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Research Forum

Is Early Intervention Effective in Improving Spoken Language Outcomes of Children With Congenital Hearing Loss?

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Purpose: The purpose of this research forum article was to present research findings on the effectiveness of early intervention for improving outcomes of children with congenital hearing loss.
Method: The method involved a narrative overview of recent findings from the Longitudinal Outcomes of Children with Hearing Impairment study.
Results: Early intervention, either in the form of amplification or cochlear implantation, was associated with higher language scores. Maternal education and communication mode used during early intervention were also significant contributors to child outcomes. Early performance predicted later language development.
Conclusion: Early intervention is effective in improving early language outcomes, at a population level.

By the time they enter school, approximately three in 1,000 children are fitted with hearing aids or receive cochlear implants for a permanent hearing loss (Australian Hearing, 2011). Congenital hearing loss has major adverse developmental and health impacts on children's lives (Helfand et al., 2001)—including speech and language (Eisenberg, 2007; Moeller, Tomblin, Yoshinaga-Itano, Connor, & Jerger, 2007), literacy, mental health, social and cognitive functioning (Marschark & Wauters, 2003), educational achievement (Powers, 1999; Qi & Mitchell, 2012), employment, and socioeconomic opportunity. Lifetime costs of all care related to deafness and lost productivity were estimated to be $117 million USD per birth cohort of 80,000 children (Keren, Helfand, Homer, McPhillips, & Lieu, 2002). By implementing universal newborn hearing screening (UNHS) programs to detect deafness soon after birth, treatment can begin early in life with the ultimate goal of improving long-term outcomes. Previous studies have linked early intervention to better preschool language (Moeller, 2000; Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998). However, systematic reviews (Nelson, Bougatsos, & Nygren, 2008; Thompson et al., 2001) have identified epidemiological and methodological flaws in published studies.

Despite widespread implementation of UNHS programs, high-quality evidence on the efficacy, at a population level, was lacking (Colgan et al., 2012). Two published quasirandomized trials of UNHS have examined the effectiveness of early intervention in achieving its goal of improving language outcomes of children with hearing loss. The Wessex study of English children who were offered UNHS in 1993–1996 revealed a benefit for receptive language at 7–8 years old, but no clear benefits for either expressive language or speech production (Kennedy et al., 2006). As the study was conducted before modernization of postdiagnostic services, the results might have been confounded by the quality of services and the time lag that occurred between diagnosis and intervention. The Developmental Evaluation of Children: Impacts and Benefits of Early hearing screening, Leiden (DECIBEL) study reported better motor and social, but not language, outcomes at ages 3–5 years in Dutch children born between 2003 and 2005 in regions with UNHS versus those in non-UNHS regions in the Netherlands (Korver et al., 2010). The study depended exclusively on parent-report tools for assessing outcomes. These mixed results leave the fundamental question of whether early intervention is effective in improving language outcomes unanswered. To address the evidence gap, we took advantage of a unique research environment in Australia to conduct the Longitudinal Outcomes of Children with

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Hearing Impairment (LOCHI) study. This presentation focused on findings of the study.

The LOCHI study is a population-based study that examines outcomes of hearing-impaired children who received early or later intervention, in a prospective manner. In Australia, all children with hearing loss have uniform access to postdiagnostic hearing services delivered according to a consistent national protocol via a government-funded service network (Australian Hearing [AH]), at no cost to the family. However, the children had differential access to UNHS during a narrow time window when different states were at different stages of rolling out UNHS (Leigh, 2006). During that time period, the LOCHI study enrolled sufficiently large numbers of children with congenital hearing loss who received either early or later intervention, depending on their state of residence. All children born between 2002 and 2007 in New South Wales, Queensland, and Victoria who were diagnosed with a hearing loss and accessed paediatric hearing services at AH centers before 3 years of age were invited to participate in the study. Of the 451 children enrolled, about 53% received hearing aids before 6 months of age.

The LOCHI study was designed to investigate the influence of age of intervention, together with a range of demographic and intervention-related factors, on outcomes of children with hearing loss (Ching, Leigh, & Dillon, 2013). In the present context, *age of intervention* refers to the age at fitting of hearing aids and, if applicable, age at cochlear implantation. Evaluations of the participants' speech, language, and psychosocial outcomes were conducted at 6 and 12 months after initial amplification or cochlear implantation, and at chronological ages of 3 and 5 years of age. At each assessment interval, information about a range of demographic characteristics was collected (for details, see Ching, Dillon, et al., 2013). Audiological information about the children was collected from the databases of AH and relevant agencies. This included age at fitting of hearing aids or cochlear implantation, settings used in the devices, degree of hearing loss, and presence of additional disabilities. Parents reported on their children's use of hearing device, age at enrollment in early educational programs, and the communication mode used in the programs. Communication was categorized into three modes: oral, manual, and combined. *Oral communication* refers to the use of spoken language. *Manual communication* refers to the use of signed languages such as Australian Sign Language. *Combined communication* refers to the simultaneous use of oral and another communication mode (e.g., spoken English and Signed English). Parents also provided information about their own hearing status and level of formal education. The postcode of residence was used for determining socioeconomic level using the census-based Socio-Economic Indexes for Areas in Australia (Australian Bureau of Statistics, 2008).

Findings at 3 Years of Age

Data collected from participants at 3 years of age showed that they scored below the normative populations (−1.5 *SD*) on global language development (a latent variable estimated by aggregating scores of nine speech and language measures). In the multiple regression analyses that used the language score as a dependent variable and 15 variables (demographic characteristics) as predictors, it was found that severity of hearing loss, gender, presence of additional disabilities, maternal education, and age at cochlear implantation significantly influenced outcomes (Ching, Dillon, et al., 2013). The model accounted for about 40% of the total variance.

Children who received a cochlear implant earlier had better language outcomes. Early implantation would not have been possible without early detection of hearing loss, fitting of amplification, and timely referral for cochlear implant candidacy evaluation. This finding supports the effectiveness of early intervention for children with severe or profound hearing loss. There was a weak, nonsignificant effect of age of amplification. Because most children using hearing aids had mild or moderate hearing loss, it is possible that the auditory stimulation received when the children were unaided was sufficient to enable development of the auditory cortex such that when hearing aids were later fitted, they were able to use the amplified signal as effectively as those who received hearing aids earlier. Perhaps the children who received early amplification did not have educational intervention that targeted the development of auditory skills sufficiently to allow the advantage of early auditory stimulation to be optimally realized at this age. In the regression analysis, age at enrollment in early educational programs (including center- and home-based programs) was not included as a predictor, because of its high correlation with age at amplification, a factor that was already included in the model. The considerable variance in scores, partly due to the young age at assessment, might also have contributed to the lack of significance of the effect of age of amplification.

Findings at 5 Years of Age

There was strong, clear evidence that earlier age at intervention was associated with better outcomes at 5 years of age. For children with hearing aids, earlier amplification was associated with better language outcomes. The impact of delay in amplification increases as hearing loss becomes more severe. For children with cochlear implants, earlier age at activation of the first cochlear implant was associated with higher language scores. Higher maternal education, use of an oral mode of communication, and the absence of additional disabilities were also significantly linked to higher language scores.

Further, it was found that early performance measures obtained when the children were younger than 2 years of age, either in the form of parent reports on the basis of the Parent's Evaluation of Aural/Oral Performance of Children (PEACH) scale (Ching & Hill, 2007) or formal tests (Preschool Language Scale) directly administered to the children (Zimmerman, Steiner, & Pond, 2002), were significant predictors of language development at 3 and 5 years

of age (Ching, Day, et al., 2013). The findings suggest that early monitoring of performance assists with identifying children who may be at risk of language development, so that changes in intervention strategies (e.g., cochlear implantation and changes in communication mode or intensity of early intervention) may be implemented before delays set in.

Despite the benefits of early intervention, the study found that many children exhibited deficits in phonological awareness (Ching & Cupples, 2015). These deficits are likely to have a negative effect on children's development of reading skills as they enter formal schooling (Cupples, Ching, Crowe, Day, & Seeto, 2014).

In summary, the LOCHI study provides evidence on the effectiveness of early intervention for improving outcomes of children with hearing loss, at a population level. It also highlights the importance of monitoring early outcomes after intervention. Further, the study suggests that strategies targeting the development of phonological awareness skills may be necessary to support children's development of literacy skills in formal education. In Phase II of the study, a range of language, literacy, and psychosocial and quality of life outcomes of the cohort will be assessed, and the factors influencing outcomes will be determined.

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