Published in final edited form as:

Hear J. 2016 June ; 69(6): 18–23. doi:10.1097/01.HJ.0000484547.75301.11.

Lessons from LOCHI

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We recently had the great privilege of listening to Dr. Teresa Ching deliver the *Marion Downs Lecture* at the American Academy of Audiology's *AudiologyNOW! 2016* conference in Phoenix, Arizona. Dr. Ching provided an excellent summary of the most recent findings from the National Acoustic Laboratories' (NAL) **Longitudinal Outcomes of Children with Hearing Impairment (LOCHI)** study. In Australia, all children with hearing loss are served by Australian Hearing, a single government-funded organization which provides hearing healthcare services governed by national standard protocols. As a result, all children receive evidence-based audiology and habilitative services (e.g., auditory function is evaluated with contemporary electrophysiologic procedures, hearing aids are fitted to prescriptive targets with the use of real-ear-to-coupler difference (RECD) and probe microphone measurements, and effectiveness of hearing aids is evaluated using objective and behavioural methods, etc.). Also, all children have access to hearing aids and cochlear implants as needed. These Australian Hearing services are provided to all Australian children from birth to 26 years of age, at no cost to families.

This government-funded and mandated model of service delivery has provided researchers at NAL with an unprecedented opportunity to conduct a prospective, longitudinal assessment of the outcomes of a large number of children with a wide range of degrees and types of hearing loss. This type of research is critically important to fully understand the impact of hearing loss and the impact of intervention on the outcomes of children with hearing loss because to date, there has been a paucity of peer-reviewed population studies evaluating the language outcomes of children who are born with hearing loss and who are fitted with hearing aids prior to six months of age. Furthermore, previous studies have not been prospective in nature, and consequently, they typically have an inherent bias in the manner in which subjects are selected for study inclusion, a fact which makes it difficult or impossible to control for the effect of factors that may influence outcome (e.g., age at implantation, the child's cognitive status, mode of communication, etc.).

Approximately 468 children are participating in the LOCHI study. Of these, 163 have cochlear implants (some are bilateral users and others are bimodal users) and 305 use hearing aids. All of them have completed evaluations of language, literacy, academic, and social outcomes at 5 years of age. Dr. Ching provided an excellent summary of the latest findings of the LOCHI study along with a discussion of how the study results may impact service delivery for children with hearing loss. In this month's installment of the *Tot Ten*, we provide just a few of the highlights from Dr. Ching's *Marion Downs Lecture*. Dr. Ching has joined us as a guest contributor this month to make sure we hit the mark in our description of the LOCHI project.

10. Hit the Target

Every pediatric audiologist worth his or her otoscope knows that it is absolutely imperative to verify the output of every child's hearing aids using real-ear-to-coupler difference (RECD) and probe microphone measurements. However, some uncertainty still exists regarding the ideal prescriptive targets to which the output of children's hearing aids should be matched. Many pediatric audiologists in North America use the desired sensation level prescriptive (DSL) v5.0 fitting method for fitting hearing aids to children, while pediatric audiologists in Australia often use the NAL-NL2 method. An earlier study conducted by DSL and NAL researchers evaluated the prescriptive method preference of school-age children in Canada and Australia. They found that the children's previous experience determined their preference for a particular fitting method. In other words, children who were initially fitted with the DSL method typically preferred it over NAL and vice versa. The LOCHI study randomly placed participants into two groups for post-diagnostic fitting of initial hearing aids – either according to the DSL prescriptive method or the NAL prescriptive method. Dr. Ching reported that on average, there were no significant differences in language outcomes between the two groups. This should not come as a surprise considering the fact that a great deal of research has been invested in each of these methods to ensure the provision of adequate audibility for children with hearing loss. So, pediatric audiologists around the globe can rejoice in the news that regardless of the fitting method that we use, we can expect satisfactory outcomes for patients fitted to evidence-based prescriptive targets.

9. All Hands on Deck

Thirty-seven percent of children participating in the LOCHI study diagnosed with hearing loss had additional disabilities. Dr. Ching reported the children who had additional disabilities in conjunction with hearing loss achieve significantly poorer language outcomes when compared to children who had hearing loss with no other disabilities. Also, cognitive ability was identified as a factor that significantly impacts the language outcomes of children with hearing loss. These findings are not surprising and are in line with other studies examining factors that influence the outcomes of children with hearing loss. However, they serve as a stark reminder that hearing healthcare professionals must ensure that a child with hearing loss is evaluated holistically and receives appropriate intervention designed to assist the child in overcoming each challenge that may impede the goal of reaching his or her full potential in all aspects of life. Importantly, children with hearing loss should be served by inter-disciplinary teams that are staffed by pediatric audiologists, speech-language pathologists who are well-versed in language development of children with normal hearing and hearing loss, as well as physicians, social workers, neurodevelopmental specialists, psychologists, educators, and allied health practitioners, etc. This team of professionals should work together to develop a cohesive plan that equips the family with the skills and resources needed to assist the child and optimize his or her communication, academic, motor, and social development.

8. Mother Knows Best

The LOCHI study examined whether parental education levels impacted a child's language outcomes. Approximately one-third of the participants' parents had earned a degree from a university. Dr. Ching noted that language outcomes were influenced by maternal education. Specifically, the children of mothers who had completed university degrees obtained higher language outcomes. The reasons for this finding are not clear, but one can assume that children who belong to families with lower levels of education also have reduced access to the resources required to pursue optimal outcomes. For example, some families may not have the means to travel to therapy and/or audiology appointments. Also, a mother with lower education levels may have a more difficult time understanding recommendations when delivered by the pediatric audiologist and other healthcare providers and determining how to implement these recommendations into the daily life of her child.

This LOCHI finding reminds us that Early Hearing Detection Intervention (EHDI) programs must strive to provide services that are easily understood, available to all families, and executable by all mothers of children with hearing loss, regardless of financial means, communication abilities, and previous educational achievement. It is also imperative to establish with the mother the importance of EHDI services, full-time hearing technology use (eyes open, ears on), and language-rich listening environment for their child's auditory brain development throughout the first three years of life.

7. Listen and Talk to Listen and Talk

A large population study like the LOCHI project, provides a unique opportunity to evaluate the impact of communication mode on language outcomes while at least partially controlling for confounding factors. Many previous studies evaluating the effect of communication mode on language outcomes are inherently biased. For instance, they are conducted by researchers who possess an expertise with a specific communication methodology or at centers that specialize primarily in the provision of services focusing on one communication mode only. Not surprisingly, these studies often conclude that the better outcomes are obtained with use of the communication mode associated with the researchers conducting the study. The primary investigators of the LOCHI study are not directly tied to any particular communication mode.

The families of about three-fourths of the LOCHI study participants used spoken language only while the majority of the remaining families used a Total Communication approach. Significantly better language outcomes were observed in children who used a spoken language-based communication mode. This finding is to be expected given the fact that the vast majority of children in the study were born to parents with normal hearing, and as a result, the family's natural mode of communication was typically via spoken language. This study finding is relevant for professionals who counsel families regarding the important considerations pertaining to the selection of a communication mode for children with hearing loss.

6. Hooked on Phonics

It is well known the children with hearing loss are at risk for delays in literacy development. LOCHI study researchers have set out to identify the most important factors associated with literacy development of children with hearing loss. Specifically, the researchers have shown that phonological awareness made a significant contribution to children's reading ability (for both words and non-words), after controlling for variations in receptive vocabulary, cognitive ability and a range of demographic variables. Phonological awareness describes the child's ability to reflect on and/or manipulate the sound structure of language. For instance, the word 'cat' is comprised of three phonological elements, /k/, /æ/, and /t/; and that /k/ may be replaced by /s/ to make up a new word 'sat'. Phonological awareness has long been suspected as the pivotal skill necessary to crack the literacy code. Indeed, Dr. Ching and her team have found that children who have deficits in phonological awareness also struggle to develop age-appropriate literacy skills. Furthermore, they learned that a significant number of children with hearing loss struggle to develop even rudimentary phonological awareness abilities. This link between phonological awareness and literacy development is a very relevant finding, because it stresses the importance that early interventionists should evaluate this ability in children with hearing loss and provide early intervention to support its development. Early assessment in the provision of early intervention for children who struggle to develop phonological awareness during the first few years of life may be a game changer by illuminating possible deficits that can be modifiable through targeted intervention.

5. The PEACH is a Peach!!

One of the most important objectives of the LOCHI study was to identify factors that are related to language outcomes of children with hearing loss. Ideally, study investigators sought to determine prognostic factors that may be used to predict the progress children with hearing loss are likely to make when timely and appropriate intervention is provided. Fortunately, the LOCHI researchers have found a simple tool that may be administered during the first few months of life to predict communication outcomes achieved throughout a child's school-age years. Specifically, early performance on the Parents' Evaluation of Aural/Oral Performance of Children (PEACH) questionnaire was found to be a significant predictor of language outcomes measured in school-age children. The PEACH is a questionnaire design to record how children with hearing loss are able to hear and communicate in daily situations. Standardized PEACH scores are available for children with normal hearing, hearing aids, and cochlear implants.

Of note, children who had lower PEACH scores at six or twelve months after fitting also had lower language outcomes at five years of age. This is a very important finding, because it equips clinicians with a tool that may be used to identify children who are risk for communication delays. Once children at risk are identified, professionals can increase the intensity or frequency of intervention and consider the use of alternative intervention strategies in order to assist the child in eliminating delays before he/she begins school. In short, every clinician should consider administering the PEACH to evaluate early

communication development and to identify children in need of additional attention and resources.

4. Outcomes and ANSD?

Although difficult to believe, it has been 20 years since Arnold Starr and colleagues first published a description of auditory neuropathy spectrum disorder (ANSD). Since that time, there has been widespread uncertainty regarding the impact of ANSD on communication outcomes. Some researchers have concluded the children with ANSD typically achieve poorer outcomes than children with cochlear hearing loss, while others have shown equivalent results. Much of this ambiguity has stemmed from the fact that most studies of children with ANSD have included small numbers of subjects or have primarily included children who did not receive early intervention (e.g., hearing aids fitted after the participants were 6–12 months old). The LOCHI study includes almost 40 children diagnosed with ANSD, and many of these children received hearing aids and/or cochlear implants at an early age. Dr. Ching reported no difference in language outcomes between children diagnosed with cochlear hearing loss and those diagnosed with ANSD. This finding is encouraging for families of children with ANSD and the professionals who serve them, because it proves that satisfactory outcomes are possible for children with ANSD when professionals do what it takes to ensure that children with ANSD receive the services required to meet their individual needs. Move on to #3 to review the LOCHI recommendations for managing the care of children with ANSD.

3. Improving Outcomes with ANSD

Dr. Ching provided several innovative and useful tips for managing the care of children with ANSD. For example, because the ABR cannot be used to estimate hearing sensitivity, many children with ANSD are not fitted with hearing aids until they are 8 to 9 months or older. It is well known that poorer outcomes are obtained when children with hearing loss receive hearing aids after six months of age. The researchers at NAL have developed a novel protocol designed to expedite the provision of intervention for children with ANSD.

One component of this protocol is the use of speech-evoked cortical auditory evoked response assessment. Specifically, the presence of a cortical auditory evoked response to the speech tokens /m/, /g/, and /t/ has been used to determine whether hearing aids should be fitted, the gain that should be provided when hearing aids are fitted, and the likelihood that hearing aids will provide audibility for speech. Many of the children in the LOCHI study who are diagnosed with ANSD were fitted with hearing aids prior to six months of age. Hopefully, additional research will establish this measure as a tool that may be used effectively in clinical settings around the world to guide intervention of children with ANSD. Dr. Ching also noted that the PEACH questionnaire is once again an effective tool to determine whether children with ANSD are making satisfactory progress with hearing aids. Specifically, the LOCHI study has found that children with ANSD who have absent cortical auditory evoked responses and low PEACH scores should receive a cochlear implant sooner rather than later. Outcomes of children with ANSD were often excellent when hearing aids

were provided prior to 6 months of age, and when needed (e.g., poor PEACH and absent cortical auditory evoked responses), cochlear implants are provided by 12 months of age.

2. Early Amplification

Although the importance of early identification and intervention is well-established, the LOCHI study has provided further clarification regarding the impact of early amplification on language outcomes of children with hearing loss. Specifically, for children with severe hearing loss (averaged hearing loss between 0.5 and 4 kHz of 70 dB HL in the better ear), language outcomes decrease by .3 standard deviations when the provision of hearing aids is delayed from 6 to 12 months. An additional .3 standard deviation delay occurs for a further 12-month delay in fitting hearing aids. Similarly, a .3 standard deviation decrease occurs when hearing aid fitting is delayed from 6 to 24 months of age for children with moderate hearing loss. The aforementioned delays are completely preventable when hearing aids are provided prior to six months of age. As a result, the LOCHI study possibly provides the most impressive evidence available for the continued need for financial support of universal newborn hearing screening programs and EHDI services.

1. Early Electric

Likewise, the LOCHI study provides overwhelming evidence for the importance of early implantation. A .7 standard deviation decrease in language outcomes was observed when cochlear implantation was delayed from 6 to 12 months. An additional .4 standard deviation reduction was observed when cochlear implantation was delayed from 12 to 18 months, and another .3 standard deviation decrease was found when cochlear implantation was further delayed from 18 to 24 months. These findings are huge. First, the LOCHI study provides some of the most impressive evidence for the need of cochlear implantation prior to the first birthday of children with severe to profound hearing loss. Pediatric hearing healthcare providers should use this data to convince third-party payers to routinely approve cochlear implantation prior to 12 months of age. Additionally, the cochlear implant industry should convince the United States Food and Drug Administration to lower the minimum age of indication of cochlear implant use from 12 to 6 months of age.

Finally, professionals working on cochlear implant teams must utilize contemporary practices and procedures to ensure children receive cochlear implantation in a timely manner. Every day counts. Again, standardized questionnaires, such as the PEACH, should be routinely administered to evaluate whether a child is making satisfactory progress with hearing aids. Also, Listening and Spoken Language Specialists who are Auditory Verbal Therapists or Auditory Verbal Educators should provide frequent feedback about their observations of children's early language development and promptly refer for cochlear implant evaluation when progress in spoken language slows or a child is performing below his hearing peers. Finally, pediatric audiologists must be well acquainted with contemporary diagnostic procedures necessary to accurately evaluate auditory function in infants (e.g. tone burst ABR, cortical auditory evoked response assessment, etc.).

The LOCHI study has provided a wealth of useful information for pediatric hearing healthcare providers. It is our job as clinicians to utilize this information in our own clinical practices in order to improve the outcomes of the children we serve. It is clear from this study that there is a need to streamline services in order that children who need cochlear implants receive them early. Thanks to Dr. Ching and her NAL colleagues for overseeing this landmark research. We look forward to learning more as the LOCHI study continues.

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