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Author: Laughton, Joan
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Educating Children Who Are Deaf or Hard of Hearing: Cochlear Implants. ERIC Digest #E554.

What is meant by a "cochlear implant"?

A cochlear implant prosthesis is a device that includes an external package

(microphone and speech processor) worn by the user and an internal package (an array of electrodes that is surgically implanted into the cochlea (end organ of hearing) in the inner ear. The internal and external components of the cochlear implant are connected via an electric coupling. Cochlear implant prostheses are designed to create hearing sensation by direct electrical stimulation of auditory neurons (nerves). Several designs of this prosthesis have been used although they have similar basic components. The speech processor is worn externally and converts characteristics of sound signals (acoustic parameters) into electrical characteristics (parameters). The purpose of the device is to improve speech recognition of cochlear implant users by representing acoustic (sound) information. The original single-channel implants have been replaced by greater use of multichannel implants, where the stimulation is distributed across an array of electrodes that evoke a wider range of auditory perception.

Cochlear implants are options for habilitation (i.e., helping a person develop or learn new skills or abilities) or rehabilitation (i.e., helping a person relearn old skills that were lost somehow) available for individuals with profound hearing impairment (Geers & Moog, 1994). After long-term use with adults, a major research effort was undertaken to evaluate effectiveness for children. In 1990 cochlear implants were approved by the United States Food and Drug Administration for children between the ages of 2 and 17. Considerable research has been directed toward the effectiveness of these devices. Most early research focused on the benefit gained from use of cochlear implants in conjunction with speechreading (Geers & Moog, 1992). More recent research has investigated the receptive and expressive language gains experienced by users of cochlear implants (Hasenstab & Tobey, 1991). Early studies of children showed that they followed a pattern similar to adults in that most users had post-lingual hearing losses (i.e., after the age of five). More recently, benefits to pre-lingually hearing impaired (i.e., before the age of two) children have been observed. Research shows that pediatric implant users gain substantial benefit from multichannel cochlear implants, that these benefits develop over a long course of time, and that multichannel implants are more beneficial than single-channel devices (Hasenstab, 1989).

Who can use this technology?

Candidacy requirements for receiving a cochlear implant are changing. Before the FDA approved implants, children with profound deafness who were at least two years old, and who received no benefit from conventional hearing aids, were the primary recipients. Several significant factors interact in the consideration of cochlear implants as an option. Age of onset of deafness is an important factor, specifically whether the deafness was prelingual or postlingual. Etiology or cause of hearing loss is significant as well. The majority of children with postlingual deafness have meningitis as the cause of deafness. These children are also at risk for additional outcomes such as neurological dysfunction or cochlear ossification (hardening of the bone), presenting surgical challenge. The majority of children receiving implants are prelingually deaf and may be completely unfamiliar with sound.

Trends in effective use of cochlear implants have been observed. The postimplant performance of children with acquired or congenital deafness before age three show speech perception results that are similar. The postimplant performance of children with postlingual deafness is better on most outcome measures, but those differences become smaller over time. Performance is better for children who are implanted when younger than age four. The research has shown large within-group differences on all measures that suggest that some factor(s) other than age of onset affect postimplant performance differences. The traditional candidacy criteria have been:

- Age 2 or older

- Profound deafness

- Consistent pattern of hearing aid use

- Intensive auditory training

- Hearing levels greater than 100 dB.

The traditional candidacy criteria have included only those children who have demonstrated no benefit from conventional amplification. Intensive auditory training should include training in detection of sounds as well as recognition of closed sets of spoken works. In a closed set, candidates are given options of words to choose from; in an open set they must decide on a word without any clues. More recent changes in candidacy criteria are leaning toward relaxing that criterion. The performance of children with some residual hearing has resulted in a recommendation to include them in the selection group. Comparative studies of children with cochlear implants and with conventional hearing aids have shown rapid gains (within six months) of the cochlear implant users (Hasenstab & Tobey, 1991). Further research detailing changes with respect to duration of implant use, significance of age of onset of deafness, and age of implantation is needed.

What are the benefits of cochlear implants?

With adults the benefits of cochlear implants have ranged from communication by hearing alone with ease (with or without speechreading) to the recognition of sounds not available prior to the implant. Some adults can recognize sounds in an open set with hearing alone. Adult cochlear implant users are primarily individuals who have learned language and then lost their hearing. The purpose of cochlear implants for children is to enable them to develop spoken language. The benefits of implants that have been shown in research include increased capacity for spoken language acquisition. This has been observed as children move from no recognition to substantial open set recognition within six months as contrasted to much longer times required for hearing aid users to attain this level of performance.

Some observers feel that successful implant use is related to age of onset of deafness and implantation, etiology (cause of deafness), type of prior language habilitation program (spoken or sign language), parent involvement, and cognitive and language development. The enhanced information about sound that is available to the user is one of the major benefits of implants when contrasted to conventional hearing aids. When implanted early after the onset of a loss, the enhanced perception of sound may be expected to provide the child with the information required for spoken language acquisition. Parents have reported rapid behavioral improvement postimplant. Both parents and teachers have reported significant receptive language improvement in phonologic (speech sounds) and semantic (word meaning) domains. Increased intelligibility of speech has also been reported. Cochlear implants are highly reliable but must be accompanied by an intensive auditory rehabilitation component for successful use.

What are the limitations of cochlear implants?

Little is currently known about the long-term effect of the cochlear implant. Implants require surgery. Although post-surgical complications have been quite low, there are risks of infection with surgical procedures. Although rare, the possibility of scalp flap complications and migration (movement) of the electrode array from the scala tympani (area in the inner ear) are present. The expense of the medical, audiological, rehabilitation, and educational components of surgical implantation is significant. Although uncommon, certain conditions may require re-implantation of the device.

What are some questions to ask in choosing this option?

Where can I find out more about cochlear implants?

What type of communication development or rehabilitation program has my child received to date?

Do I have a philosophical commitment to spoken language development for my child?

When is the optimal time for my child to receive an implant?

- Which ear will be implanted? Why?
- What are the surgical procedures and risks?
- How will I deal with after-hours emergencies or concerns?
- How will the rehabilitation plan be developed and implemented?
- What is the long-term projection in terms of device replacement and cost?
- Am I willing to commit the time, energy, and dedication required to make the use of a cochlear implant a success?
- Is my child's school ready and able to work with him as an implant user?

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A.G. Bell Association for the Deaf, 3417 Volta Place, NW, Washington, DC 20007.

American Speech-Language-Hearing Association (ASHA), 10801 Rockville Pike, Rockville, MD 20852.

Cochlear Implant Club International, 2000 Church Street, Box 111 Nashville, TN 37236.

Division for Children's Communication Development, The Council for Exceptional Children, 1920 Association Dr., Reston, VA 20191.

National Institute on Deafness and Other Communication Disorders, 9000 Rockville Pike, Bethesda, MD 20892.

Network of Educators of Children with Cochlear Implants, Manhattan Eye, Ear & Throat Hospital, 210 East 64th St., New York, NY 10021.

Dr. Laughton is Associate Professor, Department of Communication Science and Disorders, The University of Georgia.

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