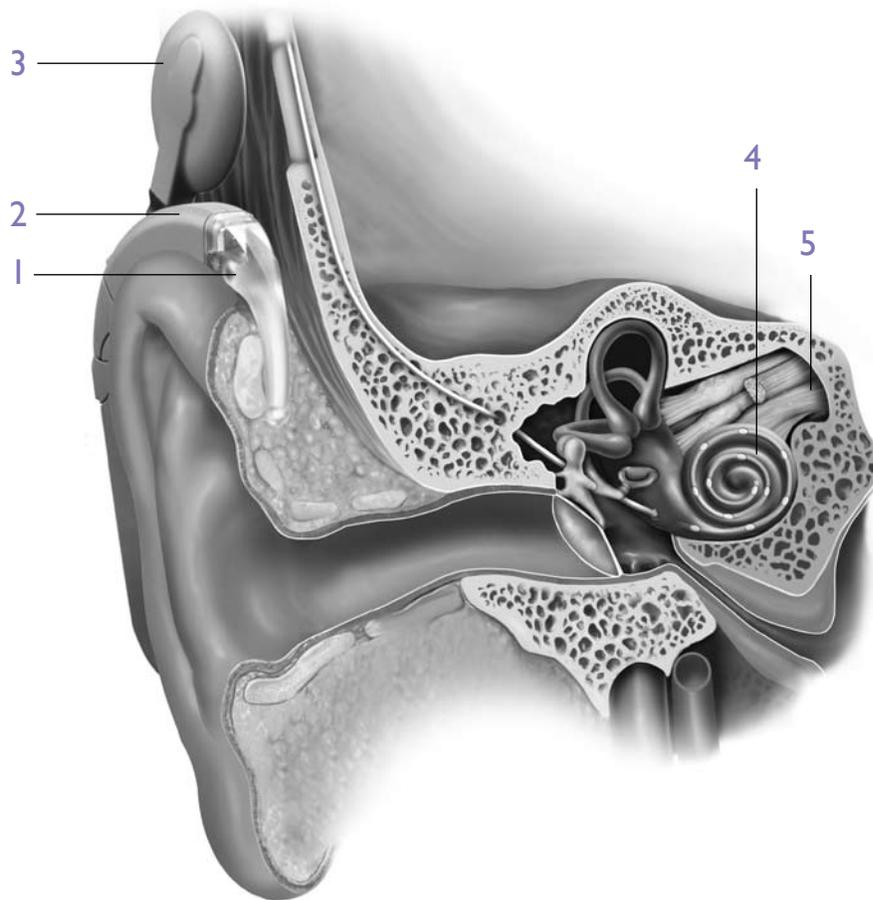
A cochlear implant is not a hearing aid. Hearing aids make sound louder; they are simply miniature amplifiers that are matched to the individual's hearing loss. If the child has more hearing loss in the high pitches than in the lows, the hearing aid will be set so that high pitched sounds are amplified more than the low pitched sounds. The sound quality can be customized to some degree, and some hearing aids use digital processing to improve the quality of the sound. Hearing aids pick up sound through a microphone, amplify the sound, and present it to the ear canal. Usually the hearing aid sits in or behind the ear, and a custom-fit earmold delivers the sound to the ear canal. From there, the sound is transmitted in the normal fashion through the rest of the outer ear, through the middle ear, and into the inner ear. In the inner ear, the remaining nerve cells sense sound and generate tiny electrical impulses that travel along the nerve to the brain, although their ability to do this accurately may depend on the degree of hearing loss. In essence, hearing aids simply 'turn up the volume' as sound is entering the ear.

Individuals with very extensive hearing loss often do not benefit greatly from hearing aids. They may be able to detect some (or even many) types of sounds, but those sounds may not be understandable. Some people may be able to understand speech only if they are able to see the speaker's face and get some cues from lipreading. Others may even be able to understand some speech without any visual cues. But, in the big picture of communication in daily life, their residual hearing often does not provide enough auditory information or clarity to allow them to communicate without significant difficulty, even with the use of hearing aids. These individuals are often candidates for more complex technology such as a cochlear implant.

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## HOW DOES A COCHLEAR IMPLANT WORK?



- 1 Sounds are picked up by the microphone.
- 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.

Cochlear implants completely bypass the outer and middle ear. They consist of two parts – one part is surgically implanted and the other is worn outside the body. Sound is picked up by a microphone, and sent to the **speech processor**, where it goes through a complex series of circuits that code the sound into electrical impulses. This **coding strategy** is essentially doing the job of the inner ear, converting sound into electrical impulses that represent the pitch and loudness variations in sound that will be recognizable to the brain.

Once this information is properly coded, it is sent up the cable to the transmitting coil. The coil's job is to get this information to the implanted portion of the system. It does that by using a radio signal to send the information through the skin and into the implanted portion. The implant contains circuitry that receives and decodes this information, generates the specified electrical pulses, and activates the

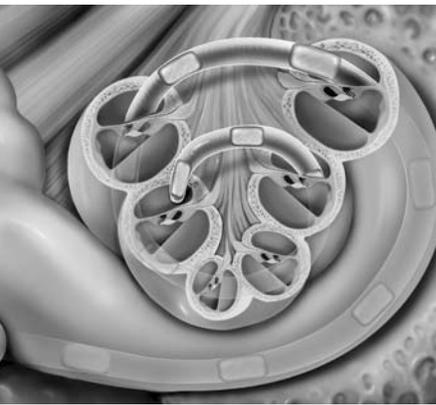
electrode contacts, also called channels, that are inserted along the snail-shaped cochlea. Different electrode contacts correspond to different pitches – remember, the cochlea is tonotopically organized (see above). In the end, the electrical signals are picked up by the hearing nerve and transmitted to the brain. These signals contain the pitch and loudness information the brain needs to analyze the sound for meaning. This information is coded and sent to the hearing nerve thousands of times each second – so fast that the subtle pitch, intensity, and loudness changes of connected speech are represented accurately.

This process seems deceptively simple. However, the normal human ear contains approximately 50,000 hair cells, with the ability to sense a myriad of pitches, while the implant contains 12 channels that can stimulate 12 different regions along the cochlea, spanning the pitch range from low pitch to high. It is logical to think that designing an implant with 50,000 channels would do the job even better, but research tells us that cochlear implant users can understand speech best when using somewhere between 6-10 channels of stimulation. So more channels in the implant doesn't necessarily result in better understanding.

It is also important to realize that a person's brain recognizes sound by comparing it to the sounds they remember hearing over their lifetime. Adults who become deaf after a lifetime of normal hearing will have much to draw on once they regain hearing through a cochlear implant. In the case of a child who is a new cochlear implant user, his or her variety of sound experiences may be very limited. Therefore, a certain amount of learning has to take place before the child is able to attach meaning to sounds. Considering all of these factors helps to explain how such sophisticated technology provides information. However, it still takes time, patience and practice before significant improvement is noted.

#### WHO IS MED-EL?

The MED-EL cochlear implants represent the culmination of over three decades of research and development in the field of cochlear implant technology. The founders of MED-EL, Drs. Ingeborg and Erwin Hochmair, are physicists who have been involved in the technical development side of cochlear implants since the 1970's, and entered the business side in 1989 when the MED-EL Company was founded in Austria. The company continues to devote approximately 35% of its revenue to further research and technology development.



INFORMATION IS  
CODED AND SENT TO  
THE HEARING NERVE  
THOUSANDS OF TIMES  
EACH SECOND.

## THE MED-EL COCHLEAR IMPLANT SYSTEM

MED-EL cochlear implant systems have a number of unique features that are designed to promote outstanding performance, creative design, and user-friendliness.

MED-EL packs a lot of power into such a small implant system. Our unique electronics design provides the user with the best battery life in the industry, 3–5 days using our most current and powerful sound coding strategies.



**L:** PULSARci<sup>100</sup> cochlear implant  
**R:** SONATAci<sup>100</sup> cochlear implant

### Features of MED-EL cochlear implants:

- :: The smallest cochlear implant available
- :: The longest electrode array in the industry and the only system to stimulate the entire cochlea
- :: Soft, flexible electrodes in four configurations to protect the cochlea
- :: Transparent reporting of reliability for both internal and external components on [www.medel.com](http://www.medel.com)
- :: Engineered according to the strictest safety standards



**L:** OPUS 2 Speech Processor  
**R:** OPUS 1 or TEMPO+ Speech Processor

### Features of MED-EL speech processors:

- :: Thinnest and lightest processors available today that include the latest and most effective coding strategies for accurate sound processing
- :: The DaCapo rechargeable battery system
- :: Multiple wearing styles and battery options, including the BabyBTE,<sup>™</sup> the world's first processor designed especially for young children
- :: Two ear-level speech processor styles:
  - The OPUS 2 switch-free design with a FineTuner remote control
  - The TEMPO+/OPUS 1 speech processor for users who prefer changing settings via integrated switches
- :: Easy-to-use connections for assistive listening devices
- :: Status lights that indicate error conditions and confirm functionality
- :: Safety locks to ensure that small children cannot disassemble the speech processor or battery pack



FineTuner remote control for OPUS 2 speech processors



OPUS 2 shown with Phonak MicroMLxS

# TEMPO+ or OPUS | Speech Processor

Enlarged to show detail

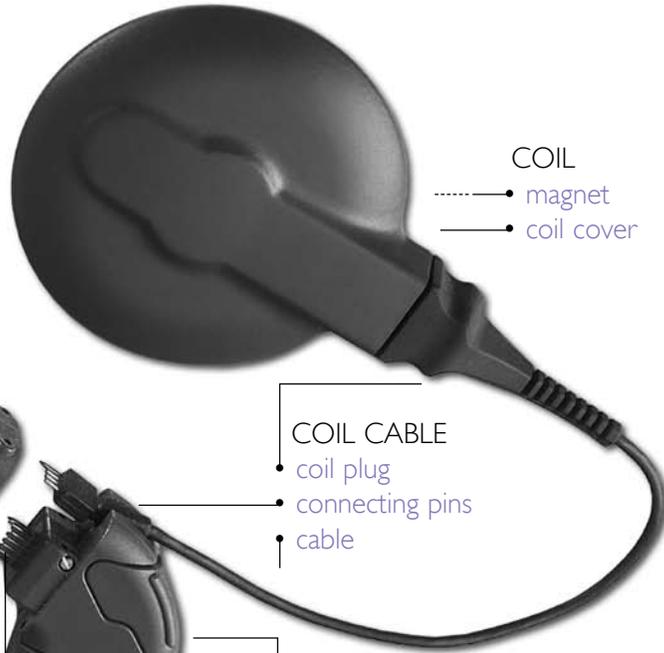
## CONTROL UNIT

- volume switch
- program switch
- sensitivity control
- status light
- microphone



## COIL

- magnet
- coil cover



## COIL CABLE

- coil plug
- connecting pins
- cable

## ANGLED BATTERY PACK

- input jack for external devices
- connecting pins
- battery pack lid
- batteries
- ON / OFF switch



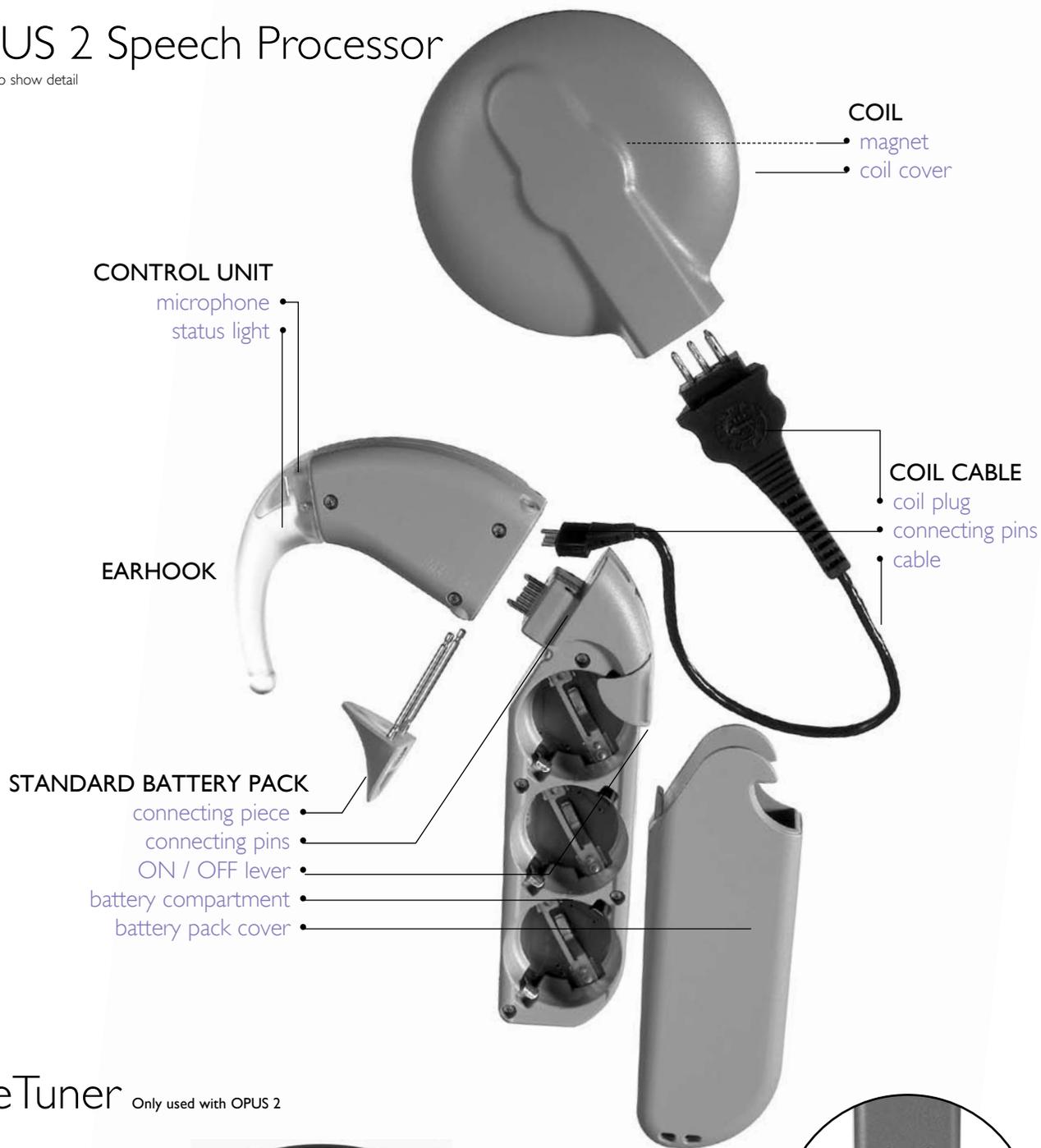
## EARHOOK

- angled earhook
- connecting pins



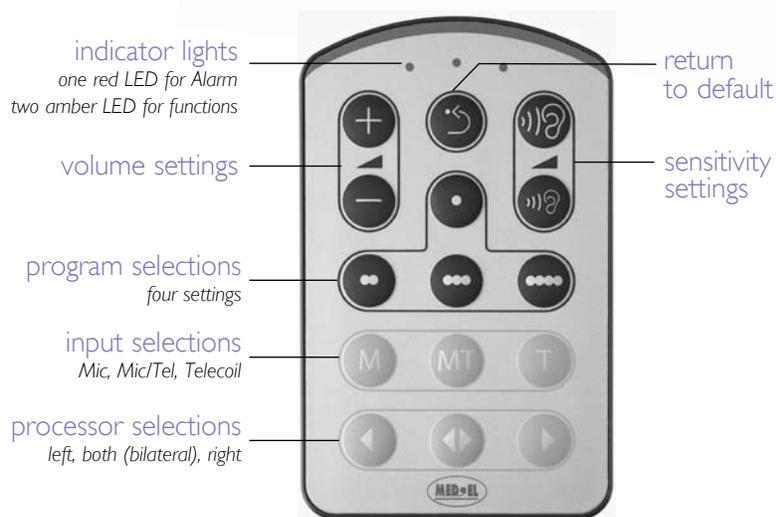
# OPUS 2 Speech Processor

Enlarged to show detail



## FineTuner

Only used with OPUS 2



The FM Battery Pack provides a standard 3-pin input port for various assistive devices.

### CANDIDACY CRITERIA

Cochlear implants are appropriate for children who do not receive adequate benefit from their hearing aids. Current approved criteria for MED-EL cochlear implants include the following:

- :: Age 12 months or older at the time of surgery
- :: Profound bilateral sensorineural hearing loss
- :: No improvement on accepted measures of auditory progress for 3-6 months while using appropriately fit hearing aids. If the child has not had access to an auditory therapy program that would ensure that any progress possible would have been achieved, the implant center may refer the child for **diagnostic therapy** during the candidacy period.
- :: Family, educational and therapy environments that support learning to listen with the cochlear implant
- :: No other medical conditions that might prevent a successful surgical procedure



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## GUIDELINES FOR REFERRAL

Many teachers feel unsure about whether a child is a candidate for a cochlear implant and are hesitant to refer the family to an implant center for evaluation. In general, a cochlear implant evaluation takes a thorough look at the child's hearing, speech, communication and language skills, as well as providing a comprehensive medical evaluation related to the hearing loss. Even if a child is referred for an implant, and is determined not to be appropriate to receive an implant, the candidacy evaluation can provide parents with a good understanding of their child's skill levels and any other options that might benefit the child.

In general, it is worth considering an implant evaluation referral if any of the following key indicators exist:

### Young children

- :: The child exhibits a profound hearing loss.
- :: The child doesn't consistently respond to his or her name using hearing alone with hearing aids. It is important that the child has had the benefit of auditory therapy to learn to make use of any **residual hearing**.
- :: The child experiences difficulty developing auditory awareness.
- :: The child does not make expected progress in auditory skill development.

### Older children

- :: The child exhibits a profound hearing loss.
- :: The child has experienced a loss of or change in hearing acuity.
- :: The child is experiencing increased difficulty in the classroom, such as struggling to understand and keep up with assignments.
- :: The child relies heavily on classroom support to follow along and stay on-task.
- :: The child is not able to communicate effectively with peers.
- :: There is a plateau of auditory skill development or loss of skills.
- :: The child is overly tired at the end of each day from the effort of communication.
- :: The child is experiencing social difficulties as a result of his or her hearing loss.



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## THE COCHLEAR IMPLANT **PROCESS**

Once a family has decided to pursue cochlear implantation for their child, it is important to realize that the child is considered a candidate. In other words, tests and evaluations need to be completed before the cochlear implant team makes any final recommendation. Families and educators often assume that a child will automatically receive a cochlear implant by virtue of making an appointment with a cochlear implant center or a physician. The candidacy process is designed to determine whether the child's hearing loss is significant enough to warrant a cochlear implant; to provide the family with information about technology, surgery and required follow-up; to determine if there are any medical reasons why the child should not have the surgery; determine what educational supports are required or need adaptation; and assess the child's current communication skills and learning style. The following section will provide a general overview of the evaluation phase and what to expect from a cochlear implant evaluation.

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## THE COCHLEAR IMPLANT TEAM

Pediatric cochlear implant centers vary in the number and type of staff members, but most use a team approach. Typically each team member has a specific area of expertise. Additionally, each team member has knowledge and understanding of the expected benefits that an implant may provide, as well as the challenges that it may introduce. Most teams have one member who also coordinates evaluations, communicates with the family and oversees the progress of the candidacy process. With the parent's permission, you may want to establish consistent communication with this or another team member early in the evaluation process, or as soon as you begin work with an implanted child. Team members may include some or all of the following: an **otologist**, an **audiologist**, a **speech-language pathologist**, an **auditory habilitation specialist**, an **educational specialist**, and occasionally a social worker or a psychologist.

## CANDIDACY EVALUATION

The candidacy evaluation will involve visits with a variety of team members. Sometimes these visits are spread out over several days. Although the exact process and order of evaluations will vary from one cochlear implant center to the next, the general process consists of the following:

## TAKING A CASE HISTORY

### **What will happen?**

The cochlear implant team needs to become familiar with the child's medical, developmental, audiologic and academic history. A family will typically meet with a variety of professionals during this phase, each focusing on a different aspect of the child's development. They may ask questions about the child's diagnosis, use of hearing aids and/or FMs, the type of school they attend, as well as their communication and language development. It is critical to have an open and honest conversation so that the members of the CI staff are able to make well-informed recommendations.

### **Why is this necessary?**

There are several audiometric and medical criteria that must be met before cochlear implantation is considered the appropriate course of action. In addition, the team needs to understand other aspects of the child's experience that contribute to his/her status as a cochlear implant candidate. For example, the child's educational environment may need substantial support in order for the child to succeed with a cochlear implant.

## AUDIOMETRIC TESTING

### What will happen?

The audiologist will perform a standard hearing test in a sound suite, both with and without hearing aids. If time and the child's maturity and attention allow, the audiologist may also perform speech perception tests. These are tests that determine what percentage of words and sentences the child is able to hear using their hearing aids. Typically these tests are done without the use of visual cues, such as lip reading, sign language or cued speech. Depending on the child's age or language level, he or she would be asked to repeat the word, point to a picture, or choose an object. Some of these evaluations may take time and the child could become too tired to complete them all. Because the audiologist wants to get the child's best results, he or she may suggest that the family complete the testing over a series of visits. If the child is an infant, and is unable to complete the type of testing mentioned above, the audiologist may use other objective measures, such as **auditory brainstem response testing**, **steady state evoked potentials**, or other electrophysiologic tests that provide information about the child's hearing sensitivity without requiring a voluntary response from the child. These tests are painless, and often the child is encouraged to sleep during the test procedure. The audiologist will also evaluate the child's current hearing aids to ensure that they are appropriately set for the type and degree of hearing loss, and are providing the best signal possible.

### Why is this necessary?

It is usually necessary for the cochlear implant center to complete its own hearing tests, even if another audiologist has tested the child recently. There are specific hearing and speech perception levels, or criteria, which must be met in order for a child to be considered for a cochlear implant. The cochlear implant team will most likely want to confirm this by their own tests before any recommendations can be made. If the child has not been fit with appropriate amplification prior to seeking a cochlear implant, the audiologist can make that determination and recommend different hearing aids. In addition, the implant audiologist can use information gained during these visits to plan for the initial stimulation by better understanding how the child may respond to electrical stimulation once the implant is in place.

NOTE: Be sure to reassure children, especially older children and teens that they may not understand the words and sentences the audiologist is testing, particularly if they are accustomed to using visual cues, lipreading or sign language. Since speech perception testing must evaluate their hearing alone, it may be stressful or discouraging for some children unless they are prepared.

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## DEVICE COUNSELING

### **What will happen?**

Device counseling usually consists of a meeting with a team member who will discuss the features and operation of the cochlear implant system, and answer any questions the family has about the process. Usually these sessions include a discussion of the family's expectations, as well as the child's. Quite often, the implant team will suggest that the candidate and family meet another "seasoned" family who can share their personal experiences and help the candidate's family develop realistic expectations about the process.

### **Why is this necessary?**

It is extremely important for families to make an informed decision about receiving a cochlear implant. Realistic expectations about the use and maintenance of the equipment, the type of progress that can be expected, and the time frame for seeing noticeable progress after the initial hook-up are very important. Many families focus mostly on the surgical procedure itself, and underestimate the type and amount of work that will be involved in helping the child develop listening and speech skills, usually for several years following the surgery. It is important that all caregivers understand that the cochlear implant is not a quick fix for deafness, and the surgery is only the beginning of a long journey toward development of listening skills that support communication.

## SPEECH AND LANGUAGE EVALUATION

### **What will happen?**

Cochlear implant teams often include habilitation specialists, such as speech-language pathologists, auditory-verbal therapists, or others who evaluate the auditory development and communication skills of pediatric cochlear implant candidates. Age-appropriate tests are administered to sample the child's language skills and speech production, as well as the child's ability to use **residual hearing** for communication. The child's family will be asked to describe his or her language and communication abilities at home and at school. **Diagnostic therapy** may be recommended throughout the candidacy process to better characterize the child's current communication abilities, prepare the child for the initial stimulation, and develop habilitative goals for the first few months of implant use.

### **Why is this necessary?**

Once again, the more information the cochlear implant team has about the child's overall development, the better equipped they are to make appropriate recommendations. The speech-language pathologist's understanding of the degree to which the child is making use of residual hearing for communication can provide

important clues that assist in forming a prognosis for progress with an implant. It is also important to recognize any other speech or language learning problems that may exist apart from the hearing loss and understand their impact, if any, on the child's ability to make use of the implant. Often, the habilitative specialist will provide post-operative therapy, or make recommendations for appropriate habilitation.

## EDUCATIONAL EVALUATION

### **What will happen?**

Some cochlear implant centers have an educational specialist, teacher of the deaf, or other team member who can assess the child's current educational environment. For babies, this environment is generally their parent-infant program, early intervention setting or an individual therapist.

### **Why is this necessary?**

The type of intervention a child receives before and after a cochlear implant is critical to the success of the procedure. The educational specialist can evaluate the child's educational setting, interact with the child's teachers and solicit their input, and identify whether the educational professionals would benefit from additional training about hearing loss or cochlear implants. With the parents' permission, the consultant can take this opportunity to discuss the child's academic status and learning style. An educational specialist may assist the family and the school in designing an **Individualized Education Plan (IEP)** that will meet the child's needs and establish realistic expectations among providers after implantation.

## MEDICAL EVALUATION

### **What will happen?**

Every child who is being considered for a cochlear implant must consult with and be examined by a doctor who specializes in surgery of the ear. This will include an extensive medical history. Each child will receive a CT Scan (x-ray) or a Magnetic Resonance Image (MRI) of the inner ear as part of the assessment. Usually, young children are sedated for the radiology exam because it requires them to be very still for several minutes. If a cochlear implant is eventually recommended, the doctor may require the child to receive a vaccination against meningitis prior to the surgery. Each case is handled individually and any child may require additional medical tests as part of his or her evaluation.

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### **Why is this necessary?**

To receive a cochlear implant, the child will have surgery under general anesthesia. The doctor must determine if there are any reasons why a child should avoid anesthesia or surgery. In addition, the surgeon needs to see the structures of the inner ear (via a CT scan or MRI) to ensure the cochlea is intact and an auditory nerve is present. The surgeon can determine whether a special **electrode array** is required. MED-EL provides a variety of different electrode arrays to accommodate for the differences in cochlear anatomy among implant candidates.

## CONSULTATION WITH SOCIAL WORKER OR PSYCHOLOGIST

### **What will happen**

Some cochlear implant centers ask families to meet with a social worker or psychologist during the candidacy phase. This professional may seek information regarding the family's support network or financial needs and help determine if any organizations or programs are available to provide assistance, if necessary. Additionally, a social worker or psychologist may need to assess the family's expectations and may ask family members to discuss why they are pursuing a cochlear implant for their child.

### **Why is this necessary?**

Families raising a child who has a hearing loss are often faced with a variety of challenges not familiar to parents of typically developing children. A social worker or psychologist can help the family in advocacy efforts, such as understanding the child's rights, accessing programs designed to assist the child and/or family, and finding or developing a support network if the parents become overwhelmed by the child's challenges. They may also assist the parents in developing effective strategies for handling any behavioral challenges that may arise. A social worker or psychologist is able to help the family navigate the complicated emotional as well as organizational details of coping with deafness and seeking a cochlear implant for their child. Cochlear implant teams are particularly concerned with making sure that families fully understand all that is involved in having a cochlear implant, helping them to identify what will support the child's success with the implant, as well as making sure that families understand their responsibilities.

## SURGERY

The cochlear implant surgery usually takes between 2-4 hours. The risks involved are considered to be small, and compare well with other ear surgeries.

The child will be given a general anesthetic, and a small incision will be made behind the ear. The hair may be shaved around the area of the incision. The surgeon will create an indentation, called a 'bed,' in the mastoid bone (the hard bone directly behind the ear). This is where the **implant case**, which holds all of the electronic components, is placed.

The surgeon will make a small opening into the cochlea to insert the **electrode array**, then the implant/electrode array are secured in place. The electrode function is usually evaluated before the incision is closed. Surgeons use different methods of suturing the incision.

When the child wakes up after the surgery, there may be some mild discomfort, and medication for pain may be administered. However, children respond to the surgery surprisingly well. They are usually up and about on the same day or the next day. The length of the hospital stay can vary, but can be as short as a day.

The surgeon will provide the family with guidelines about returning to school. Usually the child can resume reasonable normal activity in just a few days. Depending on the method of closing the incision, the child may need to return for suture removal in 1-2 weeks.

Following surgery, 3-6 weeks is required for the incision to heal and any residual swelling to subside. During this period, the child will not hear anything with the cochlear implant.

Many school health personnel have questions and concerns about caring for the child with an implant, especially in the immediate post-operative period. The primary goal is to keep the area clean and dry, and prevent any injury to the head while the incision is healing. In general, most children recover quickly from surgery and return to school with the doctor's clearance after a few days. It is unlikely that any care of the surgical incision will be needed at school, but this can be verified with the child's cochlear implant team. Rarely, some children experience balance fluctuations immediately after surgery, although these usually disappear within a matter of hours or days.

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## INITIAL HOOK-UP

The initial hook-up is the first time a child will use the external components of the cochlear implant system. The audiologist at the cochlear implant center will connect the **speech processor** to a computer loaded with specialized software. He or she will then stimulate the electrode with tiny electrical pulses (often heard as “beeps” during the **Mapping** process) and determine whether or not the child heard the stimulus. In the case of young children and babies, this determination will be done through observing changes in the child’s behavior or through **visually reinforced audiometry** (VRA). The pre-school aged child should be able to give a reliable response through **play audiometry**. Older children can raise their hand or tell the audiologist when a sound is heard. The primary goal during this initial session is to create comfortable settings so the child has a positive attitude towards wearing the device, and positive first experiences with sound. It is NOT usually expected that the child will leave this initial session hearing and understanding sounds well. Over the first few mapping sessions, the audiologist will work toward increasing the child’s range of hearing.

**NOTE:** The initial weeks of setting the child’s cochlear implant are designed to introduce him/her to the world of sound. It is a time when family members and educators should bathe him in spoken language and the sounds of his environment. It is not a time to expect the child to suddenly speak well. In other words, talk to the child – don’t ask the child to understand you – and support any new **vocal play** the child exhibits without expecting clear speech. Time and listening practice is needed before spoken language can develop.

Older children who have already developed spoken language with their hearing aids may need support with identifying familiar sounds and speech. Everything will sound different than it did with hearing aids; although over time these differences will be better and more detailed than what was heard before, initially it can be an overwhelming experience until the brain begins to adjust to the increase in sound.

## MAPPING

Cochlear implants are electrical and mechanical products, but they are implanted in human bodies that are constantly changing and growing. The electrical characteristics of the implant are fine-tuned in the mapping sessions at the cochlear implant center, so that all sound that is picked up by the microphone and processed by the system is adjusted to the ideal loudness level for each individual. Because the human body is a dynamic system, the implant sometimes needs to be adjusted over time to accommodate for changes in the sensitivity of the auditory system of the child. These adjustments simply require a visit to the implant center to re-assess the settings of the program in the speech processor.

Over the course of the child's lifetime, re-mapping of the cochlear implant will be needed regularly. "Mapping" (also called "programming") simply refers to the process of setting the levels and stimulation parameters of the individual user's speech processor, and evaluating changes in these levels over time. Mapping visits will be more frequent in the first months of implant use, and then taper off to semi-annual or annual visits. The same way that clothing sizes or eyeglass prescriptions change over time (sometimes at predictable intervals and sometimes not), the sensitivity of the auditory system to electrical stimulation also changes over time. The map, or individualized program in the speech processor, is adjusted so that the implant delivers consistent and comfortable stimulation as the body changes over time. The inner ear does not grow – it reaches adult size before the child is even born – but its sensitivity to the implant stimulation does change, and this phenomenon is seen in all implant users. It is a very normal process, and routine mapping simply attempts to keep the program up-to-date with that process.

**CAUTION:** Because a map is individualized for each child, it is very important that implant users never attempt to trade processors!

### **During a mapping visit, the audiologist will do several tasks:**

- :: Gather information from the family about the child's listening progress at home and at school or in therapy.
- :: Assess the child's progress and learn whether there are any specific problems that need to be addressed.
- :: Evaluate the function of the internal device using telemetry. This is a quick measurement through the implant programming system that gives the audiologist feedback about how well the electrodes and the internal electronics are working, and how well the internal and external equipment are communicating with each other. The audiologist may choose to deactivate some channels based on these measures. See "Deactivating channels".

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- :: Stimulate each channel (or electrode pair) with tiny pulses that are often perceived as beeping sounds. These sounds should have pitch differences depending on which area of the cochlea is being stimulated – remember that the cochlea is ‘tuned’ to perceive different pitches at different areas. Some children who have had a hearing loss for several years may not perceive pitch differences initially, but eventually should be able to perceive at least general pitch differences when different **channels** are stimulated.
  - :: Evaluate how well the auditory nerve is responding to electrical stimulation using Auditory Nerve Response Telemetry (ART™). This type of measurement allows the audiologist to see visual confirmation when the auditory nerve fires in response to sound through the implant.
  - :: Increase the electrical current on each channel to find the **most comfortable loudness** (MCL) level. The child will be asked to indicate when the sound is quite loud, but not uncomfortable. The MCL level assigned to each stimulation channel governs the maximum output of the device; the system will never send a stimulation pulse that is louder than the assigned MCL level.

**NOTE:** Because many children with significant hearing loss don't fully understand the concepts of “loud” and “soft,” the first few mapping sessions may focus as much on teaching those concepts as creating a good map until the child becomes comfortable with the process. There are many creative ways to apply the concepts of “big” and “small” to sound, but if the child is unable to provide any feedback about the loudness level, the audiologist may use some type of objective measure to gather the necessary information. Family members and educators can contribute to the success of the mapping sessions by reinforcing these comparative concepts in other areas (i.e. big toys vs. little toys). For more information, see the section “Objective measures,” next page.

- :: Ask the child to identify the softest level that is audible on each channel (commonly called “threshold”). One feature of MED-EL implants is that threshold measurements are not critical to developing a good map. Since threshold measures tend to be the most difficult to obtain due to their requirement for a high level of concentration, many audiologists choose to spend mapping sessions focusing on the MCL levels instead, particularly when programming young children.
- :: Set other parameters that govern the way the stimulation pulses are generated and may affect sound quality.

- :: Generate a program, or map, that is downloaded to the speech processor. The map ensures that the speech processor appropriately adjusts loudness levels based on the child's individual needs. Usually this map is activated so that an appropriate volume level can be determined. This may be the first time the child will hear voices and environmental sounds. At initial stimulation, this is often a very emotional moment for the family.
- :: Download one or more programs to the child's speech processor (and to the backup processor if applicable). The speech processor can hold multiple maps. See "Mapping Strategies" for more information.

Additional testing or **diagnostic therapy** may also be part of a mapping visit, depending on the implant center.

### Deactivating channels

MED-EL cochlear implant systems have 12 possible **channels** of stimulation. However, a user's performance doesn't necessarily depend on having all 12 channels activated. In general, speech perception research indicates that the "ideal" number of channels is somewhere between 6-10, depending on the study\*. Therefore, it is preferable to deactivate a channel that is not producing an effective sound perception, or that requires excessively high electrical current. This can actually improve the sound of the map without any degradation in listening performance of the child. It is not uncommon for implant users to have fewer than 12 channels activated in their map.

### Objective measures

There are several objective methods for determining appropriate stimulation methods with young children. One of the most common, the electrical stapedius reflex test (ESRT), is a painless procedure where a tiny rubber probe tip is placed in the unimplanted ear. The implant is then stimulated, which results in a very small contraction from one of the **middle ear** muscles on the unimplanted side. ESRT responses are present in the large majority of users and can provide a consistent and accurate way to measure the MCL.

Another objective measure is Auditory Nerve Response Telemetry™ (ART), which is available with current implant designs. ART allows the audiologist to measure the electrical signals produced by the auditory nerve in response to stimulation through the implant and provides an objective verification that the auditory system is being stimulated and is sending messages toward the brain.

**REFERENCES** :: (\*) Dorman MF, Loizou PC, Spahr AJ, Maloff E. A comparison of the speech understanding provided by acoustic models of fixed-channel and channel-picking signal processors for cochlear implants. *J Speech Lang Hear Res.* 2002 Aug;45(4):783-8 ; Shannon RV. The relative importance of amplitude, temporal, and spectral cues for cochlear implant processor design. *Am J Audiol.* 2002 Dec;11(2):124-7; Kiefer J, von Ilberg C, Rupprecht V, Hubner-Egner J, Knecht R. Optimized speech understanding with the continuous interleaved sampling speech coding strategy in patients with cochlear implants: effect of variations in stimulation rate and number of channels. *Ann Otol Rhinol Laryngol.* 2000 Nov;109(11):1009-20; Brill SM, Gstottner W, Helms J, von Ilberg C, Baumgartner W, Muller J, Kiefer J. Optimization of channel number and stimulation rate for the fast continuous interleaved sampling strategy in the COMBI 40+. *Am J Otol.* 1997 Nov;18(6 Suppl):S104-6.

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## Mapping strategies

The procedures used by implant centers to create maps vary a great deal from center to center. The best way to understand which programs are on a child's processor, how they vary, and when to use each of them is through regular communication with the child's implant center. For new implant users, maps are generally different in terms of loudness. As the child becomes a more sophisticated listener, the maps may vary by loudness, and also by various other parameters that affect sound quality. For the most part, children tend to have one main map that they wear most of the time. An experienced implant user may have additional maps for use in special situations, such as while using the telephone or in noisy environments.

TIP: Sometimes it is helpful to establish a predictable system with the implant center audiologist. For example, perhaps the audiologist can always designate the child's daily use program as program 1, so that if in doubt, you can always default to the main daily use program. It is also helpful to establish regular communication between the implant center audiologist, educational facility, rehabilitative providers and parents so that changes in program settings are communicated quickly and effectively to all of the child's caregivers.

## DEMYTHIFYING COCHLEAR IMPLANTS

Public awareness of cochlear implants is increasing, however certain misconceptions and myths persist. Let's take a look at some these and clarify the truths.

**MYTH ::** Cochlear Implants require brain surgery.

**TRUTH ::** The surgical procedure required is based on standard techniques that have been used for inner ear surgery for decades. The surgery is actually performed on the **mastoid bone**, which is the strong, bony housing of the brain right behind the ear. The most unique elements of cochlear implantation are the creation of a small "bed" or indentation in the mastoid bone, and the insertion of the **electrode array** into the cochlea. The human body has significant structures that protect the brain and these are not threatened by the cochlear implant procedure.

**MYTH ::** Children who have cochlear implants cannot swim or participate in sports.

**TRUTH ::** Cochlear implants are designed to withstand significant force without being damaged. MED-EL cochlear implants are either in a compact titanium housing or a durable ceramic material that are specially designed to have the same strength as the surrounding bone. Barring any specific restrictions from the surgeon or implant center, the child should be free to engage in most sports and activities. The use of helmets is recommended for any sport that traditionally uses them. This is a wise practice for any child or adult. Regarding swimming and bathing, the child simply needs to remove the external parts of the cochlear implant before going into the water.

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**MYTH ::** Cochlear implants don't provide good sound quality. Most people can only hear beeps and buzzes or speech that sounds like a robot.

**TRUTH ::** This myth probably exists because it can be difficult to understand the sounds provided by a cochlear implant during the initial days and weeks of use. Perhaps there were some users who did not allow enough time to become accustomed to the sound and stopped using their **speech processor**. However, the experience of listening with a cochlear implant improves over time and with listening practice. In the case of children who are developing spoken language with the help of a cochlear implant, we can be assured they are not hearing beeps and buzzes by listening to their own speech production. If they were hearing beeps and buzzes, they would be saying, "beeps and buzzes!"

**MYTH ::** Children with cochlear implants can't appreciate music.

**TRUTH ::** Different children respond differently to the sounds of music, some better than others. Many children with cochlear implants even learn to play musical instruments. MED-EL is always researching and developing new methods of coding sound, and one of the primary goals of this development is to improve music appreciation.

**MYTH ::** Children with cochlear implants cannot have an MRI.

**TRUTH ::** MED-EL cochlear implants are approved by the Food and Drug Administration (FDA) to be scanned in 0.2 Tesla strength MRI machines. Any MED-EL user who would require an MRI scan should contact MED-EL to obtain a request form to be completed by their physician prior to scheduling of the scan. At the time of the printing, MED-EL is the only fixed magnet cochlear implant device that is approved for MRI scanning without surgical removal of the **magnet**.



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# 9

## RESOURCES

### **MED-EL Elektromedizinische Geräte GmbH Worldwide Headquarters**

Fürstenweg 77a  
6020 Innsbruck, Austria  
Tel: 0043 512 28 88 89  
office@medel.com

### **MED-EL Corporation, North America**

USA and Canada  
2511 Old Cornwallis Road  
Suite 100  
Durham, NC 27713  
Telephone toll-free V/TDD: (888) 633-3524 (888MEDELICI)  
Fax: (919) 484-9229  
Email: implants@medelus.com  
Website: www.medel.com

### **The Alexander Graham Bell Association for the Deaf**

3417 Volta Place, NW  
Washington, DC 20007  
Telephone: (202) 337-5220  
TDD: (202) 337-5221  
Fax: (202) 337-8314  
Website: www.agbell.org

AG Bell provides extensive resources for parents and professionals related to deafness and the development of spoken language.

### **Central Institute for the Deaf**

Publications Office  
818 South Euclid Avenue  
St. Louis, MO 63110  
Telephone: (314) 652-3200

CID publishes test and classroom materials for teachers working with children who are deaf or hard of hearing.

### **Described and Captioned Media Program**

1447 E. Main Street  
Spartanburg, SC 29307  
864-585-1778 (VOICE); 864-585-2617 (TTY); 864-585-2611 (FAX)  
info@dcmp.org

DCMP supports equal access to media through described and captioned video materials. It provides a free loan service to educational institutions of captions educational media.

### **Hearing Loss Association of America**

7910 Woodmont Ave, Suite 1200 Bethesda, MD 20814  
301 657-2248  
www.hearingloss.org

The Hearing Loss Association of America (HLAA) is the nation's foremost consumer organization representing people with hearing loss. HLAA impacts accessibility, public policy, research, public awareness, and service delivery related to hearing loss on a national and global level. HLAA's national support network includes an office in the Washington D.C. area, 14 state organizations, and 200 local chapters. The HLAA mission is to open the world of communication to people with hearing loss through information, education, advocacy, and support.

### **John Tracy Clinic**

806 West Adams Blvd.  
Los Angeles, CA 90007-2505  
Telephone: (213) 748-5481  
Website: www.jtc.org

JTC provides a distance-learning program for parents of preschoolers with hearing loss and/or blindness. JTC services are free to parents.

### **The Mainstream Center at CLARKE School for the Deaf/ Center for Oral Education**

48 Round Hill Road  
Northampton, MA 01060-2124  
Telephone: (413) 582-1121  
Email: mainstream@clarkeschool.org

Provides a newsletter, training and additional resources for teachers with students who have hearing loss.

### **The Moog Center for Deaf Education**

12300 South Forty Drive  
St. Louis, MO 63141  
Phone: (314) 692-7172 Fax: (314) 692-8544 TTY:  
(314) 692-7282

The Moog Center publishes tests and classroom materials for teachers working with children who are deaf or hard of hearing.

### **National Association for the Deaf (NAD)**

814 Thayer Avenue  
Silver Spring, MD 20910-4500  
Telephone: (301) 587-1788  
TDD: (301) 587-1789  
Fax: (301) 587-1791  
Email: NADinfo@nad.org  
Website: www.nad.org

The NAD is an organization that advocates for civil rights and accessibility for the deaf and hard-of-hearing. It can provide information on captioning, sign language interpreting, and information related to deafness and Deaf Culture.

### **Oral Deaf Education (Option Schools)**

Oberkötter Foundation  
P.O. Box 50215  
Palo Alto, CA 94303-9565  
Telephone toll-free: (877) 672-5332  
TDD: (877) 672-5889  
Fax: (877) 672-5889  
Website: www.oraldeafed.org

This organization has a number of materials that support the development of listening and speaking for children with hearing loss. It is an organization made up of a number of private schools throughout the country.

### **Sunshine Cottage School for Deaf Children**

103 Tuleta Drive San Antonio, TX 78212 (210) 824-0579  
or FAX: (210) 826-0436  
www.sunshinecottage.org

Sunshine Cottage is an auditory-oral school program that publishes educational curricula and other materials for teaching children with hearing loss how to listen and speak.

FOR FURTHER READING ON CREATING  
A POSITIVE LISTENING ENVIRONMENT

FACILITATING HEARING AND LISTENING IN YOUNG CHILDREN, 2nd Edition by Carol Flexer. San Diego: Singular Publishing, 1999.

COCHLEAR IMPLANTS FOR KIDS by Warren Estabrooks, Editor. Washington DC: Alexander Graham Bell Association for the Deaf, 1998.

LISTENING AND TALKING: A GUIDE TO PROMOTING SPOKEN LANGUAGE IN YOUNG HEARING-IMPAIRED CHILDREN by Elizabeth Cole. Washington, DC: Alexander Graham Bell Association for the Deaf, 1992.

BRINGING SOUND TO LIFE: PRINCIPLES AND PRACTICES OF COCHLEAR IMPLANT REHABILITATION by Mary Koch. Baltimore MD: York Press, 1999.

CHILDREN WITH COCHLEAR IMPLANTS IN EDUCATIONAL SETTINGS by Mary Ellen Nevins and Pat Chute. San Diego: Singular Publishing, 1996.

CLASSROOM G.O.A.L.S: A GUIDE FOR OPTIMIZING AUDITORY LEARNING SKILLS by Jill Firszt and Ruth Reeder. Washington DC: Alexander Graham Bell Association for the Deaf, 1996.

Multiple resources are available at the following websites:

<http://www.agbell.org/news/catalog.pdf>

<http://www.listen-up.org/edu/teach.htm>

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## MATERIALS AVAILABLE FROM MED-EL

The **BRIDGE to Better Communication Program** was developed by MED-EL and was especially designed for education and rehabilitation professionals, implant users and parents to help BRIDGE the gap between implantation and the rapid development of improved listening skills and spoken communication.

The BRIDGE program consists of a wide variety of products, resources and materials for adult and pediatric habilitation, assessment, and device management. This process begins with identifying the implant user's current skills, setting realistic expectations and goals, and ensuring the best possible device function and listening skills each day. A variety of habilitation materials can help guide and motivate both the user and the professional toward achieving the best possible communicative competence.

To find out more about the BRIDGE to Better Communication Program, please contact the MED-EL for a catalog, or visit our website [www.medel.com](http://www.medel.com).



The image features the BRIDGE to better communication logo on the left, which includes a stylized bridge graphic above the word "BRIDGE" and the tagline "to better communication" below it. To the right, a collection of materials is displayed, including a piggy bank, a photo of a child, a book titled "My Diary For Parents and Therapists", and a book titled "Picture Perfect preschool".

PEDIATRIC & TEENS HABILITATION  
PEDIATRIC & TEENS ASSESSMENT  
ADULT REHABILITATION  
ADULT ASSESSMENT  
RESOURCES  
SOUNDSCAPE



# 10

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## GLOSSARY OF TERMS RELATED TO MED-EL COCHLEAR IMPLANT SYSTEMS

**Apical region** :: The apical region is the tip of the 'snail shell' shape of the cochlea. This region is responsible for sensing low-pitched sounds. MED-EL cochlear implants are the only implant systems that reach deep enough into the cochlea to stimulate the apical region and the part of the system that is 'tuned' to low pitched sounds.

**Audiogram** :: The audiologist does an audiogram (sometimes called audiometry) to determine the softest levels that a child can hear across low and high pitches. Often, the audiologist will also assess how well the child perceives speech sounds, which is called speech perception testing. Additionally, the audiologist may measure how softly a child can understand speech.

**Audiologist** :: An audiologist is a specialist in the diagnosis and non-medical treatment of hearing and balance problems. Audiologists obtain either a Master's or Doctoral level degree, and then complete a training fellowship prior to entering practice.

**Auditory brainstem response testing (ABR)** :: An audiologic test that roughly measures hearing acuity without any participation from the child. As the child sleeps, a clicking sound is presented to the ear, and the resulting brain activity is measured. This measure is used extensively for diagnosing hearing problems in infants and young children who are unable to respond behaviorally.

**Auditory habilitation specialist** :: This term is used in this handbook to refer to the wide variety of professionals who become specialists in teaching deaf children to use their residual hearing with hearing aids or cochlear implants. It is well accepted that children with hearing loss need special assistance to develop auditory skills. An auditory habilitation specialist can be a speech-language pathologist, a teacher of the deaf/hard of hearing, a certified auditory-verbal therapist, an audiologist – any one of a variety of related professions – who has specialized in the habilitative aspect of hearing loss.

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**Auditory Nerve Response Telemetry (ART™)** :: This is a test done by the audiologist that allows visual confirmation of the auditory nerve firing in response to stimulation from the implant. The ART measurement helps the clinician make a “rough guess” as to the sound level required to trigger the auditory nerve; although this measurement isn't completely predictive of the levels he or she will need to set in the child's processor program, it does provide confirmation that stimulation levels are roughly in the audible range for the child. ART measurements can be helpful in cases where a child cannot give adequate feedback during fitting sessions.

**Automatic gain control (AGC)** :: The AGC is a system the speech processor uses to manage sounds of different loudness. The child with a cochlear implant does not have a wide range of sound tolerance, as does a person with hearing. The AGC ensures that very loud and very soft sounds are processed accurately so that they fit into the range of hearing of the implant user.

**BabyBTE™** :: A unique wearing option available with all MED-EL speech processors that allows the entire speech processor to be attached to the clothing for security.

**Basal region** :: The basal region of the cochlea is the high-pitched region. This is the area that would be considered the base of the 'snail shell' shape, and is the area closest to where sound first enters the inner ear.

**Batteries** :: MED-EL speech processors are unique in that they have very long battery life. Several pack configurations run on size 675 batteries (for an average battery life of 3-5 days). These batteries can be purchased from MED-EL or at many drugstores and hearing aid dealers. It is critical that they are labeled as “high power” batteries. Size 675 batteries that are not labeled “high power” will result in very short battery life because their power levels fluctuate enough to signal a dead battery to the processor, even though the batteries may be fully charged. The remote battery pack uses one size AA battery (either rechargeable or alkaline).

**Battery pack** :: A modular component of the speech processor that houses the batteries that power the system.

**Channel** :: A channel refers to one of the 12 electrode pairs that are arranged along the array. The channels are numbered consecutively, with channel 1 being the lowest in pitch, and channel 12 being the highest in pitch. Not all children use all available channels, however. Channels can be deactivated for various reasons without any negative overall effect.

**Coding strategy** :: A coding strategy is a series of calculations used by the cochlear implant system to measure the sound that is presented to the microphone, analyze its components, and then determine which electrodes should be stimulated and how they should be stimulated to best represent the original sound. Next, it generates a code that is sent to the implanted portion of the system. This code tells the implant which channel address to stimulate within the cochlea, when to stimulate it, and how loud that stimulation should be to accurately represent the sound at the microphone.

**Coil** :: Also sometimes called a transmitter. The coil sends the coded information from the speech processor to the internal implant. It uses radio signals to send this message across the skin. The radio signals produced by the coil are a special frequency that is the only frequency understood by the implant receiver. The coil also contains a magnet that holds it against correct area of the head so that it is aligned properly with the implanted portion.

**Coil cable** :: The cable that connects the coil to the speech processor.

**Control unit** :: The computerized part of the speech processor that does the work of transforming sound into a code that can be sent to the implant.

**Connecting Piece** :: A connection accessory that allows a battery pack to be connected to the processor. All wearing options use some form of connecting piece; in some configurations, the connecting piece may also be the earhook. A special locking Connecting Piece safely locks the control unit and battery pack which keeps a small child from removing it from the processor.

**Communication methodology** :: The form that communication (and education) takes. Speaking, listening, using a signed or cueing system, or a complete signed language are all various communication methodologies.

**DaCapo Battery Pack** :: The DaCapo Rechargeable Battery System can be directly connected to the control unit. The system makes the processor even lighter and preserves the slim design. It is compatible with FM and other external devices. The rechargeable battery cell provides 10-12 hours of continuous operation.

**Decibels (dB)** :: The decibel is the measure of a sound's loudness. The range of normal human hearing is typically 0-120 dB, with 0 dB being barely audible and 120 dB being barely tolerable. Conversational speech is fairly loud, at around 50 dB.

**Detection** :: An auditory response that indicates a sound was heard. A child might indicate he or she detects a sound with a head turn, nodding, raising a hand, putting a toy in a container, etc. The fact that a child detects a sound does not necessarily mean he or she can discriminate it from other sounds – detection is simply an indication of the presence or absence of a sound.

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**Diagnostic therapy** :: Diagnostic therapy refers to the process of using the therapy environment to gain an understanding of a child's level of speech, language or auditory development. Through a series of fun activities, the auditory habilitation specialist may attempt to determine how well the child is making use of hearing through a hearing aid or an implant, without the use of formal test measures.

**Direct input** :: Direct input refers to plugging an external sound source directly into the speech processor using a patch cable. Any battery-operated device can be connected to the MED-EL speech processors.

**Discrimination** :: The ability of a child to understand a sound, word, or sentence. Usually speech discrimination is measured by asking the child to point to various objects or repeat various words or sentences.

**Dynamic range** :: A term used to define the loudness difference between the softest sound a person can hear, and the loudest sound they can still comfortably tolerate. The dynamic range of hearing is about 120 dB for most people with typical hearing. The dynamic range of the implant user is about 30 dB. The AGC system allows a sound range of 25-100 dB to be represented accurately by the speech processor, giving the implant user an expanded dynamic range of 75 dB.

**Earhook** :: The earhook has a dual purpose: it holds the speech processor on the ear, and in the case of the TEMPO+/OPUS I, it connects the battery pack (or battery pack cable) to the speech processor. The earhook can be ordered in a locking configuration to keep a child from removing it.

**Educational specialist** :: In this guide, the term refers to a professional who specializes in educating children with cochlear implants in a wide variety of educational settings. This professional may provide advice and support to a child's educational team, or evaluate a child's readiness for a certain type of educational approach. The educational specialist could be a teacher of the deaf/hard of hearing, an educational audiologist, or other related professional.

**Electrical auditory brainstem response testing (EABR)** :: This is a method of obtaining an ABR but using the sound generated by the implant. Because head movement can obscure the response, children are often lightly sedated for the test. This test assists in determining how well the auditory system is responding to the stimulation generated by the implant.

**Electrical stapedius reflex test (ESRT)** :: An objective measure that can be useful in establishing an MCL measurement in children who are unable to provide feedback to the audiologist about the loudness of sound. A small probe is placed in the opposite ear. The stimulation level of the implant is increased until a small muscle reflex is seen in the opposite ear. This muscle reflex is present in most people, and occurs at a level that is loud, but still comfortable. The level at which this reflex occurs correlates well with the MCL level of the map.

**Electrode array** :: The implanted device has a long, flexible portion that is inserted into the cochlea through a small opening. This portion of the device is called the electrode array.

**Electrode contacts** :: Electrode contacts are small oval-shaped disks made of platinum that are arranged along the electrode array. In MED-EL implants, they are arranged in 12 pairs. Each pair stimulates a different frequency region in the cochlea.

**Electrostatic discharge (ESD) or static electricity** :: A build-up of charge difference between a person and an object, often caused by friction between synthetic materials, or electronic equipment (such as TV screens), usually felt as a “shock” when the statically charged person touches a grounded object. The cochlear implant user does not feel the “shock” any differently from a non-user. A good example is the shock that occurs when touching a light switch after walking on the carpet. ESD tends to be worse in a dry environment. ESD can cause damage to electronic equipment of all kinds. MED-EL speech processors have built-in safeguards to protect the processor from program loss due to ESD. Please refer to the *Equipment Guide* for the child's speech processor for more discussion on ESD.

**Expressive language** :: The ability of the child to produce language to communicate with others.

**FineTuner** :: The FineTuner is the remote control device for use with the OPUS 2 control unit. It is used for changing sensitivity, volume and program settings.

**Fixation device** :: A small accessory that is attached to the battery pack that allows it to be connected to the clothing. The fixation bar can accommodate a small safety pin or diaper pin. The fixation clip can be clipped directly to clothing.

**FM system** :: An assistive device that consists of a microphone and transmitter worn by the speaker, and a receiver worn by the listener. In the case of the implant, the receiver must somehow connect to the speech processor with a patch cable, or with direct connection to the OPUS 2 FM battery cover. An FM system sends the speaker's voice to the listener using FM radio waves to help overcome the problems of distance and background noise.

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**Hair cells** :: The hair cells in the inner ear sense the pitch and intensity of sound waves that travel through the fluid of the inner ear. In most instances of deafness, the hair cells or some part of the anatomy associated with them do not function properly and cannot send signals accurately to the brain. The cochlear implant attempts to mimic the function of the hair cells by generating a signal similar to what the brain might normally receive from the inner ear.

**Hertz (Hz)** :: A measure of pitch that refers to the number of cycles per second that a sound causes oscillation. The range of human hearing is 20 Hz – 20,000 Hz. Speech information falls roughly in the frequency range 200 Hz – 6000 Hz. “Middle C” on the piano occurs at 262 Hz.

**Implant** :: The implanted portion of the system. The implant contains the receiver circuitry that decodes the signal from the coil, and also generates the tiny electrical pulses that travel down the electrode array and stimulate the cochlea. This receiver and stimulation circuitry is encased in a thin, and very strong package that sits just under the skin. The electrode array carries the electrical impulse from the implant case to the cochlea. The implant also contains a reference electrode that ensures the appropriate handling of electrical current. The implant contains a magnet, which attracts the external transmitting coil so that it is held in the correct place on the head.

**Implant case** :: The implanted electronics are hermetically sealed inside the case. MED-EL implants are the thinnest and smallest implants available.

**Individualized education plan (IEP)** :: Although the IEP has a different name in some states, the term refers to the formal educational plan that is developed for each child who receives special services through a local school district. Federal law requires that schools provide a “free and appropriate” education to all children, including those with special needs. The IEP is a document that defines the services that will be provided to meet that law. The IEP is developed with input from the child’s parents, the child (when appropriate), teachers, school administrators and special service providers.

**Inner ear** :: The anatomical portion of the hearing system that triggers nerve impulses that travel to the brain. Both the hearing and balance systems are found in the inner ear. The cochlea is a small snail-shaped structure that contains the tiny hair cells that sense sound and send signals to the auditory nerve. The semicircular canals sense balance and position changes and report these changes to the brain.

**Input dynamic range (IDR)** :: See Dynamic Range. The IDR a measure of the implant system’s ability to handle a wide range of sound inputs accurately. The IDR of the MED-EL system is 75 dB.

**LED indicator** :: The small red light on the front of the processor will flash in a variety of blinking patterns to indicate different error conditions of the processor or batteries.

**Localize** :: The act of locating the source of a sound.

**Magnet** :: There are two magnets in the system: one in the coil and the other in the implant case. Together the two hold the coil in place on the head. The implant center audiologist can adjust the magnetic strength of the coil.

**Map** :: The program stored in the speech processor that tells the system how to process sound on each channel so that it is most audible and comfortable for the individual user. Each implant user's map varies considerably from every other user. Maps also change over time, as the human body also fluctuates slightly in its sensitivity to electrical stimulation over time.

**Mapping sessions** :: A visit to the implant center where the individual's speech processor program is evaluated and changed if necessary

**Mastoid bone** :: The area of bone directly behind the ear where the implanted portion of the system is placed.

**Microphone port** :: The tiny opening on the front corner of the processor is the microphone port.

**Microphone test device (MTD)** :: An optional accessory that allows a hearing person to listen to the microphone of the processor to determine whether it is functioning adequately.

**Middle ear** :: The anatomical portion of the ear just beyond the eardrum. The middle ear consists of a small air space that holds the three small bones of hearing (malleus, incus and stapes). The Eustachian tube allows air exchange between the middle ear air space and the outside; when the ears 'pop' during a change in altitude, this is actually the pressure equalizing between the middle ear and the outside. The middle ear is the most common site of an ear infection.

**Mixing cables** :: "Mixing" refers to a feature of certain assistive listening devices (such as FM systems) that allows the user to combine the signal from the speaker with the signal from the speech processor microphone. The processors support this feature, but it is necessary to ensure that a mixing patch cable is in use.

**Most comfortable loudness (MCL)** :: MCL refers to a loudness level that is loud, but still comfortable, to the listener. This is an important measurement made on each channel during a mapping session. The final MCL setting of the map sets an upper limit for loudness, and stimulation will never exceed that limit. MCL levels are different for each user; therefore it is important that speech processors are never traded between users.

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**MRI scan** :: Magnetic Resonance Imaging is a medical diagnostic procedure. At the time of printing, MED-EL cochlear implants are FDA approved for 0.2T (Tesla) MRI scanners without the removal of the implant's internal magnet. Only machines of 0.2T strength should be utilized with MED-EL at this time. Additional factors, such as head placement, make it important for the scanning radiologist to contact MED-EL prior to scheduling the MRI scan.

**Newborn hearing screening** :: A program in place in many hospitals that allows a child's hearing to be evaluated immediately after the baby is born.

**ON/OFF switch** :: The ON/OFF switch is located on each of the TEMPO+ and OPUS 1 battery packs. The battery pack lock functions as the ON/OFF switch for the OPUS 2.

**Otologist/Neurotologist** :: An otologist is a physician who first became an ear, nose and throat specialist, and then went on to specialize in just the ears and the area of the head surrounding the ear. An otologist completes over 10 years of medical training and a specialized otology training fellowship prior to entering practice.

**Outer ear** :: The anatomical portion of the hearing system that includes the pinna (the visible "ear" on the outside of the head), the ear canal, and the eardrum (tympanic membrane).

**Phoneme** :: The smallest unit in a language that is capable of conveying a change in meaning. For example, the m in mat and the b in bat. There are 41 phonemes in the English language

**Phonemic repertoire** :: The range of various phonemes (speech sounds) that a child is able to produce. Generally, certain speech sounds seem to develop earlier than others over a period of several years.

**Play audiometry** :: An audiometric technique that teaches a young child to complete an activity when a sound is heard (such as dropping a block into a container or putting a piece in a puzzle). This facilitates testing the hearing of preschoolers and toddlers.

**Program switch** :: The program switch on the TEMPO+ and OPUS 1 allows the user to select different programs, or maps. The Fine Tuner is used to change programs for the OPUS 2 speech processor. Please refer to the implant center audiologist or parent to determine which program should be used most of the time.

**Receptive language** :: The ability of the child to understand language that is presented to him/her.

**Residual hearing** :: This is the term used to describe the hearing that remains after a hearing loss occurs. Most people with significant hearing loss still have some residual hearing that can be stimulated by amplifying sound using a hearing aid. However, the remaining hearing often does not provide enough clarity for a hearing aid to be of much benefit. These are the individuals who are candidates for cochlear implantation.

**Sensitivity control** :: The sensitivity control determines how sensitive the microphone is. High sensitivity settings cause the microphone gain to be increased. This can be good in a quiet environment, but in a noisy environment, it results in poor loudness relationships between soft and loud sounds. The general "rule of thumb" is to keep the sensitivity setting at about half-way on.

**Sound field FM system** :: An FM system that does not plug into the speech processor. Instead, a small speaker near the listener amplifies the speaker's voice. A sound field system is a good alternative to regular FM if the child is unable to provide feedback on the quality of a direct FM connection.

**Speech awareness threshold (SAT)** :: The softest level at which a child can detect a spoken word. However, the child is not required to be able to understand the spoken word.

**Speech processor** :: A tiny wearable computer that transforms sound into the coding understood by the implant. The TEMPO+ and OPUS 1 processor contain a microphone, a sensitivity control, a program switch, and a volume switch. The OPUS 2 contains a microphone and an on/off switch, with other functions accessible through the FineTuner remote control unit. The processors connect to different battery packs. The term "speech processor" is often used to refer to the entire external part of the system (processor control unit, battery pack, coil and cable).

**Speech reception threshold (SRT)** :: The softest level at which a child can hear a spoken word well enough to repeat it back correctly.

**Speech-language pathologist** :: A speech language pathologist is a specialist in the diagnosis and non-medical treatment of speech and language disorders. An SLP obtains either a Master's or Doctoral level degree, and then completes a training fellowship prior to entering practice.

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**Steady state evoked potentials** :: An objective measure of hearing that requires no participation from the child. SSEP's provide detailed information about the child's hearing acuity. This is a very new measure that does not yet have widespread availability.

**Suprasegmental** :: The cues of language that come from pitch, intensity and durational differences in the pattern of speech. Suprasegmentals are what allow an English speaker to recognize the inflection of a question, even though the question is asked in another language.

**Telecoil** :: The OPUS 2 has an integrated telecoil. The telecoil picks up magnetic sound signals coming from telephone receivers or loop systems which are installed in some public buildings, allowing another option for hearing on the phone or receiving input from assistive devices.

**Telemetry** :: A feature built into the implant system that allows the audiologist to test the function of the implanted portion of the system. This is a quick test that requires no input from the child, and provides valuable information about how well the electrodes are functioning.

**Telemic** :: An optional accessory to the TEMPO+ and OPUS 1 processors that allows the user to take advantage of two features: a built-in telecoil for accessing certain assistive listening devices, or an external microphone.

**Threshold** :: Hearing threshold is defined as the level at which a person hears a sound 50% of the time. This means, it is so soft, that the listener isn't even sure the sound is really there. When the audiologist performs an audiogram, he or she is trying to find the child's threshold of hearing at different pitches across a spectrum from low to high pitch. Threshold can also refer to the softest level of electrical stimulation a child can perceive. In the MED-EL mapping software, the threshold setting of the map is abbreviated as "THR." However, with MED-EL cochlear implants, threshold measures do not significantly impact the quality of the resulting map, and often are not measured.

**Tonotopic organization** :: The inner ear and the auditory area of the brain and central nervous system are arranged in pitch order, from low to high. Sounds of different pitches are processed by different hair cells, nerve fibers, or brain synapses. The cochlear implant, therefore, is designed to present pitch information to the areas of the cochlea that are "tuned" to be sensitive to those pitches.

**U-pin** :: A connection accessory that allows a battery pack to be connected to the speech processor without using an earhook. It is most commonly used in the BabyBTE™ configuration. The u-pin can also be ordered in a “locking” configuration, which keeps a small child from removing it from the processor.

**Visually reinforced audiometry (VRA)** :: This is a technique for obtaining responses to sounds from children who are not yet able to report what they hear. The child is presented with a sound, and when they respond, they are rewarded with something they can see, such as a puppet or an animated toy. The audiologist attempts to condition the child to look for the toy when a sound is heard, thus providing a method for testing the hearing of small children.

**Vocal play** :: The act of experimenting with the voice. Babies go through various stages of playing with their voices. This play becomes more and more speech-like until true words emerge. When a young child with a cochlear implant begins experimenting with his or her own voice, it is a good indicator that the child is hearing sound through the implant and is beginning to make the connection between hearing and the voice. With more time and practice, these vocalizations should begin to approximate words or phrases.

**Volume switch** :: The volume switch (x-y-z) on the TEMPO+ and OPUS 1 allows the user to choose different volume levels for each program. The FineTuner is used to adjust the volume levels for the OPUS 2. The audiologist sets the volume levels, so it is best to consult the child's parent or implant center for guidance on the correct volume setting for the child.



BRIDGE is a program for education and rehabilitation professionals developed by MED-EL.  
For more information about BRIDGE products, please visit [www.medel.com](http://www.medel.com).



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