National Institutes of Health

Fact Sheet — Cochlear Implants

One of the more groundbreaking biomedical achievements in the last thirty years is the cochlear implant, an electronic device that provides a sense of sound to individuals who are profoundly deaf or severely hard-of-hearing. Cochlear implants process sounds from the environment and directly stimulate the auditory nerve, bypassing damaged portions of the inner ear. Derived in part from NIH-funded research that dates back to the early 1970s and continues today, this remarkable technology enables deaf and severely hard-of-hearing individuals to enjoy an enhanced quality of life by providing the ability to listen and participate in conversations as they typically occur throughout our society.

Thirty Years Ago

- Most profoundly deaf or severely hearing-impaired children were not diagnosed until they were 2 1/2 to 3 years old. As a result, many children were not offered treatment until long after the period an individual normally starts to acquire speech and language skills.
- Children with hearing loss often fell behind their peers in language, cognitive, and social skills. They also were limited in their academic performance and long-term job opportunities.
- Prior to 1975, the primary medical device for profoundly deaf or severely hearing-impaired children and adults was the behind-the-ear (BTE) analog hearing aid. Unlike the cochlear implant, a hearing aid primarily amplifies sounds so that they can be detected by the surviving portions of the ear; therefore, the more severe the hearing loss, the less effective a hearing aid will be.
- The first cochlear implants to be tested were single-channel cochlear implants, which transmit all sound frequencies as a single signal to the inner ear. These devices proved the value of electrical stimulation of the surviving auditory nerve. Individuals were aware of environmental sounds, such as sirens, and speech lip-reading skills were significantly improved.
- In the late 1970s, implants were developed to stimulate different portions of the surviving auditory nerve, based on the different sound frequencies present in the environment. This enhancement greatly increased the complexity of the device and mimicked normal function of the inner ear.
- Individuals using this device were able to understand speech without any lip-reading cues.
- In 1984, the Food and Drug Administration (FDA) approved the first cochlear implant for use in adults ages 18 and older. Five years later, the FDA approved the first cochlear implant for use in children ages 2 years and older. And in 2000, the FDA approved the implantation of children as young as 12 months of age for one type of cochlear implant.
- The NIH sponsored two Consensus Development Conferences, one in 1988, and a second in 1995, which offered guidance on the benefits, limitations, and technical and safety issues to consider in the use and study of cochlear implants.

Today

- Nearly 100,000 individuals worldwide are fitted with a cochlear implant. In the United States, roughly 22,000 adults and nearly 15,000 children have one.
- NIH-supported scientists showed that profoundly deaf children who receive a cochlear implant at a young age develop language skills at a rate comparable to children with normal hearing.
- Although the benefits of the cochlear implant can vary among individual users, improvements in speech processors and other related technologies allow children with cochlear implants to succeed in mainstream classrooms.

- NIH-supported scientists found that the benefits of the cochlear implant far outweigh its costs in children. A cochlear implant costs approximately $60,000 (including the surgery, adjustments, and training). In comparison, the services, special education, and adaptation related to a child that is deaf before age three costs more than $1 million.

Tomorrow

The NIH is poised to make major discoveries in the *prediction* of hearing loss and cochlear implant performance, to *personalize* treatments and *preempt* poor outcomes.

- *Predicting hearing loss and the benefit of cochlear implants.* Scientists are studying the genes that cause deafness to predict which individuals are at risk of losing some or all of their hearing. Continued research on ways to assess how well current users benefit from their cochlear implants will enable scientists to design implants more effective for all future implant users.
- *Personalized treatments.* Some individuals with severe to profound hearing loss are receiving two cochlear implants, one for each ear. Research is demonstrating that these cochlear implant users are significantly better at localizing sounds and hearing speech in a noisy room, when compared to individuals with a single implant. Advanced signal processing techniques are required to fully take advantage of these capabilities. Researchers also are developing a new cochlear implant electrode designed to provide electrical stimulation of the auditory nerve for high-frequency sounds while preserving useful, residual hearing at low frequencies.
- *Preemptive approaches.* Scientists can now study the large groups of children who were identified early for hearing loss and use this knowledge to document how treatments such as cochlear implants can lead to improved speech acquisition, academic performance, and economic outcomes for these children.