



Childhood Development After Cochlear Implantation

Multicenter Study Examines Language Development

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The Childhood Development after Cochlear Implantation (CDaCI) study is one of the largest prospective, multi-center investigations underway to determine the effectiveness of early cochlear implantation on a large national cohort (Niparko et al., 2005; Fink et al., submitted 2006). The study is funded through a \$7.5 million grant from the National Institute on Deafness and Other Communication Disorders at the National Institutes of Health.

The overall goal of the five-year CDaCI study is to generate a multivariate model within and across developmental domains, identifying factors that affect and are affected by language development in children with cochlear implants (CI) and those with normal hearing (NH). The major strengths of this research design are that it longitudinally tracks children implanted at six centers across the United States (see page 29) and incorporates a normal-hearing control group undergoing the same protocol.

Participants in CDaCI include 188 CI and 97 NH children 5 years of age or younger at entry into the study. Baseline demographics of the CI subjects closely resemble those of the pediatric deaf population receiving cochlear implants in the United States as independently sampled by the research division of Gallaudet University, thus serving as a model for the CI childhood population at large. Many of the CDaCI measures replicate and extend measures collected for the National Institute of Child Health and Human Development as part of the Early Childcare Database on more than 1,300 children from 10 U.S. sites; using similar measures allows comparisons to a cohort followed for nearly 15 years on measures of language, maternal sensitivity, cognition, and social development.

The CDaCI researchers are tracking auditory function, psychosocial development, and quality of life from parents' perspectives. Outcomes in these domains serve as dependent variables surrounding the primary outcome variable of interest—language level. This analytic approach probes those domains important to the developmental learning that supports language acquisition. Notably, CDaCI builds on work by Svirskey

and colleagues (2000) who demonstrated that the language age of children with a CI improved to higher levels than would have been predicted from their pre-implant scores. Such observations support early implantation as a means of gaining experience in critical periods of language acquisition and lengthening the duration of early phonologic access.

One complexity in comparing CI and NH children is their wide range of auditory perceptual capabilities. To address this challenge, a hierarchy of speech recognition measures is utilized, on which children ascend to increasingly difficult tasks after achieving criterion levels on easier tasks (Eisenberg et al., 2006). This approach allows the researchers to examine the trajectory of language acquisition and to quantify how effectively the cochlear implant influences a child's ability to process speech. Such measurement also enables examination of those auditory factors that best predict linguistic skill, as well as outcomes measured by the other domains in the CDaCI study.

Results

Results on the first 42 pairs of children reaching one-year follow-up indicate that a proportion of the CI children achieved scores comparable to the NH controls on the earliest measures of the hierarchy, specifically the IT-MAIS/MAIS (Robbins et al., 1991; Zimmerman-Phillips et al., 2000), Early Speech Perception Battery (Moog & Geers, 1990), and the Pediatric Speech Intelligibility Test (Jerger & Jerger, 1984). In fact, some of these young CI children identified sentences under increasingly difficult levels of speech competition.

A developmental framework has guided the researchers in evaluating the "whole child" in the CDaCI study, integrating language learning with effects on social, emotional, and behavioral development (Quittner et al., 2004). Baseline data from CDaCI participants clearly demonstrate the negative, pervasive effects of deafness in the CI children prior to implantation. Significant differences in the quality of parent-child interactions between CI candidates and NH peers also are evident at baseline, with CI parents evidencing less sensitivity, less respect for the child's autonomy, and less cognitive stimulation, although these parents had greater positive regard for their children than parents in the NH group. Importantly, parent-child variables are correlated with language and parent-reported behavior problems. To the extent that early cochlear implantation increases communicative competence and quality of parent-child interactions, it may have dramatic and positive effects on the child's behavioral and social development.

The researchers also have hypothesized that a child's ability to acquire oral language is an important component of health-related quality of life (HRQL), and that the effects of cochlear implantation on HRQL are not limited to domains of hearing and communication (Lin & Niparko, in press). Instruments that measure HRQL divide into two categories: a) health index surveys, and b) health utility metrics that capture a patient's overall sense of well-being. Models of cost-effectiveness also can be derived from HRQL ratings. A child's HRQL is a key variable in developing a broader understanding of health and factors that influence health. Despite inherent challenges in measuring HRQL in very young children, the researchers have observed lower ratings of HRQL by caregivers of children with CI vs. NH on baseline measures. Taken

together, the comprehensive and prospective approach of CDaCI is designed to address questions related to the high variability and interactive processes in language outcomes after implantation. Visit <http://cdaci.org/> for more information about the study.



The authors are writing on behalf of the CDaCI Investigative Group.

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