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Epilogue: Conclusions and Implications for Research and Practice

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Abstract

The primary purpose of the epilogue article is to synthesize the key findings from the Outcomes of Children with Hearing Loss (OCHL) study by presenting a set of ten major conclusions. The conclusion statements provide a concise summary of the main results related to children's auditory and language outcomes and factors identified as moderators of these outcomes. The second section of this article summarizes the primary clinical implications that follow from the OCHL study in relation to three questions: 1) Can we afford to be complacent about the current outcomes of children who are hard of hearing? 2) What malleable factors can be addressed to promote success through implementation of best practices? and 3) What non-malleable factors are consequential and what are their implications for practice? We end with some future research directions for the OCHL project.

Introduction

The National Institute on Deafness and Other Communicative Disorders (NIDCD) recognized that children who are hard of hearing (CHH) are underrepresented in the scientific literature and, in response, increased its focus on this group of children to address research gaps (Donahue 2007). The Outcomes of Children with Hearing Loss (OCHL) study was one of two longitudinal studies funded as part of this effort. This project was designed to examine the language and auditory outcomes of infants and preschool-aged children with permanent, bilateral, mild-to-severe hearing loss who had access to contemporary services and to identify factors that moderate the relationship between hearing loss and longitudinal outcomes. There is a lack of clarity regarding the generalizability of historical studies to this contemporary group of CHH. Further, past studies had a number of limitations in sampling (e.g., composition and size), measurement (e.g., varied constructs and tools), and scope (e.g., rarely reported aided hearing or device use, see Moeller et al. 2007). It is widely expected

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See Supplemental Digital Content, Appendix A List of Acronyms used throughout Outcomes in Children with Hearing Loss Study.

that performance outcomes for CHH are improving compared to past generations as a result of the provision of early services, and recent studies provide evidence to support this notion (Fitzpatrick et al. 2011; 2012; Stika et al. 2015). However, the benefits of these practice innovations, such as early fitting of amplification, needed to be examined systematically in a large cohort of children with mild to severe hearing loss (HL). The OCHL project was designed to address research questions regarding the outcomes of this new generation of CHH and to garner evidence to guide best practices with this group. These goals were achieved by implementing a longitudinal, prospective, multi-site study that examined the developmental outcomes of a large sample of CHH (see Tomblin & Hebbeler 2007 in support of this need).

It is likely to be beneficial to read this summary concurrently with the introduction to this volume (Moeller & Tomblin, this volume, pp. XXXX). The summarized results are closely linked to the concepts and hypothesized model in the introduction; reading them in tandem will provide a broader understanding of the study. In the introduction to this issue (Moeller & Tomblin, this issue, pp. XXXX), the OCHL team hypothesized that inconsistent access to linguistic input over time would lead to variations in cumulative linguistic experience among CHH with consequent variations in language outcomes. Several factors (audibility, duration and consistency of hearing aid (HA) use, and characteristics of language exposure) were predicted to impact linguistic access and to moderate the relationship between HL and auditory and language outcomes (See Figure 1). Essentially, we proposed that HL during infancy and early childhood poses a threat to speech and language development by reducing the child's cumulative exposure to essential features of linguistic input. However, we also hypothesized that interventions that include HA fitting and consistent use would moderate this threat. Importantly, research involving CHH has the potential to inform theories about child language development, including the extent to which inconsistent access to phonological details and statistical properties within the input impacts language learning. Research with this group of children may also inform theories regarding the role of experience-dependent mechanisms in language development.

Conclusions: Outcomes and Moderators

Ten major conclusions were drawn from the results of this longitudinal research project. These synthesized conclusions follow.

Conclusion 1: Children with mild to severe hearing loss are at risk for depressed language development and the risk increases with the severity of unaided hearing levels (Tomblin et al., this issue, pp. XXXX)—CHH, on average, had poorer language outcomes during preschool than children with normal hearing (CNH) matched on age and socioeconomic status. The CNH outperformed each of the subgroups of CHH with mild, moderate, and moderately-severe HL, suggesting that children with HL within this range may be at risk for delays. In addition, hearing levels exerted influence on outcomes across time; increases in severity of HL were associated with systematic decreases in average language scores. Children with mild HL had better scores than children with moderately-severe HL, but did not differ from children with moderate HL. Language abilities improved with age for children in all four hearing categories (normal, mild,

moderate, moderately-severe), but growth trajectories were parallel, indicating that each group maintained their relative language-level status over time, with no groups closing the gap between their language level and the language level of groups with less HL. Taken together, these results suggest that children with moderately-severe HL, compared to children with lesser degrees of HL, are at greatest risk for persisting language delay based on unaided hearing alone. However, we have hypothesized that unaided hearing rarely operates alone in influencing outcomes, which is evident in the following conclusions.

Conclusion 2: Provision of well-fit hearing aids reduces risk and provides some degree of protection against language delay. Greater aided audibility is associated with better language outcomes in preschool—HAs are well-fit when speech is made as audible as possible by closely matching gain to prescriptive targets, the latter of which is dependent upon the child's degree and configuration of HL (McCreery, et al., this issue, pp. XXXX). Results indicated that optimized audibility made positive contributions to children's language and auditory development (Tomblin et al., this issue, pp. XXXX), and our previous work shows that this benefit is accrued even for the children with mild HL (Tomblin et al. 2014). Differential language growth trajectories were found for the relative amount of audibility (residualized Speech Intelligibility Index)¹ provided by HAs. Children receiving the most benefit from their HAs (i.e., greatest aided audibility after controlling for the influence of unaided hearing) demonstrated a positive language growth pattern, showing steady improvement in standard scores from age 2 to 6 years. In contrast, children receiving the lowest benefit from HAs showed no change in standard scores over the same time period. By 6 years of age, there was a cumulative difference between these groups of two-thirds of a standard deviation. In addition, aided audibility was positively associated with multiple measures of word recognition in quiet from ages 2 through 6 and in noise for 7 to 9-year-olds (McCreery et al., this volume, pp. XXXX). Children with greater aided audibility had better auditory development outcomes and speech recognition abilities than children with lower aided audibility across a wide range of ages and outcome measures. These conclusions support the inclusion of aided audibility in the model (Figure 1) as a factor that moderates the impact of HL on children's outcomes. We proposed that children with low levels of audibility would experience the greatest reductions in access to linguistic input over time, leading to delays in language development, and our language data provide support for this hypothesis.

Conclusion 3: A substantial proportion (more than half) of children's hearing aids were not fit optimally, which negatively impacted aided audibility (McCreery et al., this volume, pp. XXXX)—As we explained in the second conclusion, optimizing aided audibility contributes positively to child outcomes (Tomblin et al., this volume, pp. XXXX). Thus, it was important to determine if the children's HAs were set to optimize audibility. Audiologists set HA gain to match prescribed targets in order to

¹The Speech Intelligibility Index (SII) is used to estimate the audibility of the speech spectrum, whether aided or unaided. This measure is highly correlated with pure tone average such that poorer hearing sensitivity is associated with lower SII scores. The OCHL research team developed a measure of aided audibility that was independent of unaided hearing (Tomblin et al. 2014). This was computed by regressing unaided SII onto aided SII, resulting in a residualized SII. The residualized SII essentially is a normalized hearing aid gain measure where the magnitude of the gain is relative to the gain obtained by children with similar unaided hearing.

optimize audibility of the speech spectrum when fitting amplification. They use Root Mean Square (RMS) as a way to measure the difference between predicted and actual output values across the frequency range. Optimal fitting would be reflected in two measures: 1) close matches of the actual fitting to prescriptive targets (RMS error < 5 dB), and 2) SII levels that fall within the published normative ranges for Aided SII relative to degree of HL (Bagatto et al. 2011). Relative to this first metric, more than half of the children in the OCHL study had RMS error values that deviated from prescriptive targets by more than 5 dB, which is not consistent with best practice recommendations. In terms of aided SII values (aided audibility), over 30% of the children had SII values that fell below normative expectations, meaning that audibility was not optimized. Most of these same children with non-optimal aided SII also had fittings that deviated from prescriptive targets, suggesting strong links between prescriptive errors and reductions in audibility. Longitudinal results showed that 59% of the CHH had consistently high audibility throughout the study. In contrast, 19% experienced decreasing levels of audibility over time and 22% showed consistently low levels of audibility during preschool (McCreery et al., this volume, pp. XXXX). Reduced audibility over time is clearly an issue of concern. Fortunately, this situation can be addressed by consistently implementing best practices in monitoring pediatric amplification (Bagatto et al. 2005; JCIH 2007; AAA 2013).

Audibility may also be affected by changes in hearing thresholds over time, particularly if HAs are not adjusted to accommodate these shifts. Although degree of HL is commonly viewed as a static, single time-point measure, preschool children may experience fluctuations in hearing thresholds for a variety of reasons. A positive finding is that a majority of the children (84%) in this study exhibited stable audiometric thresholds over the time course of the study (McCreery et al., this volume, pp. XXXX). Some shifts in thresholds were associated with middle ear dysfunction or placement of tympanostomy tubes, but a majority of the changes in hearing thresholds occurred without any change in middle ear status, highlighting the need for on-going audiological assessment during early childhood. In summary, audibility is an influential factor in children's language development. Following best practices regarding consistent audiological monitoring and HA verification can serve as a protective factor to ensure that HAs are well-fit and adjusted when needed.

Conclusion 4: Early hearing aid provision results in better early language outcomes, but later-fit children demonstrated accelerated growth patterns once aided (Tomblin et al., this volume, pp. XXXX)—It is considered the standard of care to provide amplification as early as possible in children's lives to minimize the effects of HL on language development during the sensitive linguistic development period of infancy (Bagatto et al. 2005; JCIH 2007; AAA 2013). The impact of age at receipt of amplification on the outcomes of CHH can be challenging to tease out. In the current study, significant main effects were found for both age at HA fit and duration of HA use. However, there was an interaction showing that language growth trajectories differed for children fit early compared to those fit later (after 18 months). Children fit with HAs in infancy were either protected from falling behind or caught up to CNH prior to the age of 2; they also outperformed later-fit children at early stages in development. However, their growth

trajectories showed less change over time. In contrast, children who were fit with HAs later (after 18 months) showed gains in language ability over time once provided with HAs, ostensibly a pattern of reducing the gap between their language abilities and those of their typical peers. These results indicate that both early and later-fit children benefit from HAs, however, we believe that it puts children in more optimal developmental circumstances if they have stronger language skills early in development, rather than needing to catch up over time with their peers. It is also important to consider that the late identified group in the current study may differ in important ways from late-identified children prior to Newborn Hearing Screening. The late-identified group may include a mixture of children with variable early experiences (e.g., mild or late-onset HL, delayed HA fitting). Some of these characteristics of the children's histories, like periods of normal auditory stimulation prior to onset of HL, might contribute to enhanced language growth once fit with amplification. In general, these results support the inclusion of HA use duration in the model (Figure 1), but the interaction requires a nuanced interpretation. The practice of early fitting is endorsed by these results, but they also suggest that the language learning system remains open to enhanced audibility provided by HAs, even when they are accessed later than infancy.

Conclusion 5: Consistent hearing aid use provides some protection against language delay and supports auditory development—Optimized audibility is most likely to influence development when HAs are worn consistently by the child. Our results confirm previous studies showing that CHH vary in the amount of time they wear HAs (Moeller et al. 2009; Jones & Launer 2011; Walker et al. 2013; Munoz et al. 2014, 2015), but provide new insights in establishing links between HA use consistency and children's outcomes. Children with more consistent daily HA use had better language and auditory outcomes than children with less consistent use, and this was especially true for children with moderate or moderately-severe HL (Tomblin et al., this volume, pp. XXXX). Language outcomes were particularly low (average standard score = 73) for a small subgroup of children with moderately-severe losses who had low levels of daily HA use. Notably, the establishment of consistent HA use was most challenging with infants and toddlers, yet it was encouraging to find that the majority of CHH in this study increased HA use over time (Walker et al., this volume, pp. XXXX). On the other hand, a sizeable minority of CHH (10 to 16%) showed low or declining use over the course of the study. Maternal education level influenced longitudinal trends in HA use, suggesting the need to support less-resourced caregivers around the issue of device use. Overall, the results suggest that consistent HA use positively impacts language outcomes and that limited use does not. This confirms our inclusion of consistency of HA use as a moderating factor in the model (Figure 1).

Conclusion 6: Qualitative dimensions of caregiver input influence child language outcomes (Ambrose et al., this volume, pp. XXXX)—Many caregivers seek to optimize their language input to counteract the effects of the child's reduced access. Recent studies show that quality features of caregiver input are associated with language outcomes in children with cochlear implants (Des Jardin & Eisenberg 2007; Cruz et al. 2013), but less is known about the characteristics of talk directed to CHH. Qualitative and quantitative aspects of caregiver talk were examined at two child ages: 18 months and 3 years. The quality of caregiver input to CHH improved from 18 months to 3 years, but the

input at the later age point was more limited in quality and quantity than that directed to CNH. Caregivers of toddlers who are hard of hearing used a higher proportion of directive utterances than caregivers of toddlers with normal hearing, which was concerning, given that directing utterances were negatively associated with language outcomes in CHH. Longitudinal analyses revealed that quality, but not quantity, of caregiver input at 18 months predicted child language outcomes at 36 months. These results suggest that overly directive caregiver input serves as a risk factor in the model (Figure 1).

Conclusion 7: Both receptive language abilities and aided audibility influenced children's functional auditory and speech recognition skills—

Higher receptive language ability was positively associated with auditory development outcomes across all measures and age groups (McCreery et al., this volume, pp. XXXX). Likewise, children with better aided audibility and receptive language skills generally had higher speech recognition skills from age 2 years through early elementary school ages. Aided audibility made clear, positive contributions to auditory development outcomes in the CHH, but aided audibility may also exert indirect influences through contributions to children's language abilities. Reductions in aided audibility may not only impede auditory development outcomes, but also the development of language abilities that support reliance on top-down processing to fill in message gaps in noise or at a distance.

Conclusion 8: Children who are hard of hearing appear to be at particular risk for delays in structural aspects (i.e., form) of language (Tomblin et al., this volume, pp. XXXX)—

The inconsistent access hypothesis predicted that domains of language development that are dependent on processing of phonetic details in the input would be especially vulnerable to the effects of HL. This hypothesis was explored by comparing outcomes in morphology, which is especially dependent on access to details that are difficult to perceive within the linguistic input, to lexical development, which may be buffered more than morphology by contextual support and redundancy in the input. At age 4, CHH demonstrated poorer performance in morphology than in lexical development. This supports the hypothesis that morphology is an aspect of language that is at differential risk in preschoolers who are hard of hearing.

Conclusion 9: Sole reliance on norm-referenced scores may overestimate the outcomes of children who are hard of hearing (Tomblin et al., this volume, pp. XXXX)—

The findings from this study provide consistent evidence that limitations in hearing sensitivity have an impact on children's development of language. It could be argued, however, that this effect is not sufficient to lead to a disabling condition for the majority of these children. When the CHH are compared to the norm-referenced group on various measures, the differences are small. However, when we compared the CHH to our sample of CNH who were matched on age and SES, the size of the effect of HL on language doubled to two-thirds of a standard deviation. These results lead us to question the sole reliance on comparison to norm-referenced test scores for judging the adequacy of the developmental outcomes of CHH. It is likely that CHH will compete in school settings with children from similar home backgrounds, who may serve as a more realistic comparison group. Furthermore, an anonymous reviewer pointed out another way that test scores may

overestimate CHH: standardized tests scores are unlikely to reflect the level of effort that students are expending (cognitive and perceptual resources) to maintain competitiveness with peers in secondary and postsecondary schooling, where the cognitive demands increase. This suggests a need to closely monitor the outcomes of CHH including comparing their performance relative to neighborhood grade-mates.

In interpreting this study, it should be kept in mind that many CHH in the OCHL study represent the best case scenario; their caregivers are fairly well resourced and most had the advantage of early access to interventions. We might expect that a sample with greater diversity on these dimensions would not perform as well as the OCHL cohort.

Conclusion 10: The hypothesized model is supported by the findings of this study. Aided audibility, hearing aid use, and characteristics of the language environment interact to moderate the influence of hearing loss on children's outcomes (Ambrose et al., this volume, pp. XXXX; McCreery et al., this volume, pp. XXXX; Tomblin et al., this volume, pp. XXXX; Walker et al., this volume, pp. XXXX)—In general, the confirmation of the impact of these variables on outcomes leads us back to the original hypothesis. We proposed that inconsistent access over time would lead to reductions in children's cumulative linguistic experience. We further hypothesized that children with more regular interruptions in access to linguistic input would demonstrate associated language delays. Results of this study suggest that children who are most susceptible to inconsistent access in the moment and reduced linguistic experience over time are those with more significant degrees of HL, lower relative levels of aided audibility, less consistent HA use, later access to HAs, and limitations in the quality of language exposure. We conclude that these factors interact to reduce cumulative exposure to linguistic input. This finding moves us a step forward in the effort to identify mechanisms underlying language delays in the context of early childhood HL.

Clinical Implications

Several clinical implications follow from this body of work and have been addressed in the individual articles; each specific article is cited below in relation to implications emanating from that work. Primary clinical recommendations are synthesized here in relation to three broad questions: 1) Can we afford to be complacent about the current outcomes of children who are hard of hearing? 2) What malleable factors can be addressed to promote success through implementation of best practices? 3) What non-malleable factors are consequential and what are their implications for practice?

Question 1: Can we afford to be complacent about the current outcomes of children who are hard of hearing?—Overall, the results of this study lead to both optimism and caution. From the optimistic perspective, it is evident that language delays were minimized or prevented for many of these children through provision of early and effective interventions, such as well-fit HAs. Approximately half of the children (those with the highest aided audibility) demonstrated positive growth patterns, arriving at standardized language scores over time that more closely approximated CNH (Tomblin et al., this volume, pp. XXXX). However, inspection of the distributions of scores on individual

measures suggests that a sizeable minority of CHH demonstrated weak language skills (standard scores at or below 85), despite having normal nonverbal IQs. To illustrate, 36.8% of the CHH had below-average scores on the Comprehensive Assessment of Spoken Language syntax subtest at age 4 years, which was true for only 10.7% of the CNH. Similarly, 31.4% of the CHH scored in the below average range on the Goldman-Fristoe Test of Articulation at age 5 years. In contrast, only 8% of the CNH performed in this range. The percentage of CHH scoring below average is greater than would be expected based on a typical distribution (16%) or the established prevalence rate for child language disorders (7.4%; Tomblin et al. 1997). The OCHL project has identified several factors that explain variance in outcomes, and it is critical that those factors be recognized and addressed to prevent potential cascading effects of weak preschool language skills on later reading and academic achievement in the school years. The school years represent a time when children move from learning language to using language in order to learn. Within the classroom, language in both its spoken and written form is nearly the sole vehicle by which new skills and knowledge are acquired and displayed. Furthermore, the language demands of the classroom are considerably different from the home or playground settings. Academic language is often decontextualized, abstract, and formal (Snow 1983; Gumperz et al. 1984). Thus, all children with weak language skills are at considerable risk for poor classroom performance. Furthermore, the classroom confronts CHH with additional challenges. Classrooms are complex listening environments with considerable background noise and multiple speakers in a variety of locations. These environmental features are likely to interact with the child's language skills such that poor hearing and poor language conspire to make learning and classroom participation challenging. For these reasons, we cannot be complacent about the outcomes of CHH. It is critical that we recognize that CHH are at risk for language and auditory development delays. The appropriate clinical/educational response is to be proactive and vigilant, implementing best practices in service provision with emphasis on malleable factors that provide protection against risk, so that language development can be optimized for the vast majority of CHH.

Question 2: What malleable factors can be addressed to promote success through implementation of best practices?—Malleable factors are defined as any parent/caregiver/family or child-specific variables that are amenable to change as part of intervention. This study identified several malleable factors that provide protection against risk for delays in language and/or auditory skills and promote successful outcomes. These include early HA fitting (which offered advantages in early development; Tomblin et al., this volume, pp. XXXX), longer duration of HA use (Tomblin et al., this volume, pp. XXXX), higher levels of aided audibility (Tomblin et al., this volume, pp. XXXX), amplification well-fit to targets (low RMS error; McCreery et al. a, this volume, pp. XXXX), consistently-worn amplification (Tomblin et al., this volume, pp. XXXX; Walker et al., this volume, pp. XXXX), and provision of high quality language exposure in the home (Ambrose et al., this volume, pp. XXXX). Specific clinical practice recommendations in these areas are as follows.

- Recognize that CHH are at risk for delays in language and auditory development, even when identification is early. To mitigate these risks, provide well-fit HAs for all CHH, including those with mild losses (Tomblin et al. 2014), as early as

possible in development. When HA fitting occurs later in preschool, caregivers and clinicians can expect benefits for language learning and auditory development as the child's cumulative experience with amplification increases. Despite the apparent closing of the gap in language levels by 6 years of age, however, the early delays evidenced by later-fit children are not developmentally optimal and are potentially preventable with earlier HA fitting, consistent use, and parental/caregiver guidance (Tomblin et al., this volume, pp. XXXX).

- Use real ear measures and related HA verification methods to optimize audibility and then validate with RMS error and normative ranges to assist in increasing quality of fittings when optimizing audibility (Bagatto et al. 2011, McCreery et al. 2012). These steps are critically important, given the finding that high levels of audibility are associated with stronger language and auditory development in CHH (McCreery et al., this volume, pp. XXXX; Tomblin et al., this volume, pp. XXXX).
- Promote consistent daily HA use with caregivers in an individualized and responsive manner (Walker et al., this volume, pp. XXXX). The combined benefits of high levels of audibility and consistent use are clear from this study (Tomblin et al., this volume, pp. XXXX). Thus, service providers should seek to increase the consistency of daily HA use by providing regular hands-on training with the HAs and individualized problem-based strategies to address specific challenges caregivers encounter. Caregivers may also benefit from practical demonstrations of the benefits of consistent HA use, such as HL simulations, examples of listening in noise with and without HAs, or listening with malfunctioning HAs. Because inconsistent HA use was frequent with infants and toddlers who are in foundational stages of language development, there is a great need for continued support for caregivers who are dealing with HA compliance issues with the youngest children.
- With school-age children, both maternal education level and degree of HL appeared to play a role in HA use consistency. Influential factors shifted over time, which highlights the need for an age-specific emphasis in counseling efforts.
- Implement the family-centered early intervention practices of coaching caregivers to be sensitive to their child's unique linguistic needs (Ambrose et al., this volume, pp. XXXX). Along with promoting caregiver self-efficacy with device management and use, providers should encourage caregivers to provide a language learning environment for the child that is sufficiently complex to promote linguistic development. The practice of coaching parents to elicit conversations, as opposed to directing their child's attention or behaviors during interactions, is also supported.
- Closely monitor all aspects of development, but especially the domains of morphosyntax and phonology, which appear to be especially challenging for some CHH (Tomblin et al., this volume, pp. XXXX). Continued monitoring of outcomes in these areas is warranted since CHH are at increased risk for language learning difficulties. Because better audibility was associated with better performance in morphology, there is further strong support for optimizing amplification to protect against this risk.

- Refrain from sole reliance on low-average scores on norm-referenced tests to determine if a child's progress is acceptable and without developmental risk (Tomblin et al., this volume, pp. XXXX). Scores falling in the low end of the average or below average range on norm-referenced tests are comparatively even lower when matched to SES-similar peers. These scores may reveal language weaknesses that could cascade to disrupt reading and academic development. This hypothesis is a focal topic of our future research.

Many of these clinical practice recommendations provide support for existing best practice recommendations in Audiology and early intervention. We recognize that there are costs associated with provision of best practices, yet our results suggest that there are developmental benefits to be accrued that we believe justify the effort, especially if early services impact language in a way that fosters later literacy, socialization, and employment opportunities. This remains an empirical question for further research. If the current results are compared to historical results on CHH, the early implementation of best practices is bringing about better outcomes, which indirectly supports the investment. Fortunately, most of our recommendations apply to existing systems, and our clinical implications use the evidence to point to priority aspects of intervention that can be emphasized in those programs. Before leaving this discussion, it is important to acknowledge that within this supplement we have focused primarily on the impact of audiological interventions. This does not represent the full spectrum of intervention services provided to the caregivers of CHH, but full explication of that data set was beyond the scope of this supplement. In the model presented in the Introduction (see Figure 1), we hypothesized that educational interventions would exert both direct and indirect influences on cumulative auditory experience and ultimate outcomes. It is our belief that HA fitting is a critical first step, but it must be paired with early interventions that support families in adjusting and developing the knowledge and skills to promote the child's learning. Forthcoming papers (Harrison et al. in review) will address this aspect of the hypothesized model.

Question 3: What non-malleable factors are consequential and what are their implications for practice?—Non-malleable factors are those parent/family/caregiver- and child-related factors that are not directly amenable to change as a result of intervention (e.g., caregiver SES, child's degree of HL, physical growth of ear canal). Although these factors are somewhat fixed, it is reasonable to consider best practice approaches that might reduce their influence. This leads to the following clinical practice recommendations for CHH and their parent(s).

- Recognize that changes in audiometric thresholds over time can compromise the amount of audibility provided to the child and this may require adjustments in amplification (McCreery et al., this volume, pp. XXXX). Regular audiological evaluation allows monitoring of changes in audiometric thresholds, and allows for any needed adjustments of amplification in response to audiometric threshold change. Furthermore, early intervention and preschool providers and parents should regularly conduct observational checks of the child's listening ability through the HA (e.g., Ling 6 sound test), which may put them in a position to notice threshold shifts or HA malfunction and make immediate referrals to the audiologist.

- Adjust HA gain to account for the decline in the sound level in the ear canal as the child experiences normal physical growth (McCreery et al., this volume, pp. XXXX).
- Carefully monitor the outcomes of all CHH, but exercise special vigilance in regard to children with moderate-to-severe HL, who are at the greatest risk for language (Tomblin et al., this volume, pp. XXXX) and auditory delays (McCreery et al., this volume, pp. XXXX).
- Consider also that it may be especially important to carefully monitor and support caregiver-child interactions for those from lower SES backgrounds as well as those who have children with moderate-to-severe HL (Ambrose et al., this volume, pp. XXXX).
- Provide additional support to caregivers from lower SES backgrounds related to the achievement of consistent HA use (Walker et al., this volume, pp. XXXX). This might include regular hands-on training with the HAs and provision of access to appropriate parent-to-parent support experiences.

These suggested practice shifts have costs associated with them. The practicalities of limited or no reimbursement, limitations in staff time, and economic barriers for families may represent major barriers to implementation. In light of these issues, we have sought to highlight populations at greater risk (moderate-to-severe losses, lower SES backgrounds) and suggest that any needs associated with children in these groups be considered priorities for intervention. Furthermore, past experience with CHH suggests there are costs associated with not making the suggested practice shifts, in terms of failing to prevent impact of HL on literacy, socialization, and employment deficits (Bess et al. 1998)

Future Directions

Funding for the OCHL project was renewed by the NIDCD in 2013 and the continuing project is entitled “Outcomes of School Age Children who are Hard of Hearing (OSACHH).” The OSACHH project will build on the OCHL foundation by following children from the same cohort into the school years through 4th grade. The longitudinal design will be harnessed to identify early predictive and risk factors that influence academic achievement through 4th grade. Interested readers may visit <http://ochlstudy.org> for more information about the ongoing work. It is well documented that the needs of CHH are typically underestimated in school settings (Antia et al. 2009; Davis et al. 1986) because deficits are often subtle and go unrecognized. We expect that our ongoing research will challenge this practice by identifying both early and concurrent factors that contribute to persistent academic risk. In the final analysis, we seek to inform theory and practice regarding the needs of CHH so that they will no longer be characterized as “our forgotten children” (Davis 1990).

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Model of hypothesized factors that may influence the relationship between childhood hearing loss and developmental outcomes.