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Genetics, Hearing Loss, and the Audiologist

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Editor's Note:

We would like to acknowledge and thank the American Academy of Audiology for permission to reprint this important article that appeared in Audiology Today that can assist the clinical audiologist in providing the best practice care for their hard of hearing, Deaf, and deafened patients. For this I had to promise to name my next two cats after the authors… at least its better than "Butterscotch" or "Feather"!

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Understanding the potential genetic implications of hearing loss, the value of genetic testing and counseling, and recent gene therapy advances equips clinical audiologists to provide best-practice care.

When a person is diagnosed with a hearing loss, the individual and/or their family may have many questions. Often, the first question is, why? Why did the hearing loss occur? What is the cause? Genetic testing and counseling can contribute valuable information about etiology and guide patient management.

There are many potential causes of hearing loss—some are due to genetics, and others are nongenetic. It is estimated that 66 percent of sensorineural hearing loss has a genetic etiology (Jonard et al, 2023), and to date, at least 223 genes that are associated with hereditary hearing loss have been identified (Molecular Otolaryngology and Renal Research Laboratories, 2024).

In the 2019 Joint Committee on Infant Hearing (JCIH) position statement, the determination of etiology and identification of conditions related to hearing loss are cited as purposes for medical evaluation in children who are confirmed to be d/Deaf or hard of hearing. Genetic counseling and testing are recommended for individuals diagnosed with hearing loss, especially if etiology is not

evident from medical history and evaluation, or there is a family history of hearing loss (Alford et al, 2014; Liming et al, 2016; JCIH, 2019; Jonard et al, 2023).

Although coursework in genetics is incorporated into audiology program curricula, multiple studies have found that audiologists may not feel equipped to implement that knowledge clinically. Peter et al (2019) queried speech-language pathologists and audiologists in the United States to assess their knowledge, confidence, and perceived relevance of genetics in their clinical practice. They found that one-third of audiologists had low or somewhat low self-assessed confidence in applying genetics to their clinical practice, but more than two-thirds indicated that genetics is relevant to the field.

Madhu et al (2023) examined the understanding of genetics by audiologists practicing across India and found that fundamental knowledge of genetics was insufficient, and audiologists desired further education on the topic. A capstone project completed at the City University of New York in 2019 found that only 20 out of 72 AuD programs in the United States provided a dedicated genetics course (Heesemann, 2019), although information about genetics and hearing loss may be incorporated into other courses in the curriculum.

There has been an increased focus on genetics and hearing as genetic testing for hearing loss has become more widely available, and preliminary gene therapy clinical trials have indicated potential for improvement in human hearing. The prevalence of genetic hearing loss, advances in genetic testing and therapy, and the desire for audiologists to expand their knowledge base indicate that further training and continuing education on the genetic basis of hearing loss, how to implement aspects of genetic counseling into clinical practice, and advances in treatment options are essential.

Understanding Etiology of Hearing Loss

Information about etiology is important in all cases but is especially useful for infants and children identified as d/Deaf or hard of hearing. Audiologists and other members of the interdisciplinary team may encourage genetic testing to determine etiology of hearing loss. Establishing etiology can provide information on associated medical conditions as hearing loss may co-occur with heart, renal, vision, vestibular, craniofacial, and cognitive conditions.

Hearing loss may be the first condition identified, and genetic testing may provide information of other potentially impacted systems. Genetic testing and establishing etiology can aid in determining the need for involvement of additional health-care professionals if the cause for hearing loss is associated with other diseases and disorders, as may be evident in syndromes such as Alport, Treacher Collins, Waardenburg, branchio-oto-renal, and many others (Gettelfinger and Dahl, 2018).

For example, type 1 Usher syndrome is a syndrome caused by a genetic mutation that impacts hearing, balance, and vision systems. Children with Usher syndrome typically have profound congenital hearing loss. Balance difficulties are not identified until the child begins to walk, and vision problems are progressive and present later in childhood (National Institute on Deafness and Other Communication Disorders, 2017).

In cases of Usher syndrome, genetic testing may provide clinicians and families with important considerations for management, such as the potential for progressive vision loss when making choices for technology and communication modality. Alternatively, the most known cause of

nonsyndromic genetic hearing loss is mutation in connexin 26. Connexin 26 mutation has not been found to impact other body systems and typically has a good prognosis for speech perception and production following intervention (Wu et al, 2015).

Early genetic investigation can help guide practitioners and families to improve hearing loss management as hearing loss characteristics (i.e., type, severity, and progression) vary by etiology and require different management approaches. Knowledge of etiology informs the care plan and prognosis, as some conditions may be associated with progressive, fluctuating, or delayed-onset hearing loss. Options for medical and nonmedical management may be informed by known etiology, such as in cases of early identification of congenital cytomegalovirus or Alport syndrome.

The National Society of Genetic Counselors provides a resource for identifying genetic counselors at FindAGeneticCounselor.com.

Genetic Counseling and Clinical Audiologists

When an audiologist completes diagnostic testing confirming a hearing loss, this clinician is often the first practitioner to offer counseling about hearing loss and next steps. The audiologist is thus in a unique position for providing basic interdisciplinary content related to genetics and hearing.

Individuals and families approach hearing loss from multiple perspectives and backgrounds. Some may not understand why genetic testing is important, whereas others may seek immediate answers on the underlying cause of the hearing loss. Answers provided through genetic testing and counseling may help families better understand the diagnosis and implications for themselves and their families. Incorporating individual needs in shared decision-making is important when approaching genetic testing and counseling.

Audiologists will often need to counsel on the roles of the genetic counselor, the geneticist, genetic testing, and the implications of results to management of hearing loss. Genetic counselors work with patients to understand their genetic information by establishing a genetic pedigree describing the presence of the hearing loss phenotype in the family, determining if and which genetic tests should be completed, and helping patients navigate results.

Genetic counselors meet with patients to gather a thorough history to determine the risk of a genetic cause for the hearing impairment and potential impact on other family members, including development of a pedigree to chart the presence of hearing loss across family members and generations. This investigation may identify undiagnosed hearing loss or risk factors in other family members, the potential for other body system involvement, and the risk for hearing loss to future offspring (Jonard et al, 2023).

Geneticists’ roles include ordering and interpreting complex test results and working with the genetic counselor to implement results in management and counseling (Pagan, 2013). Genetic testing is becoming more widely available and approachable with technological improvements and screening protocols that increase efficiency and accessibility by reducing sequencing time and the cost of testing.

Genetic testing may not be appropriate for every patient, so family history, risk of a genetic cause, out-of-pocket costs, and patient desires should all be considered in shared decision-making between the patient/family, genetic counselors, and geneticists (Calamaro, 2021).

Audiologists can assist genetic counselors by providing a detailed report to inform phenotyping of the hearing loss (TABLE 1). Phenotyping involves providing a detailed description of the observable traits of the hearing loss and other potentially associated symptoms. Information provided by the audiologist paired with a comprehensive pre-counseling session will allow genetic counselors and geneticists to determine which additional tests should be completed (Calamaro, 2021).

TABLE 1. Examples of Information Audiologists Should Provide to Genetic Counselors

CASE AND MEDICAL HISTORY CONTENTS
Age of hearing loss onset
Type of hearing loss
Degree of hearing loss
Hearing loss configuration
Laterality and symmetry of hearing loss
Progression of hearing loss
Fluctuation of hearing loss
Presence of tinnitus
Presence of vestibular symptoms
Copies of audiological testing
Copies of imaging
Family history of hearing loss

Audiologists may support families in understanding the specific implications of genetic test results to available interventions and setting realistic expectations on outcomes. Familiarity with common genetic test protocols and results in conjunction with establishing relationships with local genetic counselors will enable the audiologist to provide evidence-based patient care. The National Society of Genetic Counselors provides a resource for identifying genetic counselors at FindAGeneticCounselor.com.

Clinical audiologists should stay abreast of genetic diagnostic and therapeutic advances by accessing continuing education courses and scientific literature and by monitoring media updates.

Implications of Gene Therapy

Gene therapy is a technique that modifies or manipulates the expression of a gene with the aim of altering biological properties to treat or cure a disease (Center for Biologics Evaluation and Research, 2018). In the past few months, preliminary results from gene therapy clinical trials have been reported that show improvements in hearing thresholds for children with congenital bilateral severe to profound hearing loss caused by mutations in the otoferlin gene, which is a common cause of auditory neuropathy spectrum disorder (Auditory Insight, 2024).

These trials involve administration of working copies of otoferlin genes to the cochlea through the round window to induce otoferlin protein production in the affected cochlea (Auditory Insight, 2024). As these advances continue, gene therapy becomes not only a research topic but a clinically relevant consideration.

Although gene therapy treatments are not currently widely available, with publicized clinical trial

results, patients may seek information on this topic from their audiologists. Counseling should include educating patients on whether they may be a candidate for current clinical trials, the specific targeted gene of available trials, the therapeutically applicable treatment window, and realistic expectations based on accurate interpretation of study results.

With pediatric patients, counseling on the importance of early auditory stimulation to promote language acquisition will be even more important as families balance the potential for future gene therapy and the importance of early intervention. Due to the potential negative impact of longer durations of deafness on speech recognition, waiting for gene therapies to become widely available is not realistic for most patients, and current best-practice care should be implemented.

Recent advances in gene therapy may cause some parents of children who have already received cochlear implants to question their earlier decision. Audiologists will need to work with these families by validating their feelings, presenting accurate data, and reassuring them about treatment decisions based on time of identification. Adult patients may also have questions about gene therapy for themselves, which will require counseling on the implications of longer duration of deafness and the therapeutically viable treatment window.

As gene therapy advances continue and become widely available, how we approach genetic counseling with our patients will evolve. Although there are many unanswered questions regarding gene therapy, clinicians have a responsibility to their patients to continue monitoring information as it becomes available to address questions and discuss implications for management of their individual hearing loss.

Conclusion

Clinical audiologists are members of interdisciplinary teams, often including speech-language pathologists, otolaryngologists, neurologists, physical therapists, and many others. With the prevalence of individuals who experience hearing loss related to genetic inheritance, genetic counselors must be recognized as important members of this team. Collaboration and support from team members with other areas of expertise will ensure comprehensive, evidence-based care.

Basic knowledge in genetics and in the services and options available through genetic counselors will empower audiologists to provide expert guidance to patients for appropriate referrals, setting of expectations, and addressing questions about current advances in genetic testing and gene therapy.

Clinical audiologists should stay abreast of genetic diagnostic and therapeutic advances by accessing continuing education courses and scientific literature and by monitoring media updates.

Audiologists should be familiar with the most common genetic conditions that cause hearing loss, have a basic understanding of genetic testing options, and be able to counsel families on the implications of findings on hearing loss management.

Preliminary results of three clinical trials (Auditory Insight, 2024) show some hearing restoration in children with hearing loss caused by otoferlin genetic mutation.

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