Considerations in the Cochlear Implant Process

Once the decision is made to pursue a cochlear implant, there are a multitude of steps involved in the process. The first step is to contact a hospital implant center. To locate an implant center, check the cochlear implant manufacturers’ website:

- Advanced Bionics
- Cochlear Corporation
- MED-EL

What's Involved in the Process?
Most implant centers utilize a team approach to provide a comprehensive assessment of a child's candidacy for cochlear implantation. The process usually involves medical, audiological, speech and language, education, and other support service professionals. Although each hospital center may have its own protocol, the following components of the process are typically included:

- **Initial consult**—Professionals from the hospital implant center inform families of the cochlear implantation process. Topics for discussion may include pre-implantation testing and counseling, insurance coverage, the types of devices available, the surgery, programming of the external components of the device, and the training process.
- **Audiological assessment**—A current Auditory Brainstem Response (ABR) evaluation is necessary for young children to confirm the degree of hearing loss. Behavioral testing should also be a part of the test battery to provide a functional assessment of a child's hearing level. For more information about understanding audiological assessment, see *Guidelines for the Audiologic Assessment of Children From Birth to 5 Years of Age*.
- **Hearing Aid Trial**—While a hearing aid trial is usually a part of the protocol, the length of the trial period may vary depending on a variety of factors. For example, a hearing aid trial may be short for young children with confirmed profound hearing levels and limited observable benefit from a hearing aid to hasten implantation in the interest of the age of the child. A hearing aid trial may be longer for an older child who has proven to be a poor hearing aid user. An implant center may be trying to determine if an older child demonstrates responsibility and motivation to wear hearing aid technology.*
*Note: The rationale for an increased trial sometimes backfires as a child with a profound loss may dislike and not be motivated to use his or her hearing aid as he or she obtains limited benefit from it. This same child may like a cochlear implant when he or she has increased access to sound. Similarly, a parent who is excited about obtaining a cochlear implant for the child may not devote sufficient time and energy to a hearing aid trial.

- **Speech-language, developmental, cognitive, and motor evaluations** — These evaluations provide information on a child’s functioning in a variety of areas. Some hospitals have on-site staff trained in the specialized evaluation tools, techniques, and test standardizations for children who are deaf. Some hospital programs collaborate with support service professionals in school programs serving deaf and hard of hearing children to obtain these evaluations. No matter where the evaluations are completed, it is important that the professionals completing them are trained in, and familiar with, the tools and standards of evaluating deaf children.

- **Medical evaluations** — Children are evaluated by an otolaryngologist (ear, nose, and throat doctor) to obtain a medical history, evaluate the structures of the ear system, and look for possible medical reasons why a child may not be a candidate for a cochlear implant. The otolaryngologist is also usually the doctor who completes the cochlear implant surgery. A CAT scan (x-ray) and/or Magnetic Resonance Imaging (MRI) of the inner ear will be completed to evaluate the anatomy of the cochlea.

- **Family education and counseling** — Family members and the children themselves (based on the age of the child) will be counseled about what to expect related to the complex considerations related to choosing a cochlear implant. A comprehensive implant center will work closely with families and children to educate them about expectations related to the implantation process and the variable outcomes associated with implantation.

- **Auditory, speech, and spoken language habilitation/rehabilitation** — Prior to implantation, children and families may meet with a specialist from the hospital center who is trained in facilitating listening, speech, and spoken language skill development after implantation. Components of the habilitation process are shared so family members have a clear understanding of the training commitment that follows the surgery. Oftentimes, children participate in the habilitation process prior to surgery to become familiar with the activities and strategies that will be used after implantation.

- **Outreach with educational programs** — Most children and families in the implantation process are already enrolled in an educational program. Collaboration between the child’s educational program and the hospital implant center can facilitate the candidacy and habilitation process related to implantation. The educational professionals may bring a perspective to the candidacy process that may not otherwise be shared by the family or observed in the hospital setting. This collaboration will also facilitate development and implementation of appropriate educational goals and communication strategies for the child when he or she returns to his or her educational placement following implantation.

**Choices During the Implantation Process**
Choosing a Manufacturer

There are three manufacturers of cochlear implants commonly used in the United States (see links above). Some hospital implant centers offer the option of choosing an implant from any of the three companies. Some hospital implant centers may only offer one brand of cochlear implant. Some implant centers may provide a preference for one manufacturer over another, while others may not. Most centers will help families compare characteristics of implants in order to make an appropriate choice. It may be helpful to speak with other families regarding their experience with a particular manufacturer as a decision is made.

Possible considerations in making this decision include:

- the size/shape of the casing of the internal component of the implant,
- the internal technology of the electrode array,
- the size and style of the external components of the implant,
- the speech-processing strategies offered by the manufacturer,
- the additional supports from the manufacturer (e.g., help obtaining insurance, ease of ordering spare parts),
- the differences in battery life, and
- the considerations related to the need for possible MRI testing in the future.

For more information comparing the impact manufacturer technologies:

Cochlear Implants Online: Brand Comparison Chart (updated by Cochlear Implant Online on June 27, 2011; retrieved July, 2011)

Deciding Which Ear to Implant

Single Ear Implantation

If a child is going to obtain a cochlear implant in one ear, there are a variety of factors involved in making a decision about which ear to implant, including:

- **Anatomy of the ear system**—CAT scans or MRIs, which indicate the condition of the cochlea and the auditory nerve, are utilized to determine the following impacting factors:

  - Is there ossification (bony growth) of the cochlea? If so, the insertion of the electrodes into the cochlea can be adversely impacted. Presence of ossification does not mean that cochlear implantation is not possible; however, the quality of sound may be diminished if a sufficient number of electrodes cannot be adequately inserted. If there is a difference in ossification levels between ears, this may influence which ear is chosen for implantation.
- Is the auditory (eighth) nerve intact? Though the implant is placed within the cochlea, sound must be transmitted to the brain via the eighth nerve. If this nerve is not intact or is not present, a cochlear implant will not be possible. Some individuals who do not have an intact auditory nerve may be a candidate for a brainstem implant which places an implant beyond the auditory nerve. The auditory brainstem implant is similar in design and function to a cochlear implant, except that the electrode is placed on the first auditory relay station in the brainstem, the cochlear nucleus. See Brainstem Implants for more information.

- Is the cochlea malformed? Though surgery may still be possible with a malformed cochlea, the ear with a better-formed cochlea is more likely to be chosen if all other factors are equal.

- If x-rays indicate that the facial nerve is too close to the surgical area, this may impact the decision on which ear to implant.

- **Electrical stimulation**—If one ear is noted to respond better to the electrical stimulation of the cochlea as noted on the Promontory Stimulation Test, this may influence which ear to implant. However, this test is not completed by all hospital implant centers, and there is no definitive research as to its benefit in identifying the best ear to implant.

- **Implantation of the better ear**—If there is a difference in hearing levels between ears, some centers may choose to implant the ear with more residual hearing. This choice reasons that since this ear has more hearing and has benefited from a hearing aid, it may have better potential to benefit from the cochlear implant. If only one ear is to be implanted, this is a harder decision to make if this ear adequately benefits from a traditional hearing aid and residual hearing could then be lost.

- **Implantation of the worse ear**—If there is a difference in hearing levels between ears, some may choose to implant the worse ear. This choice reasons that since the "better" ear could continue benefiting from a traditional hearing aid should the cochlear implant not be successful in that ear and there would be nothing to sacrifice in implanting this ear.

- **Picking the ear on the right side**—If there is no difference between ears and everything else is equal, some centers may lean towards implantation of the right ear. This choice reasons that since the "speech centers" of the brain are on the left side and there exists a crossover effect (sound transferred from the right to the left side of the brain for processing), implantation on the right side may facilitate processing of speech and language information.

**Bilateral Cochlear Implantation**

Bilateral cochlear implants are being considered for increasing numbers of children. While it is becoming the standard of care for some, it should not be considered an automatic choice for all. Bilateral implants, through providing a binaural advantage to listening, can improve general ease in listening, speech perception in noise, and localization abilities. As it is not always possible to pick the most responsive ear with single-sided implantation, bilateral implantation always gets the “best ear.” The choice of bilateral implantation should be unique to each child and take into consideration a number of issues, including:
• Would the child benefit from continued acoustic listening through a hearing aid in the non-implanted ear?
• Does the non-implanted ear have the potential to benefit from the implant related to factors including the child’s age, duration of deafness, etc. (See the module on Factors Impacting Performance Outcomes.)
• Should bilateral implantation be completed simultaneously or sequentially? If it is sequential, when should the second implant occur?
• What are the implications for a child who has an older generation of a device in one ear and is receiving a newer generation of the device in the second ear?

For more information on bilateral implantation:

• Boys Town National Research Hospital—Bilateral Cochlear Implants
• MED-EL: Two Ears Are Better Than One
• MED-EL: White Paper-Bilateral Cochlear Implantation
• Advanced Bionics—On-line courses on bilateral implantation (archived):
  - Hear More Now and in the Future with Bilateral Harmony Cochlear Implants
  - Bilateral Cochlear Implants: The Natural Choice for Children
  - Hear Confidently: Bilateral Hearing and AutoSound
  - The Real World: Bilateral Hearing and HiRes
  - Bilateral Hearing with the Harmony and T-Mic
  - Bilateral Hearing—Navigating the Insurance Maze

**Frequently Asked Questions About Cochlear Implants**

Below are brief responses to some frequently asked questions that often arise in the process to obtain a cochlear implant. These issues can be discussed in further depth with a hospital implant center

**What is the expected life of the device?**
The manufacturers indicate that the internal components of the devices are designed to last a lifetime. The external components will face wear and tear issues similar to other hearing aids and technological devices. As newer external devices evolve, a user may need to update and/or replace the external components.

**Will static electricity affect the cochlear implant?**
Electrostatic discharge can cause damage to any electronic device; however, implant manufacturers have significantly improved the design of speech processors to provide greater
resistance to this problem. Electrostatic discharge will not cause damage to the internal device, or the child, but could possibly impact the functioning of the speech processor. It is not necessary to go overboard, but in highly static environments, it may be desirable to take precautions to reduce static in the environment or remove the speech processor (e.g., on plastic playground equipment). If the environment is highly static, it is recommended to touch another object to discharge the static electricity before touching the child’s implant.

**What is the risk of internal device failure?**
While the risk of device failure is small, it is possible. There are noted to be “hard” failures of the internal device, where the internal device quickly fails. There may also be “soft” failures that are identified when there is a slow, unexplainable decline in progress. In situations where there is internal device failure, additional surgery may be required to replace the device or in some situations to reposition a device that has migrated from its intended placement.

For more information:

- [Boys Town National Research Hospital—My Baby's Hearing, Cochlear Implants: Limitations and Risks](#)
- [What Parents Need to Know About CI “Soft Failure,” posted by Chris Mallinson on September 30, 2010, by Leeanne Seaver, Hands & Voices Communicator, with contributions from experts at Advanced Bionics, Cochlear Americas, and the University of Colorado Hospital, Hands & Voices Communicator, Summer 2010](#)

**Can implanted children participate in sports?**
Cochlear implantation should not interfere with most recreational activities. Judgment should be utilized in determining if the external portion of the implant should be used during sports. The design of many of the external speech processors are continuing to improve to become increasingly water resistant to sweat and moisture. [Advanced Bionics's Neptune speech processor](#) is designed to be waterproof and usable while bathing and swimming. To learn more about each processor's compatibility with water, it is important to discuss this issue with the audiology and hospital implant professionals familiar with each device. The surgically implanted portions of the implant will not be damaged by water sports or diving into a swimming pool. The only restriction that seems to be made by implant companies is related to the diving depth permitted in deep-sea scuba diving. This is based on severe pressure changes. The Cochlear Corporation notes that their device is validated to withstand pressure at a depth of 25 meters (82 feet) underwater. Check with the other manufacturers for their recommendations. For sports that involve particular risk of head injury, common sense indicates that head protection be utilized. Clinics usually advise avoidance of activities like boxing, where a severe blow to the head is likely.

**What about waiting for the technology to improve before choosing to implant?**
Research and observation suggest that early implantation in children is closely related to optimal outcomes in spoken language development. Studies also suggest that shortened duration of deafness also positively impacts spoken language growth with an implant. If early
implantation and shortened duration of deafness are seen as positive impacting factors on cochlear implant outcomes, then waiting for new technology would not be recommended. These same issues apply to saving the second ear for bilateral cochlear implantation when technology improves at a later time.

In addition, when looking at the research and development horizons from the cochlear implant manufacturers, it appears that the surgically implanted portion of the devices will not change dramatically in the near future. If there are changes, they will most likely be to the external hardware and software systems. Individuals obtaining cochlear implants at this time should therefore be able to take advantage of upcoming advances in the external components of the device without further surgery through upgrades to new devices.

What about metal detectors and other security devices? Devices such as airport metal detectors and commercial theft detection systems produce strong electromagnetic fields. Some cochlear implant recipients may experience a distorted sound sensation when passing through or near one of these devices. To avoid this, turn off the processor when in the vicinity of one of these devices.

Cochlear Corporation, Physician’s Insert

What are the surgical risks? In general, the surgical procedure is not considered high risk. The risks reported are those associated with any surgery requiring anesthesia. The areas involved in surgery include the mastoid bone behind the ear (where the magnet portion of the implant is housed) and the cochlea housed in the inner ear (where the electrodes are implanted). This is not "brain" surgery.

As the hearing system is close to the balance system, some individuals may experience periods of dizziness following implantation. There are other possible, though uncommon, risks associated with surgery related to the facial nerve, sense of taste, and possible infection that should be discussed with the physician. (See also the module on Surgical Considerations.)

What is the risk of meningitis following implantation? In 2002, the FDA issued a public health notification highlighting the possible association between cochlear implants and subsequent bacterial meningitis. Since that time the FDA has continued to study this. As of October 2007, the FDA noted that although all cochlear implant recipients appear to be at some increased risk for bacterial meningitis caused by Streptococcus pneumoniae, those children implanted with cochlear implants that have a positioner were at greatest risk. The only model with a positioner was withdrawn from the market in July 2002.

For more information, see the FDA Notifications:
• **FDA Public Health Notification, February 2006—Continued Risk of Bacterial Meningitis in Children with Cochlear Implants with a Positioner Beyond Twenty-Four Months Post-Implantation**

• **FDA Public Health Notification; October 2007—Importance of Vaccination in Cochlear Implant Recipients**

The FDA, since 2003, has made the following recommendations to decrease the risk of meningitis:

- Healthcare providers and families should review vaccination records of current and prospective cochlear implant recipients to ensure that the patient is current on all the CDC-recommended vaccinations. For more information about these recommendations:
  - [Center for Disease Control advisory](#)
  - [Policy statement of the American Academy of Pediatrics](#)

- Cochlear implant recipients, along with their families, educators, and daycare and healthcare providers, need to be aware of the signs of meningitis. This can help ensure early detection and treatment of this life-threatening illness.

- Diagnose and treat middle ear infections promptly. In some of the meningitis cases reported to FDA, cochlear implant recipients had signs of middle ear infection (otitis media) prior to surgery or before the meningitis developed.

- Healthcare providers should consider prophylactic antibiotic treatment perioperatively in children receiving cochlear implants.

- Cochlear Americas states the following related to their devices: The Cochlear Nucleus CI500 Series cochlear implant, Nucleus Freedom cochlear implant, Nucleus 24 cochlear implant and some Nucleus 22 cochlear implants have a removable magnet and specific design characteristics to enable it to withstand MRI up to 1.5 tesla, but not higher. Those with a magnet in place must not enter a room with an MRI operating.


- Advanced Bionics states the following related to their devices: The HiRes 90K is designed with a removable magnet to allow for MRI scans. The HiRes 90K is MRI safe at 0.3 Tesla and at 1.5 Tesla; MRI safety at higher energy levels has not been tested. The magnet must be surgically removed before the patient undergoes an MRI procedure. Patients must also remove their sound processor and headpiece before entering a room where an MRI scanner is located.

- MED-EL states the following related to their device: In specified circumstances, MED-EL cochlear implant users may receive an MRI provided that they have been implanted for
at least 6 months. MED-EL cochlear implants have been demonstrated to pose no known hazard under fields of strength of 0.2 Tesla (without surgical removal of the internal magnet).

- **FDA—Before, During, and After Surgery**
- **Boys Town National Research Hospital—Pre-operative Visits**
- **Boys Town National Research Hospital—Follow-Up Visits**
- **Cochlear Americas—Precautions and Warnings**
- **Handbook for Educators: MED-EL; The Cochlear Implant Process (pp. 48-61)**

**Is the residual hearing in the implanted ear destroyed as a result of surgery?**
The design of improved electrode arrays and improved implantation procedures seems to be increasing the possibility that the cochlea may be preserved following implantation. However, there continues to be the potential loss of residual hearing following implantation, and implant companies continue to warn patients that loss of residual hearing will probably result from implantation.

**What about MRIs for individuals with cochlear implants?**
Implants and MRIs are generally not compatible due to the magnetic component of the implant. If MRIs are an issue of concern, this should be discussed with your hospital implant center. Each of the implant manufacturers notes indicators specific to MRIs as follows:

For more information, see [MRI Safety and Cochlear Implants](#).

**Other Resources About the CI Process**
For more information related to the process of getting a cochlear implant:

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