# To Be or Not to Be Implanted

*By Fan-Gang Zeng, PhD*

Cochlear implants are now widely accepted as a cure for deafness, with more than 200,000 users enjoying various degrees of success. Despite this success, several issues remain. Who should get a cochlear implant? What kind of implant should one get? How much success can be expected with the implant?

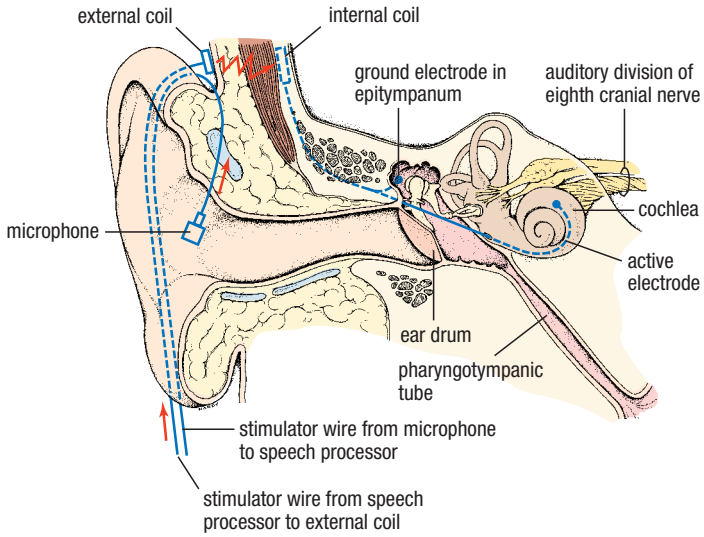
The answers to these questions change constantly with improved scientific knowledge and technological development. Several recent studies are likely to change the answers again.

## Results with Cochlear Implantation in Adults with Speech Recognition Scores Exceeding Current Criteria

Amoodi HA, Mick PT, et al
*Otol Neurotol*
2012;33(1):6

This study from the University of Toronto expanded the audiological criteria to allow more patients to receive cochlear implants. Historically, cochlear implants were used to treat profoundly hearing-impaired patients with more than 100 dB HL loss, providing mostly sound awareness and lip-reading assistance. Modern multichannel cochlear implants can provide 70-80 percent open-set speech recognition by comparison.

As a result, the implantation criteria have shifted from pure-tone threshold loss to functional assessment, allowing those who achieve less than 50 percent sentence recognition in quiet with properly fitted hearing aids, regardless of pure-tone threshold loss, to be eligible for cochlear implantation. What about those who can achieve more than 50 percent sentence recognition in quiet with hearing aids but hope to get more with a cochlear implant?




**COCHLEAR IMPLANT**

Amoodi and colleagues reported encouraging results in 27 patients who had a mean sentence recognition score of 68 percent pre-surgery (SD=9; range=61-90%) but were not satisfied with their hearing aids. Twelve months after receiving a cochlear implant, they produced significantly better performance of 95 percent (SD=6, range=76-100%), with none having worse post-surgical performance.

More importantly, their subjective rating of hearing handicap was only half with cochlear implants as with hearing aids. This study is especially intriguing because 23 of the 27 patients received the cochlear implant in their poorer ear, allowing them to continue to use bimodal stimulation after surgery. Although no such measure was obtained in this study, a significant bimodal benefit is expected.

## Electrophysiologic and Behavioral Outcomes of Cochlear Implantation in Children with Auditory Nerve Hypoplasia

Valero J, Blaser S, et al
*Ear Hear*
*2012;33(1):3*

This study, also from University of Toronto, identified a group of patients who may not be stellar cochlear implant users. All patients had hypoplasia, that is, a narrower-than-normal auditory nerve bundle. Using high-resolution imaging, the authors identified 20 (2.5%) of the 807 implanted children in their program to have either a narrow auditory nerve canal (normal diameter=1-1.18 mm) or an indistinguishable auditory nerve canal from facial nerve and vestibular nerve bundles. Using standard audiological criteria, all 20 patients seemed to be typical candidates: having severe-to-profound hearing loss and receiving little or no benefits from hearing aids.

But their implant performance is subpar in electrophysiological and behavioral measures. Compared with 17 typical implant children without auditory nerve hypoplasia in the control group, all of whom showed normal electrically evoked compound action potential (ECAP) and electrically evoked auditory brainstem potentials (EABR), only two of seven tested children with hypoplasia showed typical ECAP and five of 13 showed typical EABR. Most children with hypoplasia had abnormal ECAP amplitude and latencies, suggesting nonauditory

generators or myogenic responses that would produce facial nerve stimulation or other discomfort.

Behavioral results showed poorer-than-normal performance for the hypoplastic group at device activation. Worse yet, the poor performance didn't catch up even after 10 years of device use, and seemed to plateau at a lower level than the control group.

The subpar implant performance in children with abnormal nerve responses confirmed the findings from an earlier study conducted by researchers at the University of North Carolina at Chapel Hill. Teagle and colleagues examined ECAP responses and implant performance in 52 children with auditory neuropathy, and found positive and negative correlations between the two measures. (*Ear Hear* 2010;31[3]:325.) Those who had robust ECAP responses achieved a high level of open-set speech performance while the other who had absent or abnormal ECAP responses all achieved poor performance. The root cause of absent or abnormal ECAP performance was also related to auditory nerve deficiency.

What have these studies taught us about the cochlear implant candidacy?

The Amoodi study will continue the cochlear implant's invasion into the hearing aid market. If cost and surgery are not a factor, then a 10 percentage point relaxation in speech recognition score could mean another 10-20 percent — two to four million hearing-impaired Americans — will be eligible for cochlear implantation. Hearing aid manufacturers, of course, are not standing still, and simply watching from the sidelines. New technologies such as frequency transposition are likely to improve hearing aid performance and tip the balancing point between hearing aids and cochlear implants.

Although the Valero and Teagle studies caution against cochlear implantation in patients with auditory nerve hypoplasia and auditory neuropathy, they will actually help the cochlear implant market in the long run. It is extremely valuable for patients and parents to know whether and how much a relatively costly and risky procedure like cochlear implantation will improve hearing. One could then make an educated and appropriate decision about cochlear implantation. The decision on whether to receive a cochlear implant is going to be even more challenging as auditory brainstem and midbrain implants become viable alternatives to treating deafness caused by auditory nerve deficiencies.

At the end of the day, everyone is a winner with these scientific and technological advances. The manufacturers of hearing aids and cochlear implants will have greater overall market penetration, audiologists will have more options and tools for patients, and of course, patients will be the greatest beneficiary with improved performance and satisfaction.

**Dr. Zeng** is the director of the Center for Hearing Research, the research director of otolaryngology-head and neck surgery, and a tenured professor of anatomy and neurobiology, biomedical engineering, cognitive sciences and otolaryngology at the University of California, Irvine. He is also the chairman of the editorial board of *The Hearing Journal*.