Age-Related Hearing Loss
Innovations in Hearing Augmentation

Yona Vaisbuch, MD*, Peter Luke Santa Maria, MD, PhD

KEYWORDS

• Presbycusis • Presbyacusis • Age-related hearing loss • Geriatric otology
• Hearing aids • Hearing rehabilitation • Hearing augmentation
• Hearing loss treatment

KEY POINTS

- Age-related hearing loss is a multifactorial condition that effects a major part of the aging population.
- Left untreated, age-related hearing loss can lead to higher risks of cognitive decline, dementia, social isolation, depression, and falls.
- Stigma remains a prominent barriers, so today's devices offer in-the-canal models, miniature size, and camouflage with hair or skin color.
- The mobile era has enabled self-screening, self-fitting, and tele-rehabilitation, and continues to produce other innovations that will potentially improve accessibility.
- Although rigorous scientific efforts have been made in research on inner ear regeneration and some early phase studies exist, the clinical implication remains to be seen.

INTRODUCTION

Age-related hearing loss (ARHL) is the cumulative pathophysiologic changes that occur in hearing attributable to aging. ARHL is also often referred to as "presbycusis" or "presbyacusis."[1] It is typically a progressive, irreversible bilateral symmetric sensorineural high frequency hearing loss (HL).[2] According to the World Health Organization, ARHL is the second most common illness in the geriatric population and is the third most prevalent health condition worldwide.[3] In 2012, based on a review of 42 population-based studies, the World Health Organization estimates were that 328 million adults worldwide had disabling HL (>40 dB in the better hearing ear) and by 2025, with the world population aging, there will be 1.2 billion people over the age of 60, with more than 500 million of them who will suffer significant impairment from

Disclosure: P.S. Maria is a consultant for EarLens. Y. Vaisbuch has nothing to disclose.

Neurotology Division, OHNS Department, Stanford University, 801 Welch Road, Stanford, CA 94305, USA
* Corresponding author.
E-mail address: yona@stanford.edu

Otolaryngol Clin N Am ■ (2018) ■–■
https://doi.org/10.1016/j.otc.2018.03.002 **oto.theclinics.com**

ARHL. It affects 1 in 3 persons over the age of 65,[4] and 1 in 2 over the age of 75 in the United States.[5] It is more common in men than women, regardless of occupational or leisure noise exposure.[6,7] Unaddressed HL poses an annual global cost of $750 billion internationally. Direct costs associated include falls and depression; indirect costs include loss of productivity and the quality-adjusted or disability-adjusted life years owing to stigma experienced by individuals with HL, as well as the grief associated with the loss of hearing and the experiences related to the act of hearing or listening.[8] The etiology of ARHL is believed to involve the interaction of multiple factors, including the cochlear degeneration that occurs over time and a genetic predisposition. The primary pathologic findings include hair cells loss, stria vascularis atrophy, and loss of spiral ganglion neurons, as well as changes in the central auditory pathway like atrophy of the gray as well as white matter, changes in the content of some metabolites in the aged brain, and differences between activation of the central auditory system in the young and old brain.[9,10] Other environmental factors can influence the onset and severity of ARHL. These factors include low socioeconomic status, noise exposure, ototoxin exposure (eg, aminoglycosides, chemotherapeutic agents, and heavy metals), infections, smoking, and health comorbidities like hypertension, diabetes, vascular disease, immunologic disorders, and hormonal factors.[11,12] Patients with ARHL often present with difficulty in understanding speech in certain situations, especially in settings with loud background noise such as restaurants or grocery stores. Their families may also report that they start speaking in a louder voice than normal, without the individual being aware of it. Individuals may not present directly for hearing volume complaints, but may primarily seek help for tinnitus or a change in quality of sound, especially an inability to hear high-pitched sounds.[13] The most common interventions in ARHL are hearing augmentation via amplification of sound or direct electrical stimulation of the neural component, via cochlear implantation, when the hearing deterioration is beyond the range of amplification. Both treatments have been shown to be cost effective with the potential to bring great benefit to individuals.[14] There have been recent and emerging innovations in the field of hearing augmentation. In this article, we present an overview of the downstream effects of untreated ARHL. We discuss solutions that are currently available or likely to be available soon based on human clinical trial activity. We also present some new hearing device features that can potentially influence patient experience and satisfaction, which are crucial for adoption and compliance.

LITERATURE REVIEW

Our literature review involved PubMed, Google, and clinicaltrials.gov. The search strategy for PubMed was (''Presbycusis''[MeSH Terms] OR ''Presbyacusis''[All.-Fields]) OR (''Age Related Hearing Loss''[MeSH Terms] AND ''Innovation''[All Fields]) AND (''2007/01/01''[PDAT]: ''2017/07/01''[PDAT]). The primary author reviewed all abstracts of studies found with this search strategy. A Google and clinicaltrials.gov search was performed using the following key words: Age related Hearing loss, Presbycusis, Presbyacusis, Geriatric Otology, Hearing augmentation and Innovation. We considered those innovations appropriate for this review as those that are currently available to patients or expected to be available in the near future based on publications and activity in human clinical trials (clinicaltrials.gov).

Age-Related Hearing Loss Sequelae

A large body of evidence is accumulating supporting that ARHL is not only a contributor toward reduced quality of life, but also impacts other physical aspects of aging.