Compelling Evidence Supports Early Implantation

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In the June 2016 installment of Tot 10, we reviewed the Longitudinal Outcomes of Children with Hearing Impairment (LOCHI) study and highlighted several lessons that pediatric hearing health care clinicians should glean from the important research taking place in Australia. This month, we are headed back to the land down under to explore the latest research in the outcomes of children with hearing loss. Over the past few years, researchers from the University of Melbourne have enlightened the global pediatric hearing health care community with groundbreaking findings in early hearing detection and intervention (EHDI). These studies are made possible by the HEARing Cooperative Research Centre (CRC), which facilitates research collaborations between universities, early intervention providers, and cochlear implant programs. Here's a look at the recent updates on pediatric hearing health care by experts in Melbourne.

10. THE ALL-TIME MOST COMPELLING EVIDENCE SUPPORTING THE BENEFITS OF EARLY IMPLANTATION

In a typical top 10 list, the most relevant item is found in the no. 1 spot. In this list, however, we have elected to lead off with the most impressive and far-reaching finding from Melbourne. The use of all caps in the heading above is not hyperbolic. Researchers from Melbourne have quite possibly provided the most convincing and powerful data supporting the provision of a cochlear implant (CI) to children as early as possible. In a multi-center study, Dettman, et al., described the outcomes of 403 children who had been diagnosed with congenital severe-to-profound hearing loss and normal-to-borderline-normal cognitive skills and who had received a CI(s) at age 6 or below (*Otol Neurotol.* 2016 Feb;37(2):e82). The children were divided into five groups based on age at implantation:

- Group 1: 151 children implanted at 12 months of age or earlier
- Group 2: 61 children implanted between 13 to 18 months of age
- Group 3: 66 children implanted between 19 to 24 months of age
- Group 4: 82 children implanted between 25 to 42 months of age
- Group 5: 43 children implanted between 43 to 72 months of age

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A variety of speech, language, and auditory skills were evaluated at the age when the children entered elementary school (i.e., 5 to 6 years old). For every speech, language, and auditory outcome measure, those who received their CI before turning 1 year old performed much better than the children who received their CI at 13 months of age or later. For instance, the mean standard score for a standardized assessment of vocabulary (Peabody Picture Vocabulary Test or PPVT) was 100 for children implanted before 1 year of age, whereas the mean standard score for children implanted between 13 to 18 months of age was 83. For all measures of language, children implanted before they turned 1 year old achieved a mean score within the normal range for children with normal hearing, whereas almost half or more of the children implanted between 13 to 18 months did not develop age-appropriate language abilities at school-entry age. Additionally, open-set speech recognition was generally excellent for the children who received their CI before turning 1 year old, whereas those who received their CI after 1 year of age generally achieved poorer open-set speech recognition. Across each of the five groups in the study, a stepwise reduction in post-implant outcomes occurred for each interval of delay in implantation.

9. Don't Get Left Behind!

In another article reviewing outcomes after cochlear implantation, Leigh, Dettman, and Dowell sought to identify the ideal age of implantation for children with congenital hearing loss (*Int J Audiol.* 2016;55 Suppl 2:S9). They looked at the rate of language

From left, **Dr. Wolfe**, is the director of audiology at Hearts for Hearing and an adjunct assistant professor at the University of Oklahoma Health Sciences Center and Salus University. **Ms. Smith** is a founder and the executive director of Hearts for Hearing in Oklahoma City. **Dr. Dettman** is a senior lecturer at the University of Melbourne and a lead researcher at HEARing CRC.

growth before and after cochlear implantation in 32 children with CIs. Ideally, children with hearing loss achieve at least one year of language growth in one calendar year. Leigh and colleagues noted that prior to implantation, children with severe to profound hearing loss typically make 0.33 to 0.43 year of language growth per year. However, after implantation, children made an average of 1.03 year of language growth per calendar year.

Consequently, children who were implanted at later ages had a significant delay in their language abilities, and although they made progress after implantation, their language abilities remained delayed by an extent that closely corresponded to their age at implantation. For instance, children who were implanted between 12 to 18 months of age tended to maintain a language delay of 12 to 18 months after implantation. In contrast, children who were implanted at 6 months of age had minimal delay at implantation and thereafter tended to achieve language milestones in lockstep with their normal-hearing peers.

Leigh, et al., concluded: A CI should be offered as an option for children as early as possible to minimize language delay—as long as the child meets the audiological guidelines (see #8 below) and other medical and otological issues have been considered (*Int J Audiol.* 2016;55 Suppl 2:S9).

8. Should we reconsider cochlear implant guidelines?

Leigh, Dettman, and Dowell also sought to determine the degree of hearing loss that would indicate a child's need for a CI (*Int J Audiol.* 2016;55 Suppl 2:S9). Aided open-set word recognition was compared between 78 children with CIs and 62 children with varying degrees of hearing loss and used binaural hearing aids. Leigh and colleagues reported that children with a 65 dB HL pure-tone average had a 75 or more percent chance of improvement in open-set word recognition with use of a CI relative to use of hearing aids. Children with a 75 dB HL pure-tone average had almost a 90 percent chance of improvement in speech recognition with a CI. Leigh, et al., astutely pointed out that the decision to pursue a cochlear implant for a young child is often based on his or her degree of hearing loss rather than speech perception, which may be difficult or impossible to complete with infants and toddlers (*Int J Audiol.* 2016;55 Suppl 2:S9). They concluded that children with bilateral profound hearing loss should receive bilateral CIs as soon as practicable, and children with a pure-tone average between 65-85 dB HL should be considered for cochlear implantation if speech, language, and functional auditory performance are not progressing sufficiently.

7. How much therapy is enough?

In a presentation given at the 2016 Audiology Australia National Conference, Cindy Chu and colleagues examined the influence of the frequency of the provision of early intervention services (i.e., therapy) on language outcomes of 146 children with CIs (Audiology Australia, 2016). The findings were quite surprising. Children who received therapy on a monthly basis tended to achieve age-appropriate expressive language abilities at pre-school to school-entry age, whereas the children who received therapy on a weekly basis tended to exhibit delays in expressive language. Of note, the expressive language abilities of children who received therapy on a monthly basis was significantly better than the expressive language of children who received therapy on a weekly basis.

6. So are they saying therapy is detrimental?

No! Chu, et al., dug into the data to identify a reason for the surprising outcome described above. They discovered that children who received therapy on a monthly basis were more likely to have received CIs at an early age (under 1 year of age). As a result, the early-implanted children had little to no language delay at the time of implantation and required a less intensive therapy to keep a good pace with their normal-hearing peers. In contrast, children who received their CIs at later ages had significant language delays and consequently required more frequent and

intensive therapy to mitigate their language delays. Once again, the vital importance of early implantation is apparent.

5. Dosage and Dollars

For children who were implanted at later ages, Chu and colleagues noted that families with greater socio-economic (SES) advantage had greater access to early intervention services (Audiology Australia, 2016). Presumably, families with greater financial resources were more likely to be able to take off from work to attend therapy appointments or arrange for another caregiver to take the child to therapy. Additionally, families with greater financial resources are likely to have access to transportation needed to get to therapy appointments. Given the importance of therapy in facilitating language outcomes, particularly for children who receive CIs at later ages, our EHDI programs must identify solutions to ensure that all children have access to early intervention services, regardless of their financial resources.

4. Does type of therapy make a difference?

Dettman and colleagues also examined vocabulary development and speech perception of eight children in auditory-verbal therapy programs, 23 children in auditory-oral programs, and eight children in bilingual-bicultural (sign language, total communication) programs (*Otol Neurotol.* 2013 Apr;34(3):451). Children enrolled in auditory-verbal programs achieved better vocabulary development and speech perception than those enrolled in auditory-oral programs, whereas children enrolled in auditory-oral programs achieved better vocabulary development and speech perception than children in bilingual-bicultural programs. In short, the findings of Dettman and colleagues suggest that vocabulary development and speech perception are greater when early intervention services are focused on the development of listening and spoken language abilities (*Otol Neurotol.* 2013).

3. It's All in the Family

Creating a language-rich listening environment is key to optimizing listening and spoken language abilities, and the findings of Chu and colleagues suggest that the child's family is vital to creating a good model for listening and spoken language development (Audiology Australia, 2016). Chu, et al., measured family involvement in the child's life and reported a significant positive relationship between language outcomes and family involvement (Audiology Australia, 2016). In most cases, a child's family is likely to be his/her most consistent model of spoken language. As such, early interventionists must coach families to be superstar therapists.

2. Talking to Toddlers

Listening and spoken language specialists (LSLS) are uniquely equipped to coach parents on how to help their child develop optimal spoken language abilities. Ideally, every family should have access to an LSL specialist. Additionally, Choo and colleagues have explored the use of technology to enhance the support that a family provides for a child with hearing loss (*Stud Health Technol Inform* 2017;239:21). In their study, Choo, et al., provided families with Language Environment Analysis (LENA) language-tracking wearable devices so that they could track the quantity of spoken language to which the child was exposed at home (*Stud Health Technol Inform.* 2017). They also provided a mobile phone application (app) that had prompts, suggestions, and reminders of strategies that parents could use to facilitate the child's language development. The families in the study generally found the LENA and smartphone app to be useful in supporting the development of a language-rich listening environment. Although there will likely never be a great substitute for a good LSL specialist, professionals should embrace the use of modern technologies as supplemental tools.

1. Barriers to Earlier Implantation

Noting the critical importance of early implantation for infants with congenital severe-to-profound hearing loss, Dettman, Choo, and Dowell sought to identify the barriers that prevent early implantation for that population (*Int J Audiol.* 2016;55 Suppl 2:S64). Their study highlighted the importance of universal newborn hearing screening (UNHS) in lowering the age of implantation. Specifically, prior to the implementation of UNHS in Victoria, Australia, the mean age of implantation exceeded 3 years old, whereas after the implementation of UNHS, the mean age of implantation dropped to 0.95 years. In 2015, over 98 percent of children in the United States received a hearing screening at birth. Unfortunately, almost 40 percent of these children did not have documented results for diagnostic assessment, and almost 35 percent of children diagnosed with hearing loss did not have documented affirmation of having received early intervention services (CDC, 2015). EHDI programs must ensure that children who are at risk for hearing loss get the follow-up services they need.

Dettman, et al., also found that children whose families had greater SES advantage were more likely to receive a CI at an early age (*Int J Audiol.* 2016;55 Suppl 2:S64). Once again, our EHDI programs must ensure that expeditious diagnostic and intervention services are available to all children with hearing loss, regardless of their families' financial resources. Finally, Dettman and colleagues noted that relatively long delays existed between birth and diagnosis of hearing loss and between MRI assessment and cochlear implant surgery. System changes are necessary to optimize the efficiency of clinical pathways.

The message from Melbourne is loud and clear: Early implantation is a must for children with congenital severe-to-profound hearing loss. Pediatric hearing health professionals should take heed of these important studies and their findings when serving infants and children with hearing loss.