How well do young children using cochlear implants succeed in the development of language, speech, and academic skills? What are current research findings telling us?

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Background.
Data collected by Ertmer and published in 2002 indicated that more than 7,000 children in the US have received cochlear implants, and the numbers have been increasing by 23% yearly. Children as young as one year old are frequently being implanted. *Implantation of children at age 2 or earlier is thought to shortcut possible auditory deprivation and avoids some of the effects of this condition during the critical period of language acquisition* (Gantz and others, 1994; Moores, 1987). There is evidence that early intervention involving the use of cochlear implants (CIs) does lead to a shorter period of deafness that is correlated with better performance (Waltzman and others, 1992; Miyamoto, Houston & Kirk, 2002; Truy and others, 1998; Nikopoulos and others, 2004).

Speech, Language and Educational Benefits of Cochlear Implants.
Kirk (2000) reviewed research findings over a decade and concluded that children using CIs develop speech perception and speech production abilities beyond those typically found in deaf children who wear hearing aids. Geers (2002) in a longitudinal study reported that children using CIs were superior to those wearing conventional or tactile hearing aids in speech perception and spoken sentence length. Tomblin, Spencer, Flock, Tyler and Gantz (1999) found that substantial numbers of implanted children who were retested over seven years made significant improvements in some auditory, speech, spoken language and reading skills. Related studies by Waltzman, Cohen and Shapiro (1992), Gantz and others (1994) and Brown, Abbas and Fryauf-Bertshy (1994) have supported other findings that superior measures of speech perception including sentence recognition occur in children using CIs. Pisoni, Cleary, Geers & Tobey (1999) concluded that *children with CIs show superior underlying sensory and perceptual abilities for speech and language after implantation, and their performances continue to improve over time*. Nikopoulos and his colleagues (2004) reported that following cochlear implantation, the grammatical skills of children following cochlear implantation, were much closer to their hearing peers over time. Others have found evidence of doubling in speech intelligibility after a year of experience using CIs (Hasenstab & Tobey, 1991).

Improvements Achieved by Children Using Cochlear Implants: Some Do Much Better Than Others.
It is clear from longitudinal studies of children using CIs that many, but not all members of the research samples studied show impressive gains on tests and measures of speech, language and educational skill development. *The consensus of writers and researchers is that children implanted earlier in childhood and who receive an auditory learning special training program, tend to show the greatest improvements in these measures over time* (Bertram & Pad, 1995; Geers, 2000; Mischook & Cole, 1986).The intensity of training in the auditory/oral method of communication is considered by some authorities to be one of the most critical variables associated with the successful use of CIs by children (Moog, 2002). Fair, Louw, and Hugo (2001) further concluded from their data that when children receive appropriate habilitative services during the first six months of life, they tend to develop higher levels of communication, literacy and cognitive skills. It has also been found that children implanted at younger age levels tend to have better speech intelligibility scores than those implanted at older age levels (Peng, Spencer, & Tomblin, 2004). Further that longer use of a cochlear implant in infancy and very early childhood affects the amount of spoken language used by 3-yr-old, profoundly deaf children (Nicholas & Geers, 2006). Geers (2002) reported that speech perception and production, and certain language test scores were superior in children using CIs who were trained in auditory and speech skills, when compared to a similar group of children using CIs who were trained to communicate using Total Communication. Findings from earlier studies (Osberger and others, 1998; Tyler, 1990) were in agreement with those of Geers (2002). It has also been reported that speech intelligibility scores of 8 and 9 year olds using cochlear implants were superior in children who were in full or partial mainstreamed classes, compared with children who were in total communication classrooms. Furthermore, children who were mainstreamed typically were in program that emphasized audition (Tobey, Rekart, Buckley, & Geers, 2004). English-sounding words were presented auditorally to children with cochlear implants, and it was found that children who were in oral programs were able to reproduce these nonsense words with more accuracy than their peers in total communication programs. Children who did well in this task had superior performance in language comprehension (Dillon and others, 2004). Researchers have consistently reported that a collaborative multidisciplinary

team, where family members are full participants, is important in the development of speech, language and literacy skills in children using CIs (Beiter, Staller & Dowell, 1991; Chute & Nevins, 2002; Geers, 2002, NIH, 1995).

What Happens to Children Using CIs When They Are of School Age?

In 2002, Moog found that the majority of elementary school-aged children who were implanted early, scored within the normal range for language and reading. Results from studies by Francis, Koch, Wyatt, and Niparko (1999), and Koch, Wyatt, Francis and Niparko (1997) revealed that *75% of children with CIs were enrolled in full-time mainstream classrooms after one to four years of CI experience*. A similar finding was reported by Daya and others (2000). More recently, in a study of 86 families of children with CIs from various sections of the US, a similar finding was obtained. The majority of the families of these children reported that they were enrolled in full-time mainstreamed classes in preschools or elementary schools. Some portion of this sample of children also received some supplemental services such as speech-language therapy or educational tutoring (Hawks, Flexer, Wray & Sommers, 2003). Additional research completed by Daya, Ashley, Gysin, and Papsin (2000) found that children with cochlear implants, who grew up in multi-lingual home environments, were able to achieve the same speech perception and educational outcomes as the English-speaking children. This study's findings are also consistent with those reported by McConkey Robbins, Green, and Waltzman (2004). Children implanted between ages 2 and 12 years were evaluated for their long-term outcomes by Spencer, Gantz and Knutson (2004). They concluded that the children typically had academic achievement scores within 1 SD of their hearing peers. In the older population 50% of the college-age eligible students actually enrolled in college. Furthur, that the children tended to follow the vocational/educational patterns of their parents.

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