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Clinical Practice Guideline: Age-Related Hearing Loss

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Abstract

Objective. Age-related hearing loss (ARHL) is a prevalent but often underdiagnosed and undertreated condition among individuals aged 50 and above. It is associated with various sociodemographic factors and health risks including dementia, depression, cardiovascular disease, and falls. While the causes of ARHL and its downstream effects are well defined, there is a lack of priority placed by clinicians as well as guidance regarding the identification, education, and management of this condition.

Purpose. The purpose of this clinical practice guideline is to identify quality improvement opportunities and provide clinicians trustworthy, evidence-based recommendations regarding the identification and management of ARHL. These opportunities are communicated through clear actionable statements with explanation of the support in the literature, evaluation of the quality of the evidence, and recommendations on implementation. The target patients for the guideline are any individuals aged 50 years and older. The target audience is all clinicians in all care settings. This guideline is intended to focus on evidence-based quality improvement opportunities judged most important by the guideline development group (GDG). It is not intended to be a comprehensive, general guide regarding the management of ARHL. The statements in this guideline are not intended to limit or restrict care provided by clinicians based on their experience and assessment of individual patients.

Action Statements. The GDG made *strong recommendations* for the following key action statements (KASs): (KAS 4) If screening suggests hearing loss, clinicians should obtain or refer to a clinician who can obtain an audiogram. (KAS 8) Clinicians should offer, or refer to a clinician who can offer, appropriately fit amplification to patients with ARHL. (KAS 9) Clinicians should refer patients for an evaluation of

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Disclaimer: This guideline is not intended as the sole source of guidance regarding ARHL. Rather, it is designed to assist clinicians by providing an evidence-based framework for decision-making strategies. The guideline is not intended to replace clinical judgment or establish a protocol for all individuals with this condition and may not provide the only appropriate approach to managing this problem. As medical knowledge expands, and technology advances, clinical indicators and guidelines are promoted as conditional and provisional proposals of what is recommended under specific conditions but are not absolute. Guidelines are not mandates. These do not and should not purport to be a legal standard of care. The responsible physician, in light of all circumstances presented by the individual patient, must determine the appropriate treatment. Adherence to these guidelines will not ensure successful patient outcomes in every situation. The AAO-HNSF emphasizes that these clinical guidelines should not be deemed to include all proper treatment decisions or methods of care, or to exclude other treatment decisions or methods of care reasonably directed to obtaining the same results.

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cochlear implantation candidacy when patients have appropriately fit amplification and persistent hearing difficulty with poor speech understanding. The GDG made *recommendations* for the following KASs: (KAS 1) Clinicians should screen patients aged 50 years and older for hearing loss at the time of a health care encounter. (KAS 2) If screening suggests hearing loss, clinicians should examine the ear canal and tympanic membrane with otoscopy or refer to a clinician who can examine the ears for cerumen impaction, infection, or other abnormalities. (KAS 3) If screening suggests hearing loss, clinicians should identify sociodemographic factors and patient preferences that influence access to and utilization of hearing health care. (KAS 5) Clinicians should evaluate and treat or refer to a clinician who can evaluate and treat patients with significant asymmetric hearing loss, conductive or mixed hearing loss, or poor word recognition on diagnostic testing. (KAS 6) Clinicians should educate and counsel patients with hearing loss and their family/care partner(s) about the impact of hearing loss on their communication, safety, function, cognition, and quality of life (QOL). (KAS 7) Clinicians should counsel patients with hearing loss on communication strategies and assistive listening devices. (KAS 10) For patients with hearing loss, clinicians should assess if communication goals have been met and if there has been improvement in hearing-related QOL at a subsequent health care encounter or within 1 year. The GDG offered the following KAS as an *option*: (KAS 11) Clinicians should assess hearing at least every 3 years in patients with known hearing loss or with reported concern for changes in hearing.

Keywords

age-related hearing loss, amplification, cochlear implantation, presbycusis, sensorineural hearing loss

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Age-related hearing loss (ARHL), despite being the most common sensory deficit seen in the older population, remains an underdiagnosed and undertreated condition.[1] Between ages 65 and 74, 1 in 3 adults experience hearing loss and almost 50% of those 75 years of age or older will report hearing loss according to the National Institute on Deafness and Other Communication Disorders (NIDCD).[2] The impact of untreated hearing loss goes beyond limiting the ability to communicate. The risk of dementia, depression, cardiovascular disease, and falls has been associated with untreated hearing loss.[3-5] There is also an association between hearing loss and lower household income, unemployment, and increased social and emotional isolation compared to those without hearing loss.[6-10] Although the risks of untreated hearing loss have been well described, 1 barrier to treatment is the lack of priority placed by health care clinicians in addressing hearing loss either by insufficient screening or referral.[11] The association of untreated hearing loss with an individual's physical, mental, psychological, and social status supports the need to identify and address ARHL in a timely manner to limit the potential downstream effects.

While there are many causes of hearing loss, this guideline focuses on ARHL, which refers to progressive bilateral sensorineural hearing loss (SNHL) associated with the process of aging in persons ≥50 years old (**Table 1**). Epidemiologic studies show an increase in high-frequency hearing loss with aging, rising more rapidly in men than women.[12] Multifactorial in nature and influenced by intrinsic and extrinsic factors, ARHL is typically a symmetric and gradual process as opposed to other sudden-onset or rapidly progressive forms of hearing loss. Although the definition of symmetric hearing loss can vary, a previously published position statement of the American Academy of Otolaryngology–Head and Neck Surgery Foundation (AAO-HNSF) defines symmetric hearing loss as audiometric results within 15 dB for the pure tone average between ears with a difference in word recognition scores of 15% or less between ears.[13] From studying temporal bones, Dr. Schuknecht proposed 4 different categories of ARHL: sensory, neural, strial or metabolic, and conductive.[14] Sensory hearing loss is thought to be due to the degeneration of hair cells, starting at the basal turn, whereas neural hearing loss, which affects speech discrimination, is caused by neuronal loss. Atrophy of the stria vascularis, which changes the endolymphatic potential, is believed to cause strial or metabolic presbycusis and was initially thought to be the primary factor driving ARHL. However, more recent studies suggest that the loss of hair cells is the primary cause of ARHL.[15] Conductive presbycusis is hypothesized to be due to alterations in the cochlear aqueduct, although the mechanism is not yet proven.[16] While other forms of hearing loss (ie, drug-induced hearing loss, noise-induced hearing loss, congenital hearing loss, conductive hearing loss [CHL], and iatrogenic hearing loss) may compound hearing loss due to the aging process, they are excluded from this guideline.

Despite the high prevalence of ARHL and its effect on health outcomes, there are no evidence-based, multidisciplinary clinical practice guidelines (CPGs) to assist clinicians with identification, education, and management of this condition. In 2021, the AAO-HNSF published quality improvement measures for ARHL but did not provide guidance to clinicians for the evaluation and management of this condition.[17] This guideline provides actionable recommendations based on current best research evidence and multidisciplinary consensus while also incorporating previously proposed quality improvement measures. While the previously proposed measures defined ARHL as starting at 60 years of age, the authors of this guideline have broadened the age of inclusion for this guideline down to age 50 to promote screening for

Table 1. Abbreviations and Definitions of Common Terms

Term	Definition
ARHL /presbycusis	Progressive bilateral sensorineural hearing loss associated with the process of aging.
Sensorineural hearing loss	Hearing loss from an abnormality of the cochlea, auditory nerve, or higher aspects of central auditory perception or processing.
Progressive sensorineural hearing loss	Sensorineural hearing loss that worsens over time.
Health outcomes	Definition from WHO: A change in the health of an individual, group of people, or population that is attributable to an intervention or series of interventions.[20]
Cognition	Definition from The American Psychological Association: All forms of knowing and awareness, such as perceiving, conceiving, remembering, reasoning, judging, imagining, and problem solving.[21]
Quality of life	Definition from WHO: A individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns.[22]
Healthy aging	Definition from WHO: The process of developing and maintaining the functional ability that enables well-being in older age. Functional ability is about having the capabilities that enable all people to be and do what they have reason to value. This includes a person's ability to: • meet their basic needs; • learn, grow, and make decisions; • be mobile; • build and maintain relationships; and • contribute to society.[23]
Amplification	Any device, system, or strategy that improves access to sound through increased intensity (eg, hearing aids).
Auditory rehabilitation	Definition from ASHA: A person-centered approach to assessment and management of hearing loss that encourages the creation of a therapeutic environment conducive to a shared decision process which is necessary to explore and reduce the impact of hearing loss on communication, activities, and participations.[24]

Abbreviations: ARHL, age-related hearing loss; ASHA, American Speech-Language-Hearing Association; WHO, World Health Organization.

hearing loss, which is recommended by the American Speech-Language-Hearing Association (ASHA), despite the limited evidence noted by the US Preventive Services Task Force (USPSTF).[18,19] Much of the focus of this CPG is on the education of the clinician and patient in identification and treatment options for those with ARHL to abate its harmful impact on healthy aging.

Guideline Scope and Purpose

The main purpose of this CPG is to guide clinicians regarding the identification and management of ARHL as a recognized risk factor affecting health outcomes and quality of life (QOL) in the aging population. The goals of this CPG are to use the best available published scientific and/or clinical evidence to educate clinicians and patients and to improve access to hearing health care while reducing sociodemographic and socioeconomic barriers. Where evidence is lacking, expert consensus is provided and detailed in the guideline.

The target patient for the CPG is anyone at least 50 years old, regardless of whether they have been diagnosed with hearing loss. The CPG makes specific recommendations about screening, hearing testing, and indications for referrals to an appropriate hearing health specialist. It also covers amplification, communication strategies, cochlear implantation (CI), and other assistive technologies. Because ARHL affects patient communication in all aspects of life, this guideline applies to all settings, medical and nonmedical. The CPG focuses only on ARHL, recognizing that there are many potential causes of hearing loss over a person's lifetime. This CPG does not discuss the management of noise-induced hearing loss, which often presents in conjunction with ARHL. While genetics plays a role in ARHL, this CPG does not focus on known genetic causes of congenital hearing loss or syndromic hearing loss. This CPG is not intended for comprehensive management of ARHL and is not intended to limit or define the care of patients.

The target audience of this guideline is any clinician who encounters patients over 50. A plain language summary will be produced for use by patients and nonclinicians. In 2021, the AAO-HNSF published an article on quality improvement measures for ARHL due to its increasing prevalence and the significant disabilities from delays in diagnosis and treatment despite the lack of formal CPGs.[17] These previously published measures include screening for hearing loss in older patients during a face-to-face visit, ordering, referring, or obtaining a comprehensive audiometric evaluation within 4 weeks of

failing a hearing screening, and documentation of shared decision-making regarding treatment options for patients with diagnosed symmetric SNHL during a visit.

As such, the current multidisciplinary group was convened to review the most recent and updated published scientific and clinical evidence available to craft the CPG. By using a published, transparent CPG process to develop recommendations and identifying quality improvement opportunities deemed most important by the guideline development group (GDG) after considering public comments, the primary goal was to create actionable statements (key action statements [KASs]) that reflect current evidence-based advances in knowledge with respect to ARHL with a balance of benefits and harms.[25]

Health Care Burden

Epidemiology

Hearing loss is a global public health problem affecting approximately 466 million people worldwide.[26] This is expected to increase to 630 million by 2030 and to over 900 million by 2050.[26] Within the United States alone, an estimated 65.3% of adults 71 years and older, or 21.5 million people, has at least some degree of hearing loss.[27] Modeling projections using National Health and Nutrition Examination Surveys data, it is estimated that 78 million people may have hearing loss. Age is a significant risk factor for the development of hearing loss.[28] ARHL is a multifactorial degenerative condition of the auditory system including the ear and brain, presenting as difficulty in perception of sound and understanding of speech.[29] ARHL is the most common sensory disorder[30] and the third most common chronic health condition of older adults.[31] The prevalence of hearing loss doubles with each decade of life and affects more than 60% of individuals by age 70 and 80% of individuals older than 85 years of age.[32,33] The rise of hearing loss among older adults deserves the medical community's attention as the population ages and life expectancy has risen steadily over the past 40 years.[34,35] The US population aged 65 and older will outnumber those younger than 18 by 2038.[36] By 2060, almost 92 million individuals will be 65 or older.[36] With an aging population, degenerative geriatric conditions, such as ARHL, will become increasingly prominent on a global level.[37] Hearing loss also has a significant professional and psychological impacts. Adults with hearing loss are twice as likely to be unemployed or partly unemployed and receive 25% lower wages compared to normal-hearing adults.[38] Hearing loss is also associated with an increase in depression by 50% compared to normal-hearing adults.[39]

Population-level research has identified sociodemographic factors linked to ARHL. There is evidence of a higher prevalence of ARHL in males compared with females.[40-46] Additionally, there is evidence that hearing loss progression is twice as fast in men than in women.[47] Although considered to be secondary to occupational and noise exposures, ARHL is independently influenced by biological sex.[48] Animal and human research suggest estrogen may have a protective effect, preventing the development, and progression of hearing loss in women.[49-51]

There are limited data regarding differences in the prevalence of ARHL based on race and ethnicity. Large cohort data indicate that African Americans have a lower risk of ARHL compared to white and Hispanic populations.[33] Similar to sex differences, the mechanisms behind these findings may be due to differences in environmental or occupational exposures. However, data from animal studies have described melanin expression in the stria as having a protective effect against ARHL and the lack of melanin may contribute to marginal cell loss with age.[52] It is unknown if or how this translates to skin pigmentation. These racial and ethnic ARHL prevalence estimates may not be accurate due to longstanding inequitable access to hearing care,[43] underreporting of sociodemographic data of participants in hearing research,[53] and underrepresentation in hearing-related clinical trials[54] among some populations.

Risk Factors

ARHL arises from mixed pathology of the auditory system due to intrinsic and extrinsic factors, including interactions resulting in degenerative changes to a variety of different cochlear and neural structures. It is estimated that approximately half of the variance in ARHL may be heritable.[55] Several genetic polymorphisms have been examined with mixed conclusions. In 1 meta-analysis, the polymorphisms rs10955255 and rs1981361 may be risk factors for ARHL among various racial groups,[56] while no relationship has been noted between GST M1 and T1 polymorphisms and ARHL.[57] In temporal bone specimens, mitochondrial mutations are noted among patients with ARHL versus normal-hearing individuals.[58] Mitochondrial dysfunction associated with reactive oxygen species and apoptosis has also been proposed as a mechanism for ARHL.[59]

While the mechanisms underlying ARHL may be primarily due to genetic predisposition and aging-related cellular changes, there may be a variety of additional intrinsic metabolic and medical factors that influence the development and progression of ARHL.[60] Chronic medical conditions, such as hypertension, diabetes, and hypercholesterolemia, may influence the development of hearing loss.[61,62] Independent of age, adults with diabetes, either type 1 or type 2, have a 2 times higher prevalence of hearing loss compared to patients without diabetes.[63,64]

Extrinsic factors such as lifestyle behaviors, medication side effects, and environmental exposures may also influence the development of ARHL. The impact of diet on the development of ARHL is uncertain and complicated by poor study designs, heterogeneity of outcomes, and research examining individual nutrients. Smoking and passive smoke exposure have deleterious effects on hearing and increase the risk of hearing loss based

on cross-sectional research.[65] Ototoxic medications are an independent risk factor for hearing loss[66]; however, exposure to these medications may be difficult to avoid and their role in synergistically worsening ARHL can be difficult to determine. ARHL is further compounded by recreational and/or occupational noise exposure and its influence on hearing thresholds. In 1 large retrospective cohort study, age had a significant impact on hearing loss in both chronic occupational noise exposure and control groups.[67] Impulse noises, such as fireworks and gunfire, accelerate the progression of ARHL. Individuals exposed to gunfire at young ages demonstrate poorer pure-tone thresholds in older age compared to those not exposed.[68]

Impairments

Aging is associated with multiple related medical problems, which have been referred to as geriatric syndromes. These include impairment in vision, hearing, and balance, which synergistically negatively impact the functional status of an individual.[69] ARHL presents initially with increased hearing thresholds at higher frequencies but progresses at a variable rate to impact midrange and lower frequencies over time.[70] As hearing loss progresses, speech recognition is also affected, leading to difficulty in communication (especially, in the presence of background noise). Compared to normal-hearing controls, adults with hearing impairment also report significantly increased listening effort and fatigue.[71] Impaired communication due to ARHL has direct effects on social engagement and QOL.[72,73]

Based on prospective cohort studies, ARHL is a significant risk factor for the development of dementia.[74] The mechanism underlying cognitive decline is not fully understood but may be due, in part, to hearing loss-related social isolation, structural changes of the brain, and depletion of cognitive reserve.[75] Due to communication difficulty, adults with ARHL face social isolation and a decrease in social support.[76,77] Cross-sectional data in the United States among older adults demonstrate that greater hearing loss is associated with increased odds of being socially isolated, regardless of whether they receive hearing loss treatment or not.[78] Social isolation is a known independent risk factor for cognitive decline and may impair coping mechanisms, limit brain stimulation, and prevent physical exercise.[79,80]

Furthermore, social isolation effectively compounds ongoing cellular and cognitive decline. The neurobiological basis for hearing loss-related brain structural changes is still unknown; however, there is a correlation between hearing loss and gray matter atrophy.[81] Among older adults, after adjusting for age, sex, and education, greater hearing loss is associated with reduced total hours per week of mental activity (−3.0 hours per 10 dB of hearing loss, 95% confidence interval: −5.8 to −0.2).[82] Hearing loss significantly increases cognitive load, resulting in significant depletion of cognitive reserves.[83]

Older individuals with hearing loss are also at increased risk of depression. This association is likely related to a complex interaction of the impairments of hearing loss, declining cognition, and social isolation. Among community-dwelling older adults, depression was reported among 69% of hearing-impaired individuals versus 31% of non-hearing-impaired individuals.[6,84] ARHL tends to be associated with major depression that develops in late life (after age 60) as opposed to early onset depression diagnosed before age 60.[85] There is also a significant relationship between the loss of more than 1 sensory function loss and poorer mental health.[86]

Social isolation and hearing loss have also been linked with decreased physical activity. Adults with hearing loss are less likely to participate in physical activity[87-89] and tend to be more sedentary.[90,91] In addition to social isolation, hearing loss' impact on physical activity may be due to increased cognitive load (the amount of information one can process at any given time), walking limitations, reduced gait speed, fear of losing or breaking hearing devices, inability to hear surroundings/individuals, safety concerns, and the social stigma of hearing loss.[87,88,92-94] This lack of physical activity may also contribute to frailty among older individuals. In cross-sectional studies, hearing loss is associated with an 87% increase in the risk of frailty (risk ratio [RR]: 1.87; 95% confidence interval: 1.63-2.13) and 56% among longitudinal studies (RR: 1.56; 95% confidence interval: 1.29-1.88).[95] There is a 2-fold increased risk of falls among older individuals with hearing loss and women have a 31% greater risk for incident disability than males.[96]

Health Care Costs

ARHL results in a significant economic burden on the health care system, which includes the cost of the disorder (and the associated adverse outcomes), excess medical expenditures, and disability burden. These costs may be difficult to accurately estimate partly due to the underdiagnosis and undertreatment of hearing loss. It may also be underestimated due to omission of costs related to medical frailty, depression, and cognitive decline.[97] Based on estimates in a systematic review (SR), the total annual costs of hearing loss in Australia is estimated at $10.9 billion Australian dollars.[97] Research among a sample of US adults (≥65 years) with severe hearing loss estimates the overall lifetime cost of around $70,000 per person.[98] Research calculating overall actual or projected medical expenditures (which differs from cost) attributed to hearing loss in the United States are estimated to range from $3 to $12 billion.[99-101] Another study among a sample of US adults (≥65 years) estimated the overall lifetime hearing loss-related expenditure to be around $34,000 per person.[98] The disability burden of hearing loss can also be estimated using disability-adjusted life years (DALYs). Studies that have estimated disease-related burden DALYs have ranked the burden of

hearing loss above that of blindness and at a burden level similar to that of stroke or cardiac arrythmia.[102]

Indirect Costs

Indirect costs from ARHL are related to adverse employment outcomes (lost income, productivity, or opportunities), the economic impact on family and social support, and overall QOL. Untreated hearing loss may result in a loss of annual income estimated to be as high as $15,000; however, treatment of hearing loss may result in income increases estimated to be as high as $5000 for those who receive cochlear implants and $22,000 for those who receive hearing aids.[38,103] The economic estimates of lost productivity in the United States are reported up to $200 billion.[99,101,103]

Methods

This guideline was developed using an explicit and transparent *a priori* protocol for creating actionable statements based on supporting evidence and the associated balance of harm as outlined in the third edition of *Clinical Practice Guideline Development Manual: A Quality-Driven Approach for Translating Evidence into Action*.[25]

Stakeholder Involvement

The GDG consisted of 18 panel members representing experts in otolaryngology (including the subspecialty of otology and neurotology), audiology, primary care, and geriatrics. The GDG also included a consumer/patient representative. The GDG had 3 conference calls and 2 virtual meetings during which they defined the scope and objectives of the guideline, evaluated the systematically reviewed evidence, identified quality improvement opportunities, crafted the KASs, reviewed the relevant evidence, reviewed comments from the expert panel review for each KAS, and drafted/revised the document.

Literature Search and Selection

An information specialist conducted 2 literature searches from September through December 2022 using a validated filter strategy to identify CPGs, SRs, meta-analyses (MAs), and randomized controlled trials (RCTs).

The following databases were searched for relevant studies: AHRQ EPC Reports, Biosis Citation Index, CINAHL, ClinicalTrials.gov, CMA Infobase, Cochrane CENTRAL, Cochrane Database of SRs, CRD Web (DARE, NHS EED, HTA), ECRI Trust, Embase, Google Scholar, Guidelines International Network, HSTAT, New Zealand Guidelines Group, NICE Guidance & Advice, Proquest Central, PubMed, Scopus, SIGN, TRIPdatabase.com, and WHO ICTRP. The databases were searched using both controlled vocabulary words and synonymous free text words for the topic of interest (age-related hearing loss). The search strategies were adjusted for the syntax appropriate for each database/platform. The search was not limited to clinical study design and was limited to English language. The full strategy is found in Appendices A and B. These search terms were used to capture all evidence on the population, incorporating all relevant treatments and outcomes.

The initial English-language searches identified 34 CPGs, 185 SRs/MAs, and 220 RCTs published from inception through December 2022. CPGs were included if they met quality criteria of (a) an explicit scope and purpose, (b) multidisciplinary stakeholder involvement, (c) systematic literature review, (d) explicit system for ranking evidence, and (e) explicit system for linking evidence to recommendations. SRs were emphasized and included if they met quality criteria of (a) clear objective and methodology, (b) explicit search strategy, and (c) valid data extraction methods. RCTs were included if they met quality criteria of (a) trials involved study randomization, (b) trials were described as double-blind, and (c) trials denoted a clear description of withdrawals and dropouts of study participants. After removing duplicates, irrelevant references, and non-English-language articles, the 4 reviewers retained 18 CPGs, 88 SRs/MAs, 132 RCTs that met inclusion criteria and 48 other studies that did not meet the inclusion criteria for CPGs, SRs, MAs, or RCTs. The recommendations in this CPG are based on SRs identified by a professional information specialist using an explicit search strategy. Additional background evidence was identified including targeted searches for KAS 4 and 5 in May to June 2023 to support the needs of the GDG to supplement and fill knowledge gaps. Therefore, in total, the evidence supporting this guideline includes 12 CPGs, 46 SRs/MAs, 13 RCTs, and 90 observational and other studies.

Classification of Evidence-Based Statements

Guidelines are intended to produce optimal health outcomes for patients, to minimize harm and to reduce inappropriate variations in clinical care. The evidence-based approach to guideline development requires the evidence supporting a policy be identified, appraised, and summarized and that an explicit link between evidence and statements be defined. Evidence-based statements reflect both the *grade (level) of aggregate evidence* and the *balance of benefit and harm* that is anticipated when the statement is followed. **Table 2** defines the grades of aggregate evidence[104] and **Table 3** defines the strength of action (obligation) based on the interaction of grade and benefit-harm balance.[105] "Treatment," "harm," "diagnosis," and "prognosis" refer to the types of evidence.

Development of KASs

KASs were developed following the 2 literature searches and the assessment of the evidence. The GDG proposed topics within the scope of the guideline supported by the evidence and where there is a perceived gap in care. A

Table 2. Grades of Aggregate Evidence

Grade	OCEBM level	Treatment	Harm	Diagnosis	Prognosis
A	1	Systematic review[a] of randomized trials	Systematic review[a] of randomized trials, nested case-control studies, or observational studies with dramatic effect[a]	Systematic review[a] of cross-sectional studies with consistently applied reference standard and blinding	Systematic review[a] of inception cohort studies[b]
B	2	Randomized trials, or observational studies with dramatic effects or highly consistent evidence	Randomized trials, or observational studies with dramatic effects or highly consistent evidence	Cross-sectional studies with consistently applied reference standard and blinding	Inception cohort studies[b]
C	3-4	Nonrandomized or historically controlled studies, including case-control and observational studies	Nonrandomized controlled cohort or follow-up study (post-marketing surveillance) with sufficient numbers to rule out a common harm; case-series, case-control, or historically controlled studies	Nonconsecutive studies, case-control studies, or studies with poor, nonindependent, or inconsistently applied reference standards	Cohort study, control arm of a randomized trial, case series, or case-control studies; poor quality prognostic cohort study
D	5	Case reports, mechanism-based reasoning, or reasoning from first principles			
X	n/a	Exceptional situations where validating studies cannot be performed and there is a clear preponderance of benefit over harm			

Adapted with permission from The Oxford Levels of Evidence 2 developed by the OCEBM Levels of Evidence Working Group.[104]
Abbreviation: OCEBM, Oxford Centre for Evidence-Based Medicine.
[a]A systematic review may be downgraded to level B because of study limitations, heterogeneity, or imprecision.
[b]A group of individuals identified for subsequent study at an early, uniform point in the course of the specified health condition, or before the condition develops.

Table 3. Strength of Action Terms in Guideline Statements and Implied Levels of Obligation

Strength	Definition	Implied obligation
Strong recommendation	A strong recommendation means the benefits of the recommended approach clearly exceed the harms (or, in the case of a strong negative recommendation, that the harms clearly exceed the benefits) and that the quality of the supporting evidence is high (Grade A or B). In some clearly identified circumstances, strong recommendations may be made based on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh the harms.[105]	Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present.
Recommendation	A recommendation means the benefits exceed the harms (or, in the case of a negative recommendation, that the harms exceed the benefits), but the quality of evidence is not as high (Grade B or C). In some clearly identified circumstances, recommendations may be made based on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits outweigh the harms.[105]	Clinicians should also generally follow a recommendation but should remain alert to new information and sensitive to patient preferences.
Option[a]	An option means that either the quality of evidence is suspect (Grade D) or that well-done studies (Grade A, B, or C) show little clear advantage to 1 approach versus another.[105]	Clinicians should be flexible in their decision making regarding appropriate practice, although they may set bounds on alternatives; patient preference should have a substantial influencing role.

Refer to Table 2 for definitions of evidence grades.
[a]Option resembles the "Weak Recommendation" utilized in the GRADE classification system: Grading of Recommendations Assessment, Development and Evaluation.

preliminary list of quality improvement topics was released for public comment. The resulting topics gathered from the public comment were ranked based on importance among the GDG members. In total, 57 topics were determined and ranked by the GDG prior to the first meeting. An explicit and transparent *a priori* protocol for creating actionable statements based on supporting evidence and the associated balance of benefit and harm was used. Electronic decision support software (BRIDGE-Wiz, Yale Center for Medical Informatics) was used to facilitate creating actionable recommendations and evidence profiles.[106]

After the KASs were derived, the workgroup debated the strength of the recommendation and the strength of evidence. The evidence-based approach to guideline development requires the evidence supporting a policy be identified, appraised, and summarized and that an explicit link between evidence and statements be defined. Evidence-based statements reflect both the *quality of evidence* and the *balance of benefit and harm* that is anticipated when the statement is followed. Therefore, the strength of recommendation was determined with an adapted version of the American Academy of Pediatrics classification scheme in **Table 3**.[105]

AAO-HNSF staff used the GuideLine Implementability Appraisal to appraise adherence to methodologic standards, to improve clarity of recommendations, and to predict potential obstacles to implementation.[107] The GDG received summary appraisals and modified an advanced draft of the guideline based on the appraisal. The final draft of the CPG was revised based on comments received during multidisciplinary peer review, open public comment, and journal editorial peer review. A scheduled review process will occur 5 years from publication, or sooner if new compelling evidence warrants earlier consideration.

Guidelines are not intended to supersede professional judgment, but rather may be viewed as a relative constraint on individual clinician discretion in a particular clinical circumstance. Less frequent variation in practice is expected for a "strong recommendation" than might be expected with a "recommendation." "Options" offer the most opportunity for practice variability.[108] Clinicians should always act and decide in a way that they believe will best serve their patient's interests and needs, regardless of guideline recommendations. They must also operate within their scope of practice and according to their training. Guidelines represent the best judgment of a team of experienced clinicians and methodologists addressing the scientific evidence for a particular topic.[105] Making recommendations about health practices involves value judgments on the desirability of various outcomes associated with management options. Values applied by the guideline panel sought to minimize harm and diminish unnecessary and inappropriate therapy. A major goal of the panel was to be transparent and explicit about how values were applied and to document the process.

Financial Disclosure and Conflicts of Interest

The cost of developing this guideline was covered in full by the AAO-HNSF. Potential conflicts of interest for all panel members in the past 2 years were compiled and distributed before the first conference call. After review and discussion of these disclosures,[109] the panel concluded that individuals with potential conflicts could remain on the panel if they: (1) reminded the panel of potential conflicts before any related discussion, (2) recused themselves from a related discussion if asked by the panel, and (3) agreed not to discuss any aspect of the guideline with industry before publication. Finally, panelists were reminded that conflicts of interest extend beyond financial relationships and may include personal experiences, how a panelist earns a living, and the panelist's previously established "stake" in an issue.[110] Conflicts were again delineated at the start of the in-person meeting and at the start of each teleconference meeting, with the same caveats followed. All conflicts are disclosed at the end of this document.

Guideline KASs

Each evidence-based statement is organized in a similar fashion: a KAS is in bold, followed by the strength of the recommendation in italics. Each KAS is followed by an "action statement profile" that explicitly states the quality improvement opportunity, aggregate evidence quality, level of confidence in evidence (high, medium, low), benefit, harms, risks, costs, and a benefits-harm assessment. Additionally, there are statements of any value judgments, the role of patient preferences, clarification of any intentional vagueness by the panel, exceptions to the statement, any differences of opinion, and a repeat statement of the strength of the recommendation. Several paragraphs subsequently discuss the evidence supporting the statement. An overview of each evidence-based statement in this guideline can be found in **Table 4**.

For the purposes of this guideline, *shared decision-making* refers to the exchange of information regarding treatment risks and benefits, as well as the expression of patient preferences and values, which result in mutual responsibility in decisions regarding treatment and care.[111]

Statement 1: Screening for Hearing Loss

Clinicians should screen patients aged 50 years and older for hearing loss at the time of a health care encounter.

Evidence Strength: *Recommendation based on 1 RCT and multiple observational studies with a preponderance of benefit over harm.*

Action Statement Profile: 1

- *Quality improvement opportunity*: Promote efficiency and effectiveness of early identification of ARHL among adults

  (National Quality Strategy Domain: Coordination of Care)
- *Aggregate evidence quality*: Grade C, based on 1 RCT and observational studies
- *Level of confidence in the evidence*: High
- *Benefits*: Promotes earlier identification of hearing loss; supports early and time-appropriate intervention; enrolls patients into appropriate pathway to care; aids communication and health care interaction in "real-time" with patient and family/care partner; provides opportunity for patient education and counseling; improves patient and family/care partner awareness of hearing and importance in functioning in daily life; raises clinician awareness of prevalence and impact of hearing loss on health and health care; aids prevention of adverse events and improves patient safety; normalizes and increases acceptance of hearing loss
- *Risks, harms, costs*: Time spent and financial impact on clinicians and patients including cost of equipment, additional training and possible additional staff for screening; stigma of hearing loss combined with age; false positives causing stress, false negatives missing hearing loss and true positives causing stress and anxiety; screening fatigue and potentially increased demand of resources such as audiology services, provider education on screening, and downstream services that may be needed
- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: Identifying hearing loss by screening is critical to prevent harmful effects of untreated hearing loss. Despite limited literature on screening, there is preponderance of evidence supporting early treatment of hearing loss to prevent harmful effects of untreated hearing loss
- *Intentional vagueness*: Type, method, setting, and timing of screening was not delineated. Hearing impairment can impact any health care encounter
- *Role of patient preferences*: Limited
- *Exceptions*: Known hearing loss
- *Policy level*: Recommendation
- *Differences of opinion*: GDG was divided on the best term to use to describe the evaluation of hearing: assessing versus screening patients.

Supporting Text

The purpose of this KAS is to ensure that patients aged 50 and above are screened for hearing loss at the time of a health care encounter. Despite age being the strongest predictor of hearing loss in adults,[112] there is a growing prevalence of underdiagnosed and undertreated hearing loss,[1,112] which can lead to increased risk of frailty, depression, cognitive decline and higher health care costs.[112,113] Current estimates of hearing loss screening practices indicate that 17% of physicians conduct screening

Table 4. Summary of Guideline KASs

Statement	Action	Strength
KAS 1: Screening for hearing loss	Clinicians should screen patients aged 50 years and older for hearing loss at the time of a health care encounter.	Recommendation
KAS 2: Ear exam and other ear conditions	If screening suggests hearing loss, clinicians should examine the ear canal and tympanic membrane with otoscopy or refer to a clinician who can examine the ears for cerumen impaction, infection, or other abnormalities.	Recommendation
KAS 3: Sociodemographic factors and patient preferences	If screening suggests hearing loss, clinicians should identify sociodemographic factors and patient preferences that influence access to and utilization of hearing health care.	Recommendation
KAS 4: Hearing test	If screening suggests hearing loss, clinicians should obtain or refer to a clinician who can obtain an audiogram.	Strong recommendation
KAS 5: Identifying conditions other than ARHL	Clinicians should evaluate and treat or refer to a clinician who can evaluate and treat patients with significant asymmetric hearing loss, conductive or mixed hearing loss, or poor word recognition on diagnostic testing.	Recommendation
KAS 6: Patient education and counseling	Clinicians should educate and counsel patients with hearing loss and their family/care partner(s) about the impact of hearing loss on their communication, safety, function, cognition, and quality of life.	Recommendation
KAS 7: Communication strategies and assistive technologies	Clinicians should counsel patients with hearing loss on communication strategies and assistive listening devices.	Recommendation
KAS 8: Amplification	Clinicians should offer, or refer to a clinician who can offer, appropriately fit amplification to patients with ARHL.	Strong recommendation
KAS 9: Candidacy for cochlear implants	Clinicians should refer patients for an evaluation of cochlear implantation candidacy when patients have appropriately fit amplification and persistent hearing difficulty with poor speech understanding.	Strong recommendation
KAS 10: Assessing goals and improvement	For patients with hearing loss, clinicians should assess if communication goals have been met and if there has been improvement in hearing-related quality of life at a subsequent health care encounter or within 1 year.	Recommendation
KAS 11: Retesting	Clinicians should assess hearing at least every 3 years in patients with known hearing loss or with reported concern for changes in hearing.	Option

Abbreviations: ARHL, age-related hearing loss; KAS, key action statement.

only when patients report perceived hearing loss and 12% conduct screening during annual health maintenance appointments.[112] Several barriers to routine hearing screening described by clinicians include lack of knowledge, time, screening resources, and reimbursement.[112,114]

This CPG used the age cutoff of 50 years to align with the USPSTF guidelines as well as the ASHA.[112,114,115] The literature regarding evaluation of hearing describes screening (determining need for further evaluation) and diagnostic assessment (establishing type and degree of hearing loss) as 2 distinct entities.[112,115,116] As such, this KAS statement focuses solely on screening. Previously, the 1996 USPSTF guidelines on hearing loss screening did recommend periodically asking patients regarding hearing loss, counseling regarding hearing aid availability, and making referrals as appropriate.[115] The USPSTF updated their guidelines in 2021 conveying that the balance of benefits and harms of screening for hearing loss could not be determined given lack of related evidence.[114] This conclusion was unchanged from the USPSTF 2012 statement.[115]

The current literature review identified 1 RCT, the Screening for Auditory Impairment-Which Hearing Assessment Test, which evaluated hearing loss screening, that described the effect of hearing screening on treatment of hearing loss with hearing aids. This study enrolled 2305 male veterans aged 50 and older to compare hearing loss treatment outcomes among 3 screening modalities: (i) Handheld tone-emitting otoscope, (ii) Hearing Handicap Inventory for the Elderly-Screening version (HHIE-S), and (iii) combined handheld audiometry and HHIE-S. All participants, including the control group with no screening, underwent self-assessment questionnaires regarding their hearing and general health. The main study

outcome, rate of hearing aid use 1 year post screening, was higher in the handheld audiometry (6.3%) and the combined arms (7.4%) compared with the control group (3.3%). There was no statistically significant difference between the control group (3.3%) and the HHIE-S (4.1%) group. The HHIE-S and combined screening groups had the highest percentage of positive screens[117] with all 3 screening arms seeing significantly more positive screen referrals to audiology than the control group with the tone emitting otoscope group being the most efficient.[116] Limitations of this study include recruitment bias (73.5% participants had perceived hearing loss at baseline) and the lack of generalizability (the study was conducted in the Veterans Administration health system with 94% of participants male).

Another study among adults aged 55 or older within primary care clinics demonstrated how electronic medical record (EMR)-based prompts have the potential to promote hearing screening and improve utilization of hearing health care. Simple prompts for providers to address with patients, that is, "do you have difficulty with your hearing?," can increase referrals to audiologists for diagnostic testing (2.2%–10.7%).[1] Of those referred, 43% saw an audiologist, of whom 59% were deemed hearing aid candidates.[109] Patients who additionally completed the HHIE-S and who screened positive on this questionnaire had a higher rate of referrals (28%).[1] Audiologists rated 93.3% of referrals as being appropriate with 85.5% of referred patients identified with hearing loss. Of note, 71.5% of patients contacted after referral felt they were appropriately referred.[1]

Harms related to hearing screening are minimal, given its noninvasive nature.[114] Potential harms of screening include the negative stigma of hearing loss, false positives (and related unnecessary testing), and treatment anxiety; however, there is a paucity of research demonstrating these potential harms.[114,115,117] While cost is often cited as a potential barrier of conducting screening, a scoping review of 9 databases on hearing loss screening in adults aged 50 or older identified 5 studies reporting hearing loss screening to be cost effective, irrespective of screening modality. Earlier age at screening, more frequent screening, single-stage screening, and internet-based screening were all found to be factors supporting screening cost effectiveness based on quality adjusted life years. Of note, 4 out of these 5 studies were done outside of the United States and all 5 studies showed significant variation in research methodology, hearing loss definitions, as well as screening modalities.[112]

In addition to a low-risk of harm from the testing, hearing screening promotes increased audiology referrals and subsequent hearing aid use, which, in turn, has been shown to decrease depression and social isolation while improving QOL.[116] The justification for screening for ARHL is based on the following criteria: (i) there is a significant burden of disease for ARHL to justify related efforts, (ii) efficacious treatments are available for ARHL identified via screening, (iii) natural history of ARHL allows for sufficient time for intervention, and (iv) accurate and practical screening tools are available.[116]

Numerous modalities of hearing screening are available (**Table 5**). Some tests such as whispered voice, finger rub, watch tick, and tuning fork tests are inexpensive and easily administered, yet have been questioned for accuracy and operator dependency.[114,115,118] Patient questionnaires, both single-item and longer, for example, the HHIE-S, the Self-Assessment of Communication, its modified forms including the Revised Hearing Health Inventory (RHHI) and RHHI-S (Revised Hearing Health Inventory—Screening), and the Revised Quantified Denver Scale of Communications-Short version are available to screen for perceived hearing loss.[115,118-122]

Objective, technology-based hearing loss screens, for example, audioscope and tablet or phone app-based screening tools have been introduced in recent decades. A 2021 study identified 44 unique smartphone-based hearing screening apps and reported that these apps are widely accessible and affordable; however, only 7 (16%) had associated validation studies. Additional challenges include app variability, data security and lack of user-centered design (accounting for cognitive, vision and dexterity impairments).[123] Recently, an RCT has described computerized, self-administered hearing screening tools: automated audiogram (AMTAS), 4 frequency pure tone screen (FFS), and digits in noise (DIN). The use of these modalities significantly increased follow-up for diagnostic testing. Patients screening positive with FFS resulted in higher rates of subsequent diagnostic testing than those screened with AMTAS and DIN.[124]

While hearing screening in general is considered to accurately approximate hearing loss in older adults, the variable threshold for defining degree of hearing loss by different studies makes it challenging to compare relative accuracy of the various hearing screen modalities. These modalities also vary in cost, time efficiency, and complexity.[115,117]

There is no consensus regarding the optimal frequency of hearing screening although ASHA recommends screening every 3 years after age 50 and screening at annual clinician visits has been suggested.[118] The World Health Organization (WHO) recommends screening every 5 years for ages 50 to 65 and every 1 to 3 years after age 65.[125]

Statement 2: Ear Exam and Other Ear Conditions

If screening suggests hearing loss, clinicians should examine the ear canal and tympanic membrane with otoscopy or refer to a clinician who can examine the ears for cerumen impaction, infection, or other abnormalities.

Evidence Strength: *Recommendation based on RCTs, cohort studies, and expert opinion with a preponderance of benefit over harm.*

Table 5. Screening Options

Type of test	Method	Description	Advantages	Disadvantages	Supporting documentation and reference
History	Medical provider inquiring about perceived hearing loss—"Do you have difficulty with your hearing?"	To occur at the time of a health care encounter	-Relatively quick	-Dependent upon patient's perception of own hearing status -Dependent upon clinician inquiring independent of patient's chief complaint	1996 USPSTF recommends periodically asking patients regarding hearing loss[115]
Electronic medical record based best practice alerts	EMR prompt for inquiry on perceived hearing loss	Best practice alert with single-question prompt—"Do you have difficulty with your hearing?"	-Automatic prompting for inquiry -Relatively quick	-Dependent upon patient's perception of own hearing status -Screening fatigue (both from patient perspective and with prompting alert in EMR from provider perspective)	Zazove and Plegue[1]
Questionnaire	HHIE	25-item questionnaire intended to identify the problems being caused by an individual's hearing loss Score potential: 0-100	-Inexpensive -Positive screen related to higher rate of referrals to hearing health specialist	-Increased time requirement vs single-question screening	Zazove et al[1]
Questionnaire	HHIE-S	10-item questionnaire intended to identify the problems being caused by an individual's hearing loss Score potential: 0-40	-Inexpensive -Positive screen related to higher rate of referrals to hearing health specialist -Relative decreased time requirement vs HHIE	-Lower sensitivity (under-reports hearing loss specifically in comparison to single-question screening) -Increased time requirement vs single-question screening	Zazove et al[1] Gates and Mills[72]
Questionnaire	SAC	10-item questionnaire intended to classify an individual's communication difficulties associated with hearing loss Score potential: 10-50	-Relatively quick -Inexpensive	-Dependent upon patient's perception of own hearing status	Schow[121]
Questionnaire	RQDS	5-item questionnaire designed to measure communication difficulties in adults with hearing impairment	Relative decreased time requirement compared to the longer 25-question Quantified Denver Scale, but just as reliable	-Not as sensitive as the HHIE-S	Tuley et al[122]
Screening testing (clinician administered)	Handheld tone emitting otoscope	Typically 5-6 specified tones emitted	-Increased objectivity vs questioning -Efficient	-Cost of equipment (although relatively low)	Hsu et al[112] Yueh et al[116]
Audiometry	Screening audiogram	The standard screening audiometer tests at 1, 2 and	-Practical -Cost effective for detecting significant hearing loss	-Cost of equipment (although relatively low)	Gates and Mills[72]

Table 5. (continued)

Type of test	Method	Description	Advantages	Disadvantages	Supporting documentation and reference
		3 kHz at intensity levels of 25, 40, and 60 dB	-Can be administered by trained office personnel -Well accepted by patients		
Physical exam	Whispered voice	Clinician standing behind patient whispers words to patient (ie, number-letter-number combination)	-Increased objectivity vs questioning -High sensitivity	-Operator dependent-Imprecise	Krist et al[114] Gates and Mills[72]
Physical exam	Finger rub	With patient's eyes closed the examiner should instruct the patient to acknowledge hearing the gentle rubbing of the examiner's fingers approximately 3-4 in from each ear	-Increased objectivity vs questioning -High specificity	-Operator dependent -Low sensitivity -Imprecise	Krist et al[114] Gates and Mills[72]
Physical Exam	Watch tick test	Observation of the patient's ability to hear the ticking of a watch at a specific distance	-Increased objectivity vs questioning -High specificity	-Operator dependent -Low sensitivity -Rough and basic test -Many modern watches no longer audibly tick	Krist et al[114] Moyer[115]
Automated hearing screening	AMTAS	A computer-assisted, automated method for obtaining a screening hearing test	-Patient administered or can be administered by a nonaudiologist in clinical setting -Increased objectivity from previous categories	-Cost -Limited availability	Folmer et al[124]
Automated hearing screening	FFS	Testing for participant responses at 4 frequencies (ie, 1, 2, 4, 8 kHz)	-Patient administered or can be administered by a nonaudiologist in clinical setting -Increased objectivity vs previous categories	-Cost -Limited data (sensitivity and specificity) availability	Folmer et al[124]
Automated hearing screening	DIN	Testing speech recognition thresholds in the presence of noise	-Potentially more reflective of a person's functional hearing ability in real-life situations[124] -Patient administered or can be administered by a nonaudiologist in clinical setting -Increased objectivity vs previous categories	-Cost -Limited data (sensitivity and specificity) availability	Folmer et al[124]

(*continued*)

Table 5. (continued)

Type of test	Method	Description	Advantages	Disadvantages	Supporting documentation and reference
Screening testing (patient administered) - Smartphone application	Smartphone hearing screening application	Multiple options of downloadable smartphone hearing screening applications each with varying degrees of individual instruction for use	-Cost-effective -Accessible -Increased individual interest in self-administered screening options with recently passed OTC hearing aid act	-App variability -Data security -Lack of user-centered design (accounting for cognitive, vision and dexterity impairments).	Irace et al[123]

Abbreviations: AMTAS, automated audiogram; DIN, Digits in Noise; EMR, electronic medical record; FFS, frequency pure tone screen; HHIE, Hearing Handicap Inventory for the Elderly; HHIE-S, Hearing Handicap Inventory for the Elderly-Screening version; RQDS, Revised Quantified Denver Scale of Communications-Short version; SAC, Self-Assessment of Communication; USPSTF, US Preventive Services Task Force.

[a]Overall, harms related to hearing screenings are rare, given the noninvasive nature of hearing screens.[114]

Action Statement Profile: 2

- *Quality improvement opportunity*: Identify and treat correctable causes of hearing loss (National Quality Strategy Domain: Coordination of Care, Patient Safety)
- *Aggregate evidence quality*: Grade B, based on CPGs, randomized controlled trials, cohort studies, and expert opinion
- *Level of confidence in the evidence*: High
- *Benefits*: Identify medical and/or correctable causes of hearing loss; prevent unnecessary referrals and guide appropriate referrals; possible time or cost saving from obviating need for unproductive care; allow earlier intervention for reversible causes of hearing loss
- *Risks, harms, costs*: Possible additional time or financial expense to clinician or patient, cost of equipment; additional training or staff involved in exams; incorrect diagnosis could cause distress; missed diagnosis by inexperienced personnel could give false assurances; accurate diagnosis could also cause stress, distress, or anxiety
- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: Examining the ear is low-risk and can identify medical conditions; therefore, it is an important part of assessing patients who screen positive for hearing loss
- *Intentional vagueness*: The type of the clinician examining the patient, the type and elements of the examination, and the equipment being used to conduct the examination
- *Role of patient preferences*: Limited
- *Exceptions*: None
- *Policy level*: Recommendation
- *Differences of opinion*: None

Supporting Text

The purpose of this statement is to encourage clinicians, when allowed by the scope of their practice, to examine the ears of patients whose hearing screening suggests hearing loss. An ear examination can reveal correctable causes of hearing loss and allow earlier intervention.[126,127] Disorders in the canal, tympanic membrane, or middle ear structures can cause CHL, which are often reversible. These conditions of the ear are distinct from sensorineural causes, yet may worsen the overall severity of hearing loss. Therefore, an ear examination is a key initial step in the assessment of hearing loss.

Several disorders involving the ear canal can affect hearing. For example, excessive cerumen or cerumen impaction can cause hearing loss.[127,128] Cerumen impaction is more common in older adults.[129] Obstructive cerumen should be completely removed to allow adequate conduction of sound through the external auditory canal

(EAC) and to facilitate a full view of the tympanic membrane.[72,128]

Other disorders that can affect the ear canal and hearing include otitis externa, otorrhea, canal cholesteatoma, foreign bodies, granulation tissue, or structural abnormalities such as stenosis, atresia, or large exostoses.[127,130] If an abnormality is identified, it should be addressed, medically or surgically, or referred to an appropriate clinician to address.[131]

Abnormalities of the tympanic membrane or middle ear may also contribute to an abnormal hearing screen. Perforation of the tympanic membrane, tympanosclerosis, or retraction of the tympanic membrane can compound ARHL severity.[127,130] There are numerous middle ear conditions that may cause CHL, such as chronic suppurative otitis media with or without cholesteatoma, chronic otitis media with effusion, ossicular erosion, otosclerosis, tympanosclerosis, or neoplasms.[127,130] An ear exam allows the clinician to detect the presence of external and middle ear conditions and to recommend treatment for appropriate medical and surgical care.

If a reversible cause of hearing loss is identified and treated in the same visit, access to care is improved while reducing unnecessary referrals. Furthermore, if the exam reveals a reversible cause of hearing loss that requires specialized treatment, a referral to the appropriate clinician can be made. Finally, addressing correctable disorders of the ear such as cerumen impaction or infection is often necessary prior to managing ARHL.

Statement 3: Sociodemographic Factors and Patient Preferences

If screening suggests hearing loss, clinicians should identify sociodemographic factors and patient preferences that influence access to and utilization of hearing health care.

Evidence Strength: *Recommendation based on randomized trials, SRs, database analyses, cross-sectional surveys, and qualitative or mixed methods studies with a preponderance of benefit over harm.*

Action Statement Profile: 3

- *Quality improvement opportunity*: Recognize how social determinants of health (SDOH) relate to ARHL and use data on sociodemographic factors and patient preference to address barriers to access and utilization of hearing health care
  (National Quality Strategy Domain: Coordination of Care, Person- and Family-Centered Care)
- *Aggregate evidence quality*: Grade C, based on studies including large databases, retrospective case control, prospective cohort studies, SRs, and observational studies of limited quality
- *Level of confidence in the evidence*: High
- *Benefits*: Advocacy for the patient and to influence policy change, identify barriers to access, alignment with patient preferences, shared decision making, promote equity of care, alleviate stigma of hearing loss, improve communication, educate, and counsel patients and family/care partners on resources
- *Risks, harms, costs*: Time; potential exposure of personal details; inability to mitigate barriers; family/care partner, patient, and clinician's frustration with inability to mitigate barriers; generating or worsening bias based on identifying these factors that can impact patient treatment; antagonizing or offending patient
- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: Understanding sociodemographic factors and patient preferences is important to ensuring adequate hearing health care
- *Intentional vagueness*: Which sociodemographic factors are being queried and how the assessment is to be done
- *Role of patient preferences*: Limited
- *Exceptions*: None
- *Policy level*: Recommendation
- *Differences of opinion*: None

Supporting Text

The purpose of this statement is to encourage physicians to identify sociodemographic factors and patient preferences that influence access to and utilization of hearing health care and to document the discussion in a health care encounter.

Despite advances in treating hearing loss, marked disparities exist in access to and utilization of hearing health care.[132,133] There is a lower prevalence of hearing aid use and CI among older adults from lower socioeconomic positions and from certain racial or ethnic groups. SDOH encompass the social, economic, and environmental conditions that influence an individual's health and well-being. In the context of ARHL, SDOH can impede access to appropriate care.[134] Socioeconomic status, education level, cultural background, housing conditions, and social support networks can all influence subjective experience of hearing loss and ability to seek or adhere to treatment. Environmental or occupational conditions, such as excessive noise exposure, can compound ARHL. Most data collected on hearing health care in racial and ethnic groups reflect individual patient characteristics and outcomes, and fewer data are available on the contextual factors and system-level influences that can influence access and outcomes related to hearing health. Nonetheless, identifying SDOH allows clinicians to address the broader challenges that patients may face related to hearing, such as social isolation, communication difficulties, mental health concerns, and lifestyle adjustments. This perspective allows for more effective interventions that address the circumstances of each patient.

Understanding the social context of hearing loss involves understanding the conditions in which people live and work as well as their age. For example, information on patients' living conditions, work environments, and recreational settings can reveal opportunities to mitigate noise exposure. Understanding socioeconomic context can also reveal barriers to accessing hearing health care services, such as financial constraints, limited insurance coverage, attitudes toward health care, or difficulty with transportation. Lack of insurance coverage and cost of health care play significant roles in limiting access to hearing health care and hearing aids[135-137] and has been linked to lower utilization of hearing aids in Hispanic/Latinx adults.[136] Neighborhoods without engagement between clinical teams and community members also face greater obstacles to CI.[138] Community engagement can improve uptake and adherence of hearing services.[139-141]

Education level, health literacy, and trust in the health care system are also factors that can influence hearing health.[134] Lower educational attainment is associated with lower hearing aid use and poorer outcomes after CI.[142-144] Furthermore, low health literacy reduces understanding of health care information and is associated with poorer health outcomes and utilization of health care services.[145,146] Social supports and education level shape both how adults access hearing health care services and adherence to hearing aid usage.[147,148] Engaged patients who understand their condition are more likely to actively participate in problem-solving, decision-making, and acceptance of treatments for hearing loss. In addition, lack of trust or prior negative experiences with the health care system can be barriers in accessing and utilizing health care.[149] Limited race concordance between patients and clinicians may accentuate these barriers.[150-152]

It is recommended that the clinician document sociodemographic factors and patient preferences. This can involve the use of standardized tools; for example, a structural vulnerability questionnaire and assessment tool can aid in identifying limitations across domains of financial security, residence, risk environments, food access, social network, legal status, and education.[153]

Recognizing patients' treatment preferences promotes patient-centered hearing health care. Preferences can vary based on cultural norms, personal beliefs, and individual values. For example, some patients may prefer hearing aids as a primary intervention, while others may favor other assistive devices or communication strategies. Although cost and quality are commonly cited concerns for patients, stigma associated with hearing loss is another major factor in adherence. Perceptions of stigma linked to individual, cultural, and community identity can influence hearing health care usage and outcomes.[154,155] Such views influence the decision making of individuals with hearing loss,[156] and patients may prioritize less conspicuous or more expensive hearing options or no hearing aid. Therefore, involving patients in decisions can support a sense of ownership and control. Understanding patient preferences allows clinicians to tailor care, which increases acceptance, adherence, and overall satisfaction. Attention to sociodemographic factors and preferences can thus reduce disparities and improve overall hearing health outcomes.

Statement 4: Hearing Test

If screening suggests hearing loss, clinicians should obtain or refer to a clinician who can obtain an audiogram.

Evidence Strength: *Strong recommendation based on randomized controlled studies and SRs with a preponderance of benefit over harm.*

Action Statement Profile: 4

- *Quality improvement opportunity*: Identification of degree and type of hearing loss allows for appropriate intervention for the management of hearing loss
  (National Quality Strategy Domain: Prevention and Treatment of Leading Causes of Morbidity and Mortality)
- *Aggregate evidence quality*: Grade A for the accuracy of audiograms with diagnosing hearing loss, based on multiple RCTs and SRs; Grade B for use of app-based testing, online testing, tablet-based testing, and other objective modalities, based on large variations in cross-sectional studies and limited RCTs
- *Level of confidence in the evidence*: High for audiograms, moderate for other modalities
- *Benefits*: Earlier identification of severity of hearing loss; support early and time-appropriate intervention; enroll patients into appropriate pathway to care; aid communication and health care interaction in "real-time" with patient and family/care partner; provide opportunity for patient education and counseling; improve patient and family/care partner awareness of hearing and importance in functioning in daily life; provide ability for clinician awareness of impact and prevalence of hearing loss on health care; prevention of adverse events and improving patient safety; normalization and acceptance of hearing loss validation of disability for the patient and family/care partner
- *Risks, harms, costs*: Time; financial impact on clinicians and patients; cost of equipment; additional training and possible additional staff for screening; stigma of hearing loss combined with age; false positives causing stress or distress; false negatives missing hearing loss; increased demand of resources such as audiology services; true positives causing stress; distress; anxiety; provider education on screening; and downstream services that may be needed

- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: Pure tone audiometry (PTA) is the gold standard and it is critical to know the severity and type of ear-specific hearing loss to be able to provide guidance and further care. While access to audiometric testing may be limited, when possible, this is the gold standard and should be completed.
- *Intentional vagueness*: None
- *Role of patient preferences*: Moderate
- *Exceptions*: None
- *Policy level*: Strong recommendation
- *Differences of opinion*: While the GDG agreed that an audiogram is the gold standard, some felt that the CPG should specify the different components in a comprehensive evaluation, whereas others felt that the CPG should allow for other forms of hearing reassessments, including app-based and online testing, to encourage better access to hearing testing.

Supporting Text

The purpose of this statement is to prompt clinicians to obtain or refer patients with suspected ARHL for an audiogram.

Patients presenting with suspected ARHL should undergo audiometric evaluation. Distinguishing types and severity of hearing loss requires a comprehensive diagnostic evaluation. Comprehensive diagnostic testing should include the following components: the measurement of pure tone thresholds, speech audiometry, tympanometry, and acoustic reflex testing. PTA is considered the gold standard for detecting hearing loss.[157-159] PTA is a widely used and reliable tool used to measure hearing sensitivity through 2 pathways, bone conduction and air conduction.[160] It establishes the pattern of hearing loss at various frequencies, differentiates the degree (mild, moderate, severe, or profound), and configuration of the hearing loss.[160] PTA is considered a low-risk, low-cost diagnostic test that can inform a diagnosis, symptom etiology or pathophysiology, and direction for appropriate treatment.[161,162] PTA can be repeated and compared to previous testing to monitor for changes in hearing loss.[160]

There can be limitations with obtaining PTA. Due to critical workforce shortages in the United States, 56.6% of US counties do not have access to audiologists, and lower-income and older adults are disproportionately affected. Older adults may also have difficulty completing audiometric testing in the setting of cognitive dysfunction. Testing variations can also influence the results as pure-tone thresholds can vary slightly with different transducers and their placement. Standard diagnostic test-retest variability in adults fluctuates typically by ±5 dB across frequencies.[160,163]

When access to PTA is not available, evaluation may be obtained by online, computer-based hearing screening, or by a smartphone app. These newer technologies offer an alternate for screening for hearing loss and testing.[123] Pure tone and word recognition are the most common types of online hearing tests. Online hearing tests (home hearing tests) can only detect the degree of hearing loss, whereas an in-person hearing test conducted by a hearing professional can distinguish between different types of hearing loss. Among patients with previous experience with hearing tests, online digital audiometry has been demonstrated as a clinically accurate method for hearing assessment indicating that the air and bone conduction thresholds measured using the online digital audiometer are no different from those obtained using a conventional audiometer (96%–100% test agreement).[164] The home hearing test is an accurate and cost-effective method of establishing pure tone conduction threshholds when compared to manual audiometery.[165] Remote diagnostic testing for hearing loss, compared with in-person diagnostic PTA, is reported to have an 87%–100% sensitivity and 60%–90% specificity.[166] Audiometric app technology utilizes smartphones or tablets for hearing screening in settings where access to in-office audiometric testing may not be readily available. The disadvantages to online hearing evaluation include lack of standards for headphone or earphone calibration, misinterpretation of the results, lack of professional medical advice, and the need for a reliable internet connection.[167] An online hearing test cannot ensure optimal listening conditions (ie, a sound-controlled booth) for a reliable test and there are limitations for a true medical diagnosis. Advantages to online hearing evaluation for the patient are that it may be free, convenient, and less intimidating than in-person assessments.[167] Such technology promotes free diagnostic hearing testing to the public and promotes health awareness of hearing loss. However, limitations include wide variability in app features, lack of validation for the majority of apps, and lack of user-centered designs for older adults.

Overall, this KAS stresses the importance of further evaluating the suspected hearing loss with audiometric testing. While a referral for an audiogram is the gold standard for hearing loss evaluation in any patient with suspected hearing loss, alternative testing methods such as online, computer-based testing or other technologies may be utilized for patients with limited access to audiologic services or limited testing ability.

Statement 5: Identifying Conditions Other Than ARHL

Clinicians should evaluate and treat or refer to a clinician who can evaluate and treat patients with significant asymmetric hearing loss, conductive or mixed hearing loss, or poor word recognition on diagnostic testing.

Evidence Strength: *Recommendation based on 1 RCT for sudden SNHL, and multiple observational studies with a preponderance of benefit over harm.*

Action Statement Profile: 5

- *Quality improvement opportunity*: Identify and treat conditions that can complicate the management of ARHL
  (National Quality Strategy Domain: Patient Safety, Coordination of Care)
- *Aggregate evidence quality*: Grade C, based on evidence for the effectiveness of treating these conditions and harms associated with failure to treat including a randomized trial for sudden hearing loss and numerous observational studies demonstrating treatment effect
- *Level of confidence in the evidence*: High
- *Benefits*: Identify other treatable causes of hearing loss; identify situations where hearing loss requires medical/surgical management; more appropriate referrals to specialists; increase provider awareness
- *Risks, harms, costs*: Time to see additional providers; cost of additional visits; patient anxiety
- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: Primary care providers need better guidance on when to refer patients with hearing loss
- *Intentional vagueness*: What defines "asymmetry" and "poor" discrimination will be discussed further in the subtext
- *Role of patient preferences*: Limited
- *Exceptions*: None
- *Policy level*: Recommendation
- *Differences of opinion*: Some members of the group wanted to specify that this should be a referral to an otolaryngologist. The GDG elected to keep it slightly vague to allow for different referrals that could be appropriate based on what is available locally

Supporting Text

The purpose of this statement is to identify or refer to a clinician who can evaluate for conditions that may coexist with ARHL and complicate the identification and management of ARHL. There are 3 types of hearing loss depending on which part of the auditory anatomy is affected: conductive, sensorineural, and mixed. Mixed hearing loss includes both CHL and SNHL. The key to management of hearing loss is correcting medically treatable causes and identifying the type and cause of hearing loss that is atypical of ARHL.[168] ARHL should be symmetric—both ears should exhibit similar degrees of hearing loss. Additionally, poor word recognition is generally considered when the unaided monosyllabic word score is less than or equal to 60%.[169]

CHL

First, CHL occurs when there is pathology in the EAC or middle ear that blocks conduction of sound from reaching the inner ear. Examples of EAC obstruction include cerumen, foreign body, stenosis, and atresia. Middle ear pathologies include tympanic membrane perforation,[170] middle ear effusion, cholesteatoma, or ossicular discontinuity or fixation such as otosclerosis.[171] Rarely, inner ear anomalies can cause a CHL, such as a mobile third window, as seen in superior canal dehiscence.[172] All these conditions can potentially be corrected with intervention, and, therefore, should be referred to an otolaryngologist for further evaluation.[161]

SNHL

The second type of hearing loss is SNHL in which the inner ear, cochlear nerve, or higher central auditory centers are affected. ARHL is 1 example of this kind of hearing loss along with noise-induced hearing loss and idiopathic sudden SNHL (SSNHL). SSNHL, hearing loss that occurs rapidly within 72 hours, is an otologic emergency covered in an independent CPG by the AAO-HNSF.[173] Initially, patients should be educated and can be offered steroids as soon as possible.[173] For treatment failures and/or patients presenting between 2 and 6 weeks after onset, intratympanic steroid therapy should be offered. All patients should have an evaluation to rule out retrocochlear pathology such as a vestibular schwannoma or meningioma.[174] In addition, autoimmune inner ear disease, infections such as Lyme, syphilis, and human immunodeficiency virus can also result in SSNHL. The patient's history and physical exam may warrant further blood and lab testing and subsequent treatment.[175]

Identification and management of hearing loss that is atypical of ARHL is just as important as identification of ARHL. ARHL should be symmetric—both ears exhibit similar degrees of hearing loss. Cases of asymmetric sensorineural hearing loss (ASNHL) warrant further evaluation. There are several definitions of ASNHL summarized in **Table 6**.[176]

Workup of ASNHL may include radiographic imaging and directed labs. The standard work-up for a patient presenting with ASNHL often includes a MRI of the internal auditory canals to exclude retrocochlear pathology, such as a vestibular schwannoma or meningioma.[181] If history of head trauma is elicited prior to the onset of the ASNHL, computed tomography of the temporal bone may be useful to evaluate fractures or anatomic abnormalities involving the inner ear structures.[182] Serological tests should only be ordered if a condition is suspected by history.[183] Despite the extensive and costly testing algorithm available, in the majority of cases, the etiology of the ASNHL remains unclear.

Statement 6: Patient Education and Counseling

Clinicians should educate and counsel patients with hearing loss and their family/care partner(s) about the impact of hearing loss on their communication, safety, function, cognition, and quality of life.

Table 6. Asymmetric Sensorineural Hearing Loss Definition

Definition of asymmetric sensorineural hearing loss	Source
≥15 dB HL at 2 or more frequencies, or ≥15% difference in speech recognition score	Cueva[177]
≥15 dB HL at 3000 Hz	Saliba et al[178]
≥20 dB HL at 2 contiguous frequencies, or ≥15 dB HL at any 2 frequencies between 2000 Hz and 8000 Hz	Gimsing[179]
≥10 dB HL at 2000 Hz for those with history of loud noise exposure (ie, military)	Tolisano et al[180]

Abbreviations: dB HL, decibels hearing level, which is defined as the level at which sounds need to be in order to be heard by the patient; Hz, Hertz, frequency of the sound being tested.

Evidence Strength: *Recommendation based on numerous MAs of prospective cohorts, cross-sectional studies, SRs, and 1 RCT with a preponderance of benefit over harm.*

Action Statement Profile: 6

- *Quality improvement opportunity*: Promotion of education of the impact of ARHL on patient-centered outcomes
  (National Quality Strategy Domain: Patient Safety, Person- and Family-Centered Care, Coordination of Care, Prevention and Treatment of Leading Causes of Morbidity and Mortality, Health and Well-Being of Communities)
- *Aggregate evidence quality*: Grade B, based on numerous MAs of prospective cohorts, cross-sectional studies, SRs, and 1 RCT regarding the impact of hearing loss on these domains, but there is very little data on the benefits of counseling specifically
- *Level of confidence in the evidence*: Medium, as we are combining multiple domains (evidence strength varied for safety, communication and QOL)
- *Benefits*: Empower patients to adapt to their ARHL including communication within their family; promote adherence to hearing amplification and support may be increased; provide an opportunity for improved health care communication
- *Risks, harms, costs*: Time for counseling, time required for clinicians to be educated on the topic; create anxiety regarding the risk of cognitive decline; risk of family discord if there are differences of opinion among the patient and their family/care partner
- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: None
- *Intentional vagueness*: None
- *Role of patient preferences*: Limited
- *Exceptions*: None
- *Policy level*: Recommendation
- *Differences of opinion*: None

Supporting Text

The purpose of this statement is to ensure clinicians provide patients and their family/care partner(s) with education and counseling on the impact of hearing loss on their communication, safety, function, cognition, and QOL.

Communication

ARHL impacts communication abilities by limiting what a patient hears and understands. Thus, ARHL can impact patients' relationships at home, professional communication, and their ability to communicate in public and effectively communicate in the health care system (patients may not understand what is being said to them). ARHL is often overlooked by clinicians in clinician–patient communication[184] and can have adverse effects on clinician–patient communication in various health care settings, including hospitals.[185]

Safety

Hearing is essential for situational awareness and, thus, ARHL may increase the risk of safety issues in environments requiring situational awareness, such as the workplace or health care systems. One SR found hearing loss to be associated with increased agricultural work-related injuries.[186] Hearing loss can affect a worker's ability to hear and understand potential safety warnings (particularly if background noise is present) and to communicate with their supervisor, thus introducing potential coworker discrimination.[187] Employer education on the impact of hearing loss in workers who are required to rely on spoken or sound clues in the environment to perform their job is needed to maintain safety in the workplace.

Function

Hearing loss impacts various aspects of hearing function as well as functions indirectly related to hearing. Expectedly, ARHL affects the ability to understand language in both quiet and background noise settings and alters perception of speech in spatially distributed soundscapes,[188] making it challenging to orient to the external world.

ARHL is also associated with various aspects of vestibular dysfunction, increasing fall risk. Although mechanisms of balance loss may be diverse given the independent effects of aging on balance, the underlying driver of hearing loss may also affect the vestibular system and, thus, balance function. Specific balance deficits

related to ARHL have been identified that include loss of postural control, increased gait variability, increased fall risk, and vestibular loss.[5,189,190]

ARHL is related to a decline in overall health function as well. ARHL is associated with cardiovascular and all-cause mortality,[191] declines in bone mineral density;[191] and an increased risk of rheumatoid arthritis,[192] and it is more common in patients with diabetes.[62] ARHL contributes to overall disability and a decline in the ability to complete activities of daily living (ADLs);[193] it, thus, is also associated with prefrailty and frailty,[194] potentially leading to loss of independence. ARHL, being more common and progressing more rapidly, has a significant impact on the aging population with learning disabilities.[195] Patients with learning disabilities are a unique population that may require personalized counseling in addition to more frequent hearing screening and testing.

Cognition

Cognitive function and HL have been extensively investigated. Although causal relationships are incompletely understood, MAs and SRs demonstrate a clear association between ARHL and cognitive loss.[196-200] ARHL worsens cognitive decline in those with mild cognitive impairment[201] and HL is worse in those with cognitive impairment, specifically Alzheimer's.[196] Most cognitive domains, regardless of each domain's reliance on auditory function, are impaired by hearing loss, including executive function, processing speed, working memory, language, verbal memory, and general cognition.[202] Beyond functional decline, ARHL is also associated with brain atrophy, in addition to expected atrophy in the auditory cortex.[203] ARHL is associated with whole brain cortical thickness reduction and hippocampus volume reduction.[204]

As a result of these studies, ARHL has been identified as a potentially modifiable risk factor for cognitive decline, cognitive impairment, and dementia.[205] Cohort studies have shown hearing aid use decreases dementia risk by 8%–29%.[3,206] The Lancet Commission on dementia prevention, intervention, and care encouraged the use of hearing aids for hearing loss and reduction of hearing loss by protection of ears from excessive noise exposure as a means of reducing dementia risk at a population level. In the review, hearing aid use was shown to be protective of cognitive decline based on multiple large cross-sectional studies.[206] A recently completed RCT, the Aging and Cognitive Health Evaluation in Elders (ACHIEVE) study, was the first RCT to investigate the impact of hearing aids on primary prevention of long-term cognitive changes in healthy older participants. The total cohort analysis showed no effect from the hearing intervention. However, a prespecified sensitivity analysis showed that the effect differed between the 2 study populations that comprised the cohort. In older adults with increased risk for cognitive decline, there was a reduction in cognitive decline, suggesting that hearing intervention might reduce cognitive change over 3 years in populations of older adults at increased risk for cognitive decline but not in populations at decreased risk for cognitive decline.[207] In essence, ARHL impacts cognition and is a potentially modifiable risk factor for cognitive impairment.

QOL

ARHL reduces the QOL of patients[73] as well as that of their loved ones, family/care partners, and community.[208] Loss of QOL may be related to high levels of listening effort and fatigue[71] in addition to noted associations of lower social, physical, and mental activities in those with ARHL. Family/care partner's reduction in QOL is attributed to the burden of communication, restriction of social life and thus, poorer relationship satisfaction overall.[208] ARHL is associated with significant mental health challenges, including more social isolation and loneliness,[7] decreased levels of well-being,[209] and increased odds of depression,[4] comparable to other major health conditions such as stroke, vision loss, cardiac disease or pulmonary disease.[210] QOL is likely also affected due to employment-related concerns: ARHL is associated with unemployment[8] or "underemployment." Studies find those with acquired hearing loss are more likely to receive disability[9] and are over-represented in lower socioeconomic jobs; 2 of 3 workers with acquired hearing loss feel as though their employment is restricted due to hearing loss.[10] Additionally, a study in 2022 showed that individuals with a hearing loss (PTA > 40 dB) had an odds ratio of 2.35 of not being employed compared to those without hearing loss. On the other hand, those with a mild hearing loss (25 dB < PTA < 40 dB) did not have increased odds, suggesting that unemployment may be related to higher degrees of hearing loss.[211]

Clinicians should educate and counsel patients with hearing loss and their family/care partner about the impact of hearing loss on their communication, safety, function, cognition, and QOL. While the ideal mode of education may vary with each individual, difficulty with auditory communication in patients with ARHL favors educational methods that are more visual (such as written handouts).

Table 7 contains the key elements of patient education for ARHL. The following principles are important to consider while educating or counseling patients with ARHL and their plan of care.

- Identify and address any physical and cognitive functional barriers to understanding teaching materials. This may include language or health literacy barriers. Use pictures or drawings to augment verbal and written materials.
- Identify and address any conditions that might affect adherence to the plan of care, such as living alone or with an older adult spouse, financial vulnerability, lower educational level, lack of supportive systems, preconceived ideas about

Table 7. Suggested Education and Counseling Points

Communication	Untreated hearing loss limits what you can hear and understand. This can affect relationships at home, work, and in health care settings. Improved hearing can improve communication with your family, friends, coworkers, as well as health care providers.
Safety	Untreated ARHL may increase the risk of safety issues. Hearing is essential for situational awareness. It can also affect your ability to hear and understand safety warnings. Studies show that hearing loss is linked to increased work-related injuries. Improved hearing increases your awareness of your surroundings and your ability to hear alerts and warnings.
Function and health	Untreated ARHL is associated with problems related to daily functioning. It can cause problems related to balance, fall as well as your heart and joint. It can also lower your ability to complete daily activities around the house or at work. Improving your hearing can help and enhance your day-to-day functioning.
Cognition	Studies show a clear link between untreated ARHL and cognitive decline. This includes your ability to think, learn, remember, and solve problems. Hearing loss may impact memory loss or losing your thoughts. Studies show that the use of properly fitted hearing aids may reduce cognitive decline. It may also reduce the risk of developing dementia.
Quality of life	Untreated ARHL significantly reduces the quality of life for individuals and their families. Listening effort and fatigue, along with lower levels of social, physical, and mental activities, contribute to this reduction. Family members may also experience reduced quality of life from communication challenges. Treating hearing loss and positive coping strategies can lower the risk of depression and social isolation.
Adherence to treatment recommendations and referrals	It is important to follow your treatment recommendations and referrals to get the maximum results. This includes keeping your appointments and asking questions. Bring a family member or friend with you to your appointments as you may desire.

Abbreviation: ARHL, age-related hearing loss.

hearing loss, and access to unproven health information via the internet, social media, or friends and family.
- Involve family members in the education and consultation as appropriate for the patient's situation.
- Identify patients who may need extra time in developing their understanding of the information being provided.
- Identify and address challenges with using educational brochures or other materials that were not developed for the older patient with hearing loss.

Statement 7: Communication Strategies and Assistive Technologies

Clinicians should counsel patients with hearing loss on communication strategies and assistive listening devices (ALDs).

Evidence Strength: *Recommendation based on limited studies with a preponderance of benefit over harm.*

Action Statement Profile: 7

- *Quality improvement opportunity*: Provision of evidence-based recommendations from providers and medical research to support patient-informed decision making

  (National Quality Strategy Domain: Patient Safety, Person-and Family-Centered Care, Coordination of Care, Prevention and Treatment of Leading Causes of Morbidity and Mortality, Health and Well-Being of Communities)
- *Aggregate evidence quality*: Grade B, SR of 15 RCT concluding that counseling-based aural rehabilitation reduced activity limitations and participation restrictions.
- *Level of confidence in the evidence*: High
- *Benefits*: Education on supportive measures outside of amplification; affordability of supportive measures; immediate intervention; family/care partner, provider, and patient awareness; patient empowerment; safety; augmented support for hearing loss; opportunity for shared opportunities and accessibility; ease in implementation
- *Risks, harms, costs*: Costs; time; potentially overwhelming to patients family/care partners
- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: There are numerous communication strategies that can be immediately effective and implemented in real time to support patient/family/care partners/clinician communication
- *Intentional vagueness*: What are assistive technologies, communication strategies

- *Role of patient preferences*: Moderate
- *Exceptions*: None
- *Policy level*: Option
- *Differences of opinion*: None

Supporting Text

The purpose of this statement is to encourage clinicians to educate their patients and family/care partners in methods to improve communication with communication strategies and ALDs.[212,213] Communications strategies include speaking and listening techniques, as well as environmental manipulations, that improve communication (eg, facing a person when speaking, rephrasing when the message is not understood, moving away from noise, etc). Although hearing aids are included under the umbrella of ALDs, ALDs are typically defined as devices that solve specific listening challenges (eg, hearing the television, hearing on the telephone, alerting to warning signals, etc).

Communication strategies and assistive devices are potentially low-cost, readily available solutions that can improve communication in clinician–patient interactions in real time and can support improved patient communication and safety in day-to-day living. Although amplification is a first-line approach to the management of mild-to-moderate hearing loss,[214] amplification does not eliminate all communication challenges. Communication strategies can be used with and without amplification to improve communication interactions. Every clinician can promote good communication strategies that will impact the well-being of their patients.

Communication strategies

Aural (spoken/heard) communication depends on the integrity of the signal received. Auditory rehabilitation, which includes communication strategies, is a core component of the management of ARHL. Both communication strategies and technologies, such as amplification, seek to optimize the signal received and are integral to successful communication in the context of hearing loss.

Communication strategies can be used by the individual with hearing loss and their communication partner. In the health care setting, the communication partner is the clinician. For individuals with hearing loss, communication strategies can work synergistically with amplification. For individuals with hearing loss, it is often more difficult to understand a new communication partner (eg, a new health care clinician)[215] and the use of masks reduces visual cues and reduces sound.[216] Many individuals do not employ good communication strategies regularly and have to be mindful when they communicate.[185] A handout is a useful tool to provide the patient with hearing loss and their family/communication partners as a reminder to improve communication at home, in social interactions, and in the workplace[217,218,219,220] (**Tables 8** and **9**).

Table 8. Communication Strategies for Communication Partners, Including Health Care Clinicians[219,220]

Face the person you are talking to on the same level (sitting vs standing) in good lighting.
Do not talk as you walk away or from another room.
Speak clearly, slowly, distinctly, but naturally.
Get the person's attention before starting to talk. This gives the listener a chance to focus attention.
When communicating complicated information, avoid complex sentences.
Keep your hands away from your face while talking.
Minimize extraneous noise (TV, water running, other sound sources).
If the message is not understood, rephrase rather than repeating.
If time, date, or medication information is being provided, have the individual repeat the instructions.
Provide important information and instructions in writing.
Speakers should take turns speaking and not speak over each other.

This is a newly created table using information from the 2 references and from common clinical practice.[219,220]

ALDs

ALDs can be assigned to one of the following categories: (1) solutions targeted at a specific listening situation without the use of hearing aids, (2) accessories to hearing aids to improve hearing in noise, (3) telephone communication, and (4) alerting devices. In these cases, the ALD may provide the individual with an auditory signal or an alternative signal (eg, text, flashing lights, etc) to improve communication or alert them to auditory signals.[221] An individual with hearing loss can work with a hearing health care clinician to identify ALDs that will solve communication and alerting challenges, or they can access these devices/solutions directly through a variety of online and in-store retailers. Devices in each of these categories can be low- or high-tech solutions. In many cases, there are free apps that can be used in each category if the patient is a smartphone user. Some patients will be able to download and use these apps independently, while others will need support from family members or a hearing health care clinician.

In a health care setting, a simple noncustom amplifier can be used by clinicians to improve communication in real time with their patients.[222,223] Given that the majority of communication in a health care interaction is auditory, the use of amplification will reduce the effort needed by the patient with untreated hearing loss to communicate and fully participate in care decisions.[224] These low-cost amplifiers can be used with headset covers that can be disposed of after single use and the device can be wiped with a cleaning solution, allowing the device to be used across patients. If a noncustom amplifier does not provide enough communication support, a free speech-to-text app can be employed to convert the spoken conversation to text in real time. The success of this solution is dependent

Table 9. Examples of Questionnaires That Can Be Used to Assess Hearing-Related Quality of Life

Abbreviated profile of hearing aid benefit[260]	A 24-item questionnaire in which an individual assesses their difficulty in hearing in everyday situations. The benefit gained from a hearing aid is measured by comparing an individual's responses with and without amplification.
Hearing Handicap Inventory for the Elderly[253]	A 10-item questionnaire that determines an individual's perception of the social and emotional effects of hearing loss.
Health Utilities Index Mark 3[261]	Specific hearing-focused questions measuring an individual's capacity to hear in a variety of settings
Katz Index of Independence in ADLs[254]	ADL are related to personal care and include bathing or showering, dressing, getting in and out of bed or a chair, walking, using the toilet, and eating.
IADLs[255]	Instrumental activities of daily living are activities related to an individual's ability to live independently. Preparing meals, managing money, shopping for groceries or personal items, performing light or heavy housework, and using a telephone are all IADLs.
MOS SF-36[256]	A 36-item self-administered questionnaire that measures 8 aspects of an individual's quality of life including limitations in physical, social, and usual role activities due to health problems; limitations in usual role activities due to emotional problems; bodily pain; general mental health; vitality; and perceptions of general health.

Abbreviations: ADL, activities of daily living; IADL, Lawton instrumental activities of daily living scale; MOS, medical outcome study.

on the patient's literacy. To support this communication solution, it is advisable to have a tablet available in the clinic to run this program (Wi-Fi or data is required). The patient's experience with amplification and/or speech-to-text in the clinical interaction may motivate them to use these communication solutions in their daily lives.

If a patient with personal hearing aids expresses frustration with hearing in noisy and complex listening situations, they may benefit from the use of a remote microphone. This device is paired (via Bluetooth®) with their personal hearing aids, and when placed near the signal of interest, it transmits the sound directly to the hearing aids. This technique improves the signal-to-noise ratio, thereby improving signal quality. This solution only works if the remote microphone is placed in close proximity to the signal of interest (eg, near the mouth of the communication partner). A patient who uses this type of technology may ask the clinician to clip the remote microphone to their lapel while communicating. The individual with hearing loss would work with their hearing health care clinician to secure a remote microphone that works with their specific brand and model of hearing aids.

To be HIPAA compliant, the clinic will need to use a speech-to-text app that is designed for health care. This will require purchase of the app as well as a business associate agreement with the company of origin. Zoom, Amazon, Microsoft, Google, and Ava all have paid health care versions of their free speech-to-text apps that are HIPAA compliant.

Telephone communication is essential for communication and safety. Every patient needs access to successful telephone communication, including, in some instances, interacting with their clinician or office staff (eg, receiving results, scheduling, asking follow-up questions). A federally funded program provides free landline amplified and captioned (text) phones to any individual in the United States with hearing loss.[225] The clinician must sign a form confirming that the individual has hearing loss to access this program. There are multiple providers in every state who support this program by supplying free equipment and training to the consumer. The clinician can keep these forms in the clinic to provide patients in need of a telephone solution. A parallel solution is available for mobile phone users. The patient will need to download one of many free apps to set this feature up on their mobile phone.

Alerting to a variety of alarms impacts an individual's ability to maintain employment/education (eg, waking to an alarm clock), remain safe and independent in their home (eg, alerting to the phone ringing, the doorbell/door knock, and alerting to a smoke detector), and maintain social relationships (eg, doorbell/door knock, phone ringing). In many instances, the individual with hearing loss does not realize what alerting signals they are missing because they are not aware that the signal occurred.[221] Some individuals may already be employing ubiquitous solutions, including having their mobile phone vibrate to attract their attention. The patient's family/care partners may be more accurate reporters in terms of whether the individual alerts to a variety of signals. Family/care partners can be enlisted to test whether the individual can alert to the smoke detector by activating the test signal at home. If the signal is not perceived, amplified and flashing smoke detectors can be obtained directly by consumers.

The clinician may want to add these questions to their history with patients with hearing loss to promote safety and independence: (1) do you alert to your phone ringing, (2) do you alert to your alarm clock, (3) do you alert to your smoke detector, and (4) are you able to use your phone to communicate? A patient with hearing loss may indicate that a family/care partner provides support in these areas (eg, wakes them up, takes phone calls for them). These strategies do not promote independence and

can cause undue burden on the family/care partner and stress in the relationship. The clinician can encourage the pursuit of assistive devices to solve these challenges and promote safety and independence.

Statement 8: Amplification

Clinicians should offer, or refer to a clinician who can offer, appropriately fit amplification to patients with ARHL.

Evidence Strength: *Strong recommendation based on multiple RCTs with a preponderance of benefit over harm.*

Action Statement Profile: 8

- *Quality improvement opportunity*: Timely management of ARHL can decrease the burden of disease (National Quality Strategy Domain: Patient Safety, Person-and Family-Centered Care, Coordination of Care, Prevention and Treatment of Leading Causes of Morbidity and Mortality, Health and Well-Being of Communities)
- *Aggregate evidence quality*: Grade A, based on multiple well-designed RCTs
- *Level of confidence in the evidence:* High
- *Benefits*: Potential delay in cognitive decline, improve functioning, improve communication, improve mental health, improve social functioning, improve safety, potential mitigation of tinnitus
- *Risks, harms, costs*: Cost, dissatisfaction if misfit initially, exacerbate underlying otologic conditions (eg, otitis externa, myringitis, etc), rare medical complications of hearing aids (eg, mold material getting stuck, obstructing cerumen, etc)
- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: Amplification can be beneficial even with minimal hearing loss
- *Intentional vagueness*: Amplification may mean more than just hearing aids
- *Role of patient preferences*: High. While the clinician should offer amplification to everyone, patients have a choice regarding if they pursue it and whether they choose to see an audiologist or look into direct-to-consumer options (eg, over the counter)
- *Exceptions*: None
- *Policy level*: Strong recommendation
- *Differences of opinion*: None

Supporting Text

The purpose of this statement is to encourage clinicians and older adults with hearing loss to manage ARHL with appropriately fit amplification.

Amplification takes multiple forms and includes prescription hearing aids, over-the-counter hearing aids, personal sound amplification products (PSAPs), and other ALDs (ALDs—refer to KAS 7). Regardless of designation, high-quality options exist within each category. The basic components of amplification include microphones, an amplifier, power source and a speaker, along with hardware and software to optimize hearing in a range of environments. Amplification is typically programmed by professionals who can verify that audibility (ability to hear sounds at different pitches and input levels) has been restored to the listener. Appropriately fit amplification results in the return of the perception of sound across frequencies (pitches) and input sound levels while maintaining physical and sound comfort. This may be accomplished through a variety of approaches, most commonly through measurement of the output of the hearing aid in the individual's ear canal for the purpose of tuning the devices. More recently there are some options for devices to be individually fit by the listener depending on the type of device, such as self-fit, over-the-counter hearing aids. Amplification can be delivered effectively through various approaches, such as clinic-based approaches in partnership with audiologists, hearing instrument specialists, through the support of community health workers, or individually managed.[140,226,227]

Amplification, in partnership with auditory rehabilitation, is effective in improving hearing-related QOL, listening ability, and health-related QOL. Together, they are the first-line approach to the management of mild-to-moderate hearing loss, which represents the majority of ARHL from a population perspective.[214] Hearing loss, even a mild degree, can impact an older adult's ability to age well. ARHL has been independently associated with negative outcomes across multiple domains essential to healthy aging, including cognitive, physical, socioemotional, economic, functional, and health-related consequences.[4,8,97,185,228-230] Based on the prevalence of hearing loss and its degree of association with dementia, hearing loss is the largest potentially modifiable risk factor for dementia over the life course when considering a population.[206] Furthermore, appropriately fit amplification may be protective.[207,231]

In a multicenter, parallel-group RCT, the ACHIEVE trial, participants aged 70 to 84 years with untreated hearing loss and without cognitive impairment were randomized to receive a hearing intervention, consisting of provision of hearing aids and auditory rehabilitation, versus a health education control.[207] Participants (n = 977) were recruited from 2 distinct study populations: (1) participants from a longstanding observational study (atherosclerosis risk in communities [ARIC] study, n = 238) who were a random sample of the population when they were initially recruited and (2) healthy volunteers (de novo cohort, n = 739) who were newly recruited into the ACHIEVE trial. Participants were followed for 3 years, and a neurocognitive battery was administered annually. Overall, at the end of 3 years in the combined analysis of the ARIC and de novo cohorts, rates of cognitive decline in the hearing intervention versus the health education control groups were not different. However, in a prespecified sensitivity analysis, replicating

the primary analyses stratified by the 2 distinct study cohorts, hearing intervention in the ARIC cohort was associated with a 48% reduction in 3-year cognitive change as compared to participants who received the health education control. No effect of hearing intervention in reducing cognitive decline was observed in the de novo cohort. An explanation for these results is based on differences in the rate of cognitive change seen between the ARIC and de novo cohorts. The de novo control participants had a nearly 3-fold slower rate of cognitive change over 3 years than the ARIC control participants. Such a slow rate of cognitive change limits the ability to detect any further reduction with hearing intervention within 3 years in the de novo cohort. The difference in rates of cognitive change between the de novo and ARIC cohort control participants are consistent with the de novo cohort representing healthy volunteers who had fewer risk factors at baseline for cognitive decline (eg, lower age, higher education, fewer medical comorbidities) than the ARIC cohort who represent a random sample of the population and had a greater number of risk factors for cognitive decline (eg, older, lower education, lower income, higher rates of diabetes and hypertension, more likely to live alone). Based on findings from the ACHIEVE trial, the first RCT of a hearing intervention on long-term cognitive changes, appropriately fit amplification and associated auditory rehabilitation appears to reduce cognitive loss within 3 years for those at-risk of cognitive decline.

Clinicians and older adults with hearing loss must consider the type of technology and/or delivery approach that is best suited to the individual's needs and priorities.[232] The pathway of care will be dependent on the severity and complexity of the hearing loss, the individual's ability to self-manage care, and the communication goals of the individual. Amplification entails devices that generally must be programmed to allow custom fitting, which can be accomplished by hearing care clinicians, such as audiologists and hearing instrument specialists, or through self-fit approaches that may rely on Bluetooth®-based technology. Preprogrammed options are available and can be effective. An individual's access and comfort with mobile technologies, like downloading applications and connecting devices via Bluetooth®, should be considered alongside an individual's manual dexterity, cognitive function, and availability of support from family/care partners and/or clinicians. Cost and insurance coverage are also considerations when navigating available options, where state-based Medicaid programs provide variable coverage and federal-level Medicare currently provides no coverage for hearing aids.

Specific recommendations regarding the provision of amplification are beyond the scope of these guidelines. General guidance for patients seeking care through a hearing care clinician should expect care that is informed by the degree of hearing loss and the individual's communication demands and lifestyle. The physical fit of devices must be appropriate and comfortable, and devices should be tuned to the individual's needs. Bilateral hearing is required to localize sound and improve hearing in noise and, whenever possible, bilateral, versus unilateral, hearing aids should be fit.

Figures 1 and **2** provide a guide to possible pathways to care by measured or perceived degree of hearing loss. The level of hearing loss, perceived communication challenges, and communication demands influence the recommended pathway to care (eg, hearing care professional or self-care). Education and counseling will support all individuals experiencing hearing loss. **Figures 1** and **2** provide example solutions for the various levels of perceived hearing loss, communication challenges, and communication demands. Modifications to the recommended care pathways should be informed by patient and care partner priorities, available audiological services, insurance coverage, financial concerns, presence and degree of cognitive impairment, a patient's technology access, use, preferences, and self-efficacy, mobility and available transportation, navigational needs, and available assistance and general support.

Statement 9: Candidacy for Cochlear Implants

Clinicians should refer patients for an evaluation of CI candidacy when patients have appropriately fit amplification and persistent hearing difficulty with poor speech understanding.

Evidence Strength: *Strong recommendation based on several SRs and MAs of prospective clinical trials with a preponderance of benefit over harm.*

Action Statement Profile: 9

- *Quality improvement opportunity*: Promote effective management of ARHL to reduce the burden of disease
  (National Quality Strategy Domain: Prevention and Treatment of Leading Causes of Morbidity and Mortality)
- *Aggregate evidence quality*: Grade A, based on high level SRs of prospective clinical trials on CI efficacy
- *Level of confidence in the evidence*: High
- *Benefits*: Capturing patients with hearing loss that may need CI; early identification of CI candidates; early discussion and introduction of CI even if not candidate; provider education on benefits and safety of CI; patient validation of the reason for difficulty in hearing; normalizing CI use in society
- *Risks, harms, costs*: Time; cost; potential overutilization of resources; patient anxiety and stress; need to address provider knowledge gaps
- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: Panel feels there is under-referral of patients who would benefit from CI

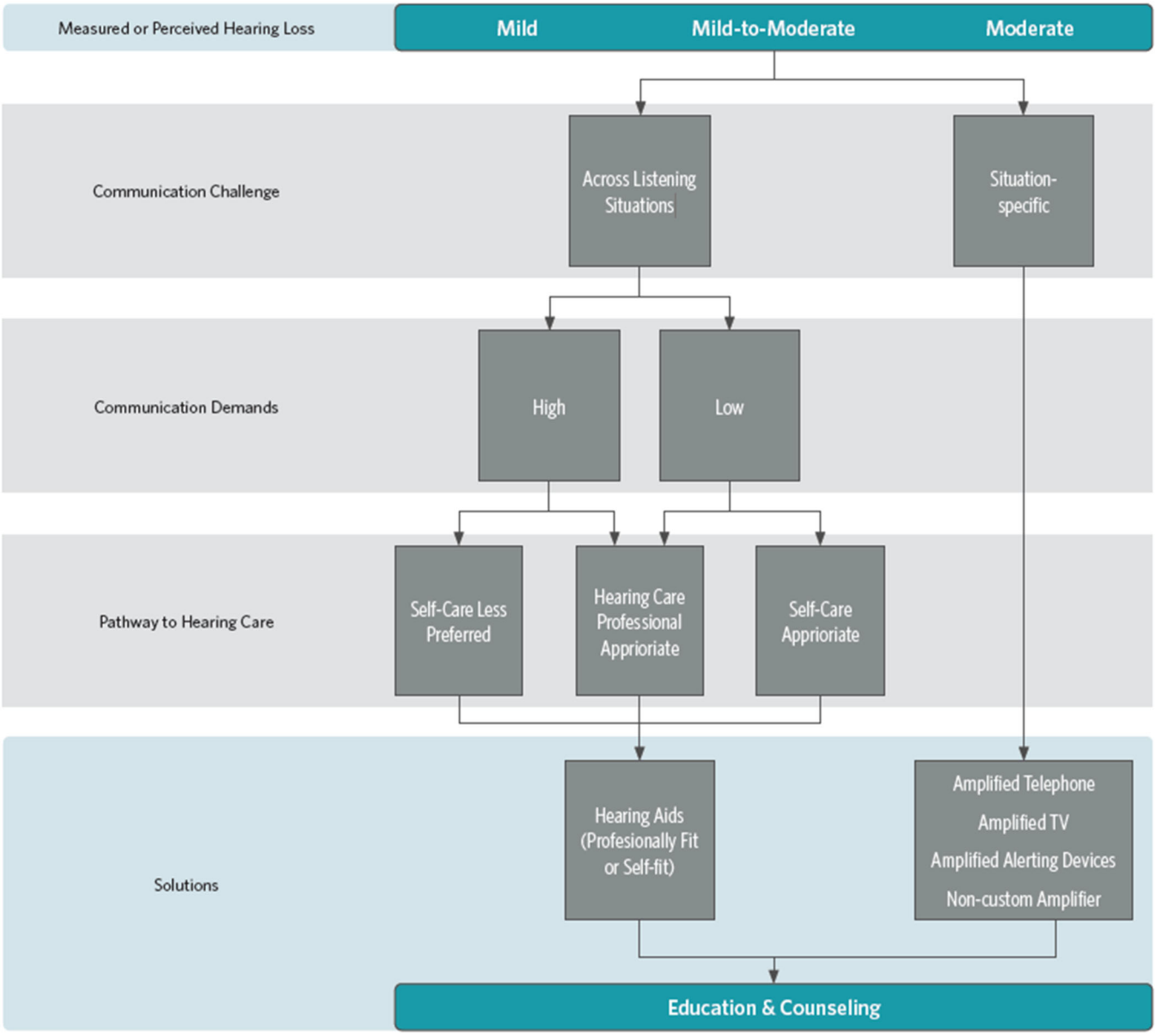

Figure 1. Recommended Hearing Care Pathways and Solutions by Degree of Measured or Perceived Hearing Loss: Mild to Moderate. Modifying Considerations Include Patient and Care Partner Priorities and Preferences, Available Audiological Services, Insurance Coverage, Cognitive Impairment, Financial Concerns, Technology Access, Use, Preferences, and Self Efficacy, Mobility, Transportation, Navigational Needs, Available Assistance, Available Support from Care Partners.

- *Intentional vagueness*: Severity of hearing loss and speech understanding, appropriate fit amplification, who will assess cochlear implant candidacy
- *Role of patient preferences*: Moderate
- *Exceptions*: Candidates who are unable or unwilling to have surgery
- *Policy level*: Strong recommendation
- *Differences of opinion*: None

Supporting Text

The purpose of this statement is to ensure timely referral for CI candidacy assessment for patients whose appropriately fit hearing aids provide limited benefit and who score poorly on speech recognition testing. This process entails patient education about cochlear implants, verification of appropriate hearing aid fit, and referral to a CI center for CI candidacy when appropriate.

Clinicians should discuss with patients that a CI may be a good option in patients who experience little benefit from continued hearing aid use. Cochlear implants are surgically implanted hearing devices that bypass damaged cochlear hair cells and electrically directly stimulate the cochlear nerve. This is unlike hearing aids that amplify acoustic input and rely on remaining cochlear hair cells to transduce sound into electrical impulses to the cochlear nerve. When hearing loss is significant enough for CI consideration, hearing aids typically cannot provide

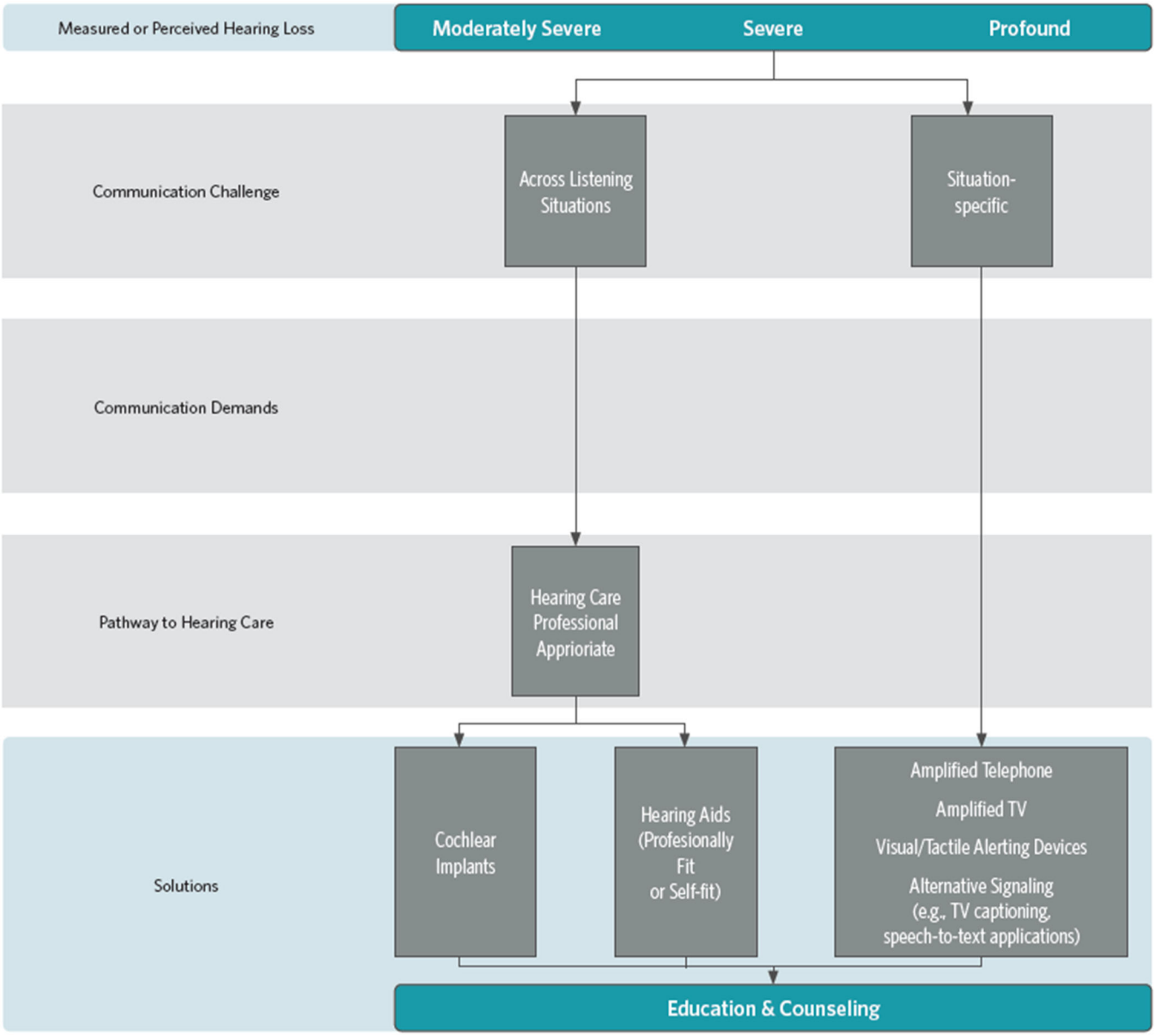

Figure 2. Recommended Hearing Care Pathways and Solutions by Degree of Measured or Perceived Hearing Loss: Moderately Severe to Profound. Modifying Considerations Include Patient and Care Partner Priorities and Preferences, Available Audiological Services, Insurance Coverage, Cognitive Impairment, Financial Concerns, Technology Access, Use, Preferences, and Self Efficacy, Mobility, Transportation, Navigational Needs, Available Assistance, a Vailable Support from Care Partners.

adequate *clarity* of the sound being amplified and patients experience little benefit in speech understanding.

Cochlear implants have been the standard for hearing optimization for patients with severe to profound hearing loss for decades. They have consistently been shown in numerous clinical trials to be safe, effective in improving communication ability, and able to improve hearing-related QOL for appropriately selected candidates.[233-240] Patients with residual low-frequency hearing and poor speech recognition have been shown to benefit from CI as well.[235-237] CIs have also been shown to improve patient scores on several cognitive testing domains after implantation.[241-245] As such, candidacy criteria and indications have continued to expand over the years, making them available to patients with more residual hearing. Based on extensive data of efficacy, in 2022, Medicare expanded their criteria for CI candidacy.[246]

CI safety and efficacy have been demonstrated across wide age ranges, including adults ages 80 and older.[247,248] Candidates should not be excluded from evaluation solely due to age. Timely referral for CI evaluation may avoid *delaying* appropriate medical treatment for hearing loss and unnecessary patient costs for newer hearing aids that fail to provide benefit. Traditional CI candidates are generally covered by commercial, Medicare, and

Medicaid payers, although some payers may require a preapproval process.

Many patients who would benefit from CI do not get them. It is estimated that only 5%–12.7% of potential CI candidates in the United States receive a device.[249,250] This significant underutilization may in part be due to both expanding candidacy criteria combined with inadequate clinician knowledge of when to refer. Because CI candidacy is primarily determined by limited benefit from hearing aids, microphone verification (real-ear) measures performed by an audiologist can determine if hearing aids are meeting actual prescriptive targets. Some patients may be unsatisfied with hearing aids due to under amplification. This can be identified during CI candidacy assessment leading to benefit even for patients who may not be CI candidates.[251,252]

Several referral guidelines on audiometric criteria for CI have been published. A commonly used and validated heuristic is the "60/60" guideline by Zwolan et al,[169] with a 96% sensitivity and 34% false-positive rate for identifying CI candidates. According to Zwolan et al, patients should be referred for a CI evaluation when the audiometric pure tone average thresholds of the *better* hearing ear are ≥60 dB and if the unaided monosyllabic word recognition is ≤60%.[169] While not every patient referred using the "60/60" guideline will meet Medicare and Medicaid criteria for cochlear implant, this guideline increases the likelihood that patients who actually meet CI candidacy are identified in timely fashion. Both pure tone threshold average and speech testing scores should be available on a routine diagnostic audiogram. A typical CI candidacy evaluation then includes a comprehensive evaluation of hearing and medical history, a thorough discussion regarding cochlear implants, a separate battery of word and sentence recognition tests with hearing aids in place, a surgical candidacy evaluation by a CI surgeon, and preoperative imaging workup. Some CI centers may include other components, such as QOL questionnaires, vestibular testing, cognitive testing and more. CI surgery is safe and is typically performed in an outpatient setting. After surgery, patients follow closely with their audiologists for activation, counseling, and continued programming.

Statement 10: Assessing Goals and Improvement

For patients with hearing loss, clinicians should assess if communication goals have been met and if there has been improvement in hearing-related quality of life at a subsequent health care encounter or within 1 year.

Evidence Strength: *Recommendation based on limited evidence with a preponderance of benefit over harm.*

Action Statement Profile: 10

- *Quality improvement opportunity*: Articulation of common goals and success in reaching those goals between providers and patients can support effective, efficient, and patient-centered care (National Quality Strategy Domain: Patient Safety, Person-and Family-Centered Care, Coordination of Care)
- *Aggregate evidence quality*: Grade C, based on observational studies and a single RCT
- *Level of confidence in the evidence*: High
- *Benefits*: Identifying non-users of technology; opportunity to reassess hearing; opportunity to move to a different technology if they are not getting adequate benefit; opportunity to reeducate patients chose not to address hearing at the initial visit; prioritize hearing health during health care encounters
- *Risks, harms, costs*: Overuse of resources; unnecessary visits; premature assessment before adequate adjustment to new technology; patient time; clinician time
- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: Assessing outcomes of interventions provides opportunities to improve hearing health outcomes
- *Intentional vagueness*: How should the assessment be done and timing of the actual assessment
- *Role of patient preferences*: Moderate
- *Exceptions*: None
- *Policy level*: Recommendation
- *Differences of opinion*: There was significant discussion among the GDG related to when the follow-up should occur. Some favored a shorter time interval and others preferred to leave it more open

Supporting Text

The purpose of this statement is to encourage clinicians to assess if patients with ARHL are benefitting in terms of communication and hearing-related QOL from chosen interventions or if other strategies should be considered. Clinicians are encouraged to utilize age, language, and health literacy appropriate measures to assess outcomes. Questionnaires may be hearing-specific or be broader health status questionnaires. Examples presented here are among the most common but others exist and may also be appropriate to use.

For patients with diagnosed hearing loss, difficulties with communication and QOL may be assessed in several ways. Questionnaires are 1 option and can measure different aspects related to hearing-related health or overall QOL depending on the goals to be measured. The HHIE-S, or its modified form RHHI-S, is a 10-item questionnaire that determines an individual's perception of the social and emotional effects of hearing loss.[120,253] Health-related QOL also may be assessed by using standard checklists measuring ADLs[254] and instrumental ADLs.[255] Alternatively, the

Short Form 36 Health Survey (SF-36) or Health Utilities Index Mark 3 (HUI-3) could be used could be used. The SF-36 is a 36-item self-administered questionnaire that measures eight aspects of an individual's QOL including limitations in physical, social, and usual role activities due to health problems; limitations in usual role activities due to emotional problems; bodily pain; general mental health; vitality; and perceptions of general health.[256]

The HUI-3 includes specific hearing-focused questions measuring an individual's capacity to hear in a variety of settings. The HUI-3 may be more sensitive than other measures to treatment effects for hearing loss.

Questionnaires may be used at initial hearing evaluations so that at subsequent follow-up appointments, screenings can be repeated, allowing the clinician to discern changes in both the patient's hearing and hearing-related QOL Adjustment to hearing aids can take several months. One year should be more than sufficient for patients with ARHL to become familiar with and accustomed to using any hearing aid or device.[257-259]

Statement 11: Retesting

Clinicians should assess hearing at least every 3 years in patients with known hearing loss or with reported concern for changes in hearing.

Evidence Strength: *Option based on prospective and retrospective studies with a preponderance of benefit over harm.*

Action Statement Profile: 11

- *Quality improvement opportunity*: Promotion of retesting can detect the progression of the disease and facilitate efficient management of ARHL
  (National Quality Strategy Domain: Patient Safety, Person-and Family-Centered Care, Coordination of Care, Prevention and Treatment of Leading Causes of Morbidity and Mortality, Health and Well-Being of Communities)
- *Aggregate evidence quality*: Grade C, based on prospective and retrospective studies
- *Benefits*: Identify progressive hearing loss; opportunity for earlier intervention; opportunity for enrolling patient into appropriate pathway to care; provide opportunity to appropriately aid communication and heath care interaction in "real-time" with patient and family/care partner; provide opportunity for patient education and counseling (specifically regarding the progressive nature of hearing loss over time and the need for retesting at regular time interval); improved awareness of hearing and importance of functioning in daily life; improved patient safety as it relates to hearing loss and impacts thereof, improved acceptance of hearing loss
- *Risks, harms, costs*: Time and cost of additional testing, stigma of hearing loss; testing fatigue; potential increased demand of resources such as audiology services; stress; distress; anxiety associated with new diagnosis of hearing loss
- *Benefits-harm assessment*: Preponderance of benefit over harm
- *Value judgments*: While there is limited/no evidence for the benefit of reevaluation, the expert opinion of the group is that there is significant value in reassessment for a known progressive condition such as hearing loss
- *Intentional vagueness*: Time interval for rescreening is wide (at least every 3 years), specific method of testing used for reassessment
- *Role of patient preferences*: Limited
- *Exceptions*: Patients already under the care of a hearing health specialist
- *Policy level*: Option
- *Differences of opinion*: None

Supporting Text

The purpose of this statement is to ensure patients with known ARHL are re-evaluated and undergo longitudinal testing of hearing following initial identification of hearing loss on a regular basis.

Periodic re-evaluation is especially important as data show progressive hearing deterioration over time. According to the NIDCD, the rate of hearing loss increases to 8.5% for people in the age range of 55 to 64 years, 25% for ages 65 to 74 years and 50% for ages 75 years and older.[112] As such, a clinical workflow (**Figure 3**) should capture hearing deterioration over time to ensure that patients receive time-sensitive management. Early detection of hearing loss and appropriate intervention can aid in the mitigation of many associated adverse effects related to untreated hearing loss.[125] The consequences of unaddressed adult-onset hearing loss include difficulties in communication, social withdrawal, emotional dysfunction and cognitive decline.[125] According to the WHO, assessing hearing is therefore a critical part of the full assessment of monitoring an older person's health and intrinsic capacity.[262]

Most hearing losses feature an insidious progression that is often subtle and can go unrecognized.[125] In a longitudinal population-based study in adults aged 42 to 94 years at baseline, hearing sensitivity was measured twice, 5 years apart. The intent of this study was to capture the 5-year incidence and progression of hearing loss. The mean PTA 0.5, 1, 2, and 4 kHz of the at-risk for progression of hearing loss group was 46.3-dB HL at follow-up compared with 39.5-dB HL at baseline examination. The overall 5-year progression of hearing loss (defined as greater than a 5-dB increase in PTA 0.5, 1, 2, and 4 kHz) was 53.3% (95% CI, 50.2%–56.4%) with higher rates of progression in patients who were older and those with hearing loss at baseline.[263] This underlines the

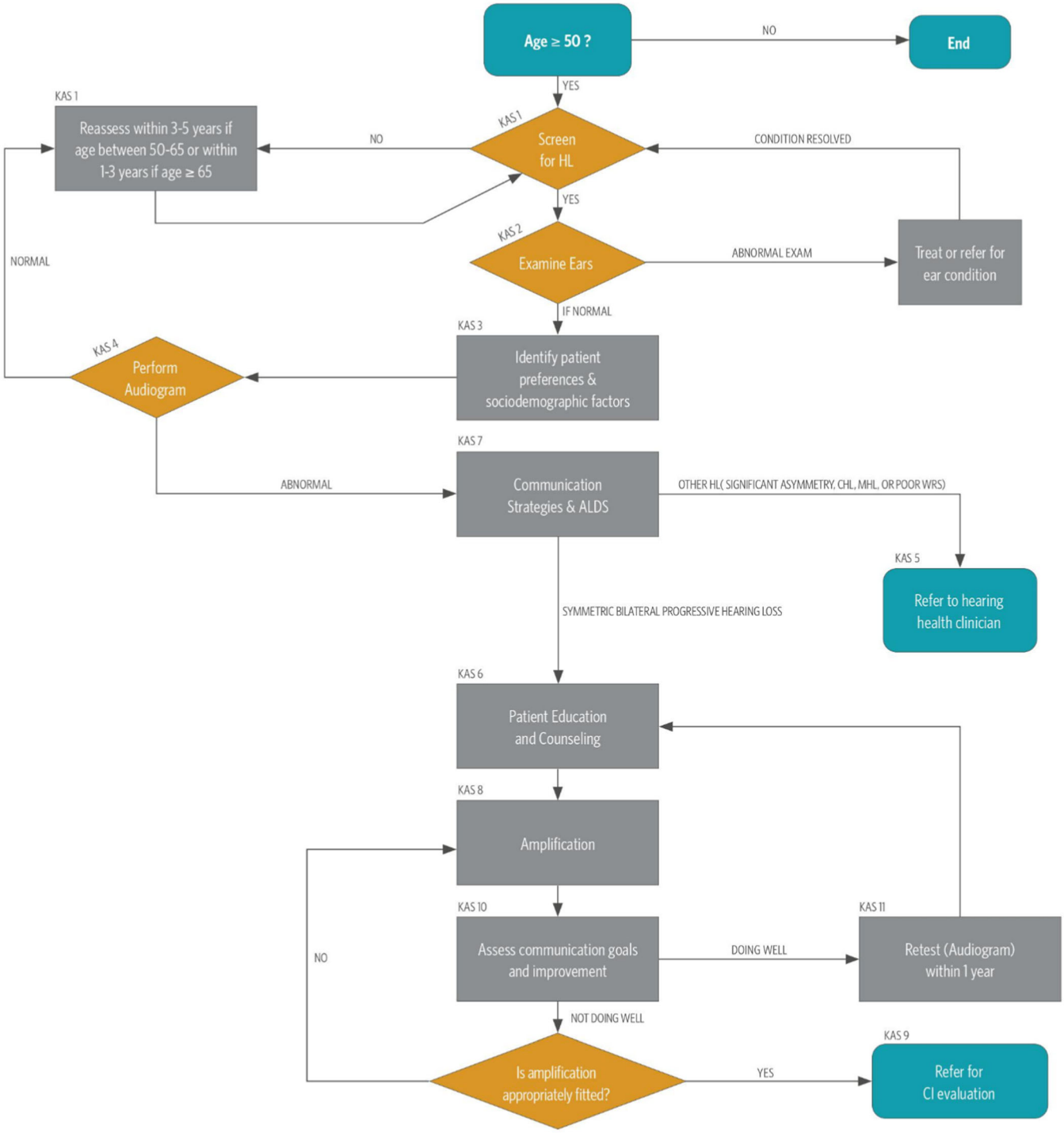

Figure 3. Flowchart Showing Key Action Statements (KASs) and Process of Care.

need for frequent testing and reassessment and is the basis for the current recommendation to retest hearing at least every 3 years.

Some patients warrant more frequent or earlier reassessment. For patients with known hereditary factors resulting in earlier or more rapid decline of hearing, hearing should be assessed more frequently to capture progression in a timely fashion. Additionally, concern about a change in hearing raised by the patient, family, or care partner should warrant prompt hearing assessment.

Implementation Considerations

The complete guideline is published as a supplement to *Otolaryngology–Head and Neck Surgery* to facilitate reference and distribution. An executive summary of the recommendations will also be published to summarize the

KASs for clinicians and offer a concise overview of essential text, tables, and figures. The guideline will be presented to AAO-HNSF members and other clinicians, including an international audience, as a Panel Presentation at the AAO-HNSF 2024 Annual Meeting & OTO EXPO. A full-text version of the guideline is available for free at www.entnet.org. A plain language summary aimed at parents and family/care partners will be available as well. Additionally, pertinent educational materials will be developed in conjunction with the GDG's patient advocate.

Individual and societal knowledge and attitudes regarding hearing loss influence health-related behaviors and may prevent the successful implementation of these guidelines. Ageism and negative stigma regarding hearing loss have resulted in the marginalization of hearing as a health priority. The lack of knowledge of the negative impacts of hearing loss and the recommendations of hearing screening, diagnosis, and treatment among the general public may fuel the pervasive underutilization of hearing health care. A lack of population-level awareness and prioritization of hearing will limit the application of these guidelines. A comprehensive policy-driven public awareness strategy to promote hearing health would be an impactful method to amplify the message of this guideline.

With an aging population, primary care providers are tasked with maximizing and managing the health of an increasing number of older adults. The burden of chronic disease within this population creates an expanding burden to provide comprehensive care within contracting clinical encounter time. Considering the time constraints to provide preventive care and proactive chronic disease management, clinicians may struggle to prioritize hearing loss screening. While EMR tools and alerts may prompt clinicians to address hearing function during clinical encounters, providers may be unfamiliar with the most accurate and time-efficient methods to screen for hearing loss. The limited dissemination of the research evidence supporting hearing screening, diagnosis, and treatment and the lack of standardized protocols informing how to implement this care represent significant barriers to practical use of these recommendations. The terminology and definitions of this guideline could create some confusion as to who is responsible for hearing health care. The GDG was purposeful in defining "clinician" broadly: the impact of hearing loss and screening should not be the sole responsibility of an audiologist, an otolaryngologist, nor primary care provider. Any time and place that a patient interacts with the health care system is an opportunity for preventative health care, such as hearing screening, to occur. The perception that only audiologists and otolaryngologists should screen for hearing loss can perpetuate the limited access and utilization of hearing health care and the adverse effects of untreated hearing loss. The use of technology to evaluate and protocolize hearing screening in traditional and nontraditional health care settings has the potential to promote these guidelines. The co-existence of hearing loss with other chronic health conditions and their compounded negative impact on the health of aging adults creates a public health priority for everyone in the health care system to address hearing loss.

Limited access to diagnostic hearing tests and the lack of hearing specialists creates barriers to guideline implementation. This shortage may further delay care and discourage patients from seeking evaluations. The GDG specifically includes information in this guideline regarding online screening tools and applications knowing that any information regarding available resources may assist clinicians. Additionally, the cost and availability of recommended interventions, such as hearing testing and hearing aids, may not be covered by insurance. Over-the-counter products, while to some may still be unaffordable, may provide a better alternative than no intervention, even if inadequate. This guideline includes a flowchart of the guideline KASs in **Figure 3**. The flowchart facilitates more rapid understanding of the guideline logic, the sequence of the action statements, and the interrelationship of key recommendations. The flowchart can be adopted as a quick reference guide to support the implementation of the guideline's recommendations.

The AAO-HNSF will continue to promote adherence to the guideline's recommendations through its quality improvement activities. Per AAO-HNSF policy, the guideline will be reviewed and updated 5 years from the time of publication.

Research Needs

This guideline was developed based on the current body of evidence regarding ARHL. As determined by the GDG's review of the literature, assessment of current clinical practices, and determination of evidence gaps, research needs were determined as follows:

1. Benefits of screening on QOL, communication ability, and function
2. Potential harms and costs associated with screening
3. Standardization of hearing loss threshold definition by studies on screening
4. Accuracy of various screening tools including head-to-head comparisons of different screening modalities
5. Inclusion of diverse subpopulations and underrepresented groups in risk-stratification, screening, management, and outcomes research
6. How to overcome disparities in management of ARHL
7. How to improve access to hearing health
8. Accuracy and validation of smartphone-based hearing assessments as screening and/or diagnostic tools

9. How to address the lack of available hearing health care in underserved regions
10. Effect of counseling of patients and family/care partners
11. Health literacy and counseling education
12. Hearing aid use, compliance, and benefit in appropriately fit hearing aids vs others (eg, OTC hearing aids, hearing aids from wholesale clubs/ warehouses without audiology support).

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Supplemental Material

Additional supporting information is available in the online version of the article.

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Appendix A. Stage 1 Literature Search

See **Table A1**.

Table A1. Stage 1 Literature Search: CPGs, SRs, and Meta-analyses

Websites and databases searched	Search terms	#
AHRQ EPC reports	Hearing 5 Presbycusis 0 Presbyacusis 0 Speech 4 Auditory 0	9
CMA infobase	presbycusis OR presbyacusis OR hearing OR speech OR auditory 4/5 (1 language)	4
CRD Web (DARE, NHS EED, HTA)	presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss" [Any Field] OR "hearing loss"[title]	87
ECRI trust	presbycusis OR presbyacusis OR hearing OR speech OR auditory	51
Guidelines international network	Hearing 3/8 (5 language) Presbycusis 0/0 Presbyacusis 0/0 Speech 1/3 (2 language) Auditory 0/2 (2 language)	4
HSTAT	((presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss")) AND (assess*[Title] OR evaluat* [Title] OR Treat*[Title] OR mitigat*[Title] OR remediat*[Title] OR rehabilitat*[Title] OR regenerat*[Title] OR manage[Title] OR managing[Title] OR management[Title] OR "hearing aid"[Title] OR "hearing aids"[Title] OR "cochlear implant"[Title] OR "cochlear implants"[Title] OR "hearing technology"[Title] OR "hearing technologies"[Title] OR "assistive device"[Title] OR "assistive devices"[Title]) Filters: Report; Documentation	119
NICE guidance and advice	Hearing 1 Presbycusis 0 Presbyacusis 0 Speech 0 Auditory 1 /2 (1 out of date)	2
New Zealand Guidelines Group	Hearing 46 Presbycusis 0 Presbyacusis 0 Speech 17 Auditory 3	66
SIGN	All guidelines available	136
TRIPdatabase.com	presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss" Filter: All Secondary Evidence	19
Google scholar	Guideline* AND (presbycusis OR presbyacusis OR "age related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss")	0
Biosis citation index	(presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss") AND (geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR ageism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*) (Topic) and ("systematic review*" OR "systematic literature review*" OR "meta-analy*" OR guideline* OR "best practice*" OR "good practice*" OR consensus OR	488

(*continued*)

Table A1. (continued)

Websites and databases searched	Search terms	#
	report OR pathway* OR "practice parameter*" OR statement* OR "position paper" OR "task force*" OR "expert panel" OR recommend* OR synthesis OR "rapid review*" OR "appropriateness criteri*" OR "classification criteri*" OR "diagnostic criteri*" OR pubmed OR medline OR embase OR scopus OR "web of science" OR "web of knowledge" OR CINAHL OR PsycInfo OR "Google Scholar" OR ScienceDirect OR Ebsco OR Elsevier OR ovid OR "cochrane database" OR "cochrane library" OR "search strateg*" OR PRISMA) (Topic) not ("case report*" OR pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age*" OR preschool* OR "pre-school*" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion*" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR Drosophila) (Title) | Refined by: Languages English	
CINAHL	CINAHL TITLE SEARCH 185 ((MH "Presbycusis" OR TI("age-related hearing loss" OR arhl OR presbycusis OR presbyacusis) OR AB("age-related hearing loss" OR arhl OR presbycusis OR presbyacusis) OR (TI("age-related" OR "aging" OR ageing OR progressive OR "adult onset" OR "advancing age" OR "advanced age" OR elder* OR older OR age OR aged) OR AB("age-related" OR "aging" OR ageing OR progressive OR "adult onset" OR "advancing age" OR "advanced age")) AND (MH "Speech Perception" OR MH "Hearing Disorders" OR MH "Hearing Loss, Partial+" OR TI("speech perception" OR "hearing health care" OR "hearing impair*" OR "hearing deficit*" OR "hearing loss" OR "hearing status" OR "hearing difficult*" OR "hearing preservation") OR AB("speech perception" OR "hearing health care" OR "hearing impair*" OR "hearing deficit*" OR "hearing loss" OR "hearing status" OR "hearing difficult*" OR "hearing preservation")))) AND ((MH "Age Specific Care" OR MH "Age Factors" OR MH "Ageism" OR MH "Aged+" OR MH "Hospitalization of Older Persons" OR MH "Health Services for Older Persons" OR MH "Dental Care for Older Persons" OR MH "Rehabilitation, Geriatric" OR MH "Housing for Older Persons" OR MH "Gerontologic Nursing+" OR MH "Gerontologic Care" OR MH "Assisted Living" OR MH "Aging+" OR TI (geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*) OR AB(geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*))) AND (TI("systematic review*" OR "systematic literature review*" OR "meta-analy*" OR guideline* OR "best practice*"	185 + 71

(*continued*)

Table A1. (continued)

Websites and databases searched	Search terms	#
	OR "good practice*" OR consensus OR report OR pathway* OR "practice parameter*" OR statement* OR "position paper" OR "task force*" OR "expert panel" OR recommend* OR synthesis OR "rapid review*" OR "appropriateness criteri*" OR "classification criteri*" OR "diagnostic criteri*" OR pubmed OR medline OR embase OR scopus OR "web of science" OR "web of knowledge" OR CINAHL OR PsycInfo OR "Google Scholar" OR ScienceDirect OR Ebsco OR Elsevier OR ovid OR "cochrane database" OR "cochrane library" OR "search strateg*" OR PRISMA) OR AB (pubmed OR medline OR embase OR scopus OR "web of science" OR "web of knowledge" OR CINAHL OR PsycInfo OR "Google Scholar" OR ScienceDirect OR Ebsco OR Elsevier OR ovid OR "cochrane database" OR "cochrane library" OR "search strateg*" OR PRISMA) OR SO(Cochrane) OR AF("task force" OR committee* OR council* OR association OR "working group" OR society OR consortium) OR CA("task force" OR committee* OR council* OR association OR "working group" OR society OR consortium)) NOT (TI("case report*" OR pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age*" OR preschool* OR "pre-school*" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR (month* AND age)) OR (MH "Animals+" NOT MH "Human") OR TI(mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion*" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR Drosophila))	
	CINAHL FILTER SEARCH 71 ((MH "Presbycusis" OR TI("age-related hearing loss" OR arhl OR presbycusis OR presbyacusis) OR AB("age-related hearing loss" OR arhl OR presbycusis OR presbyacusis) OR (TI("age-related" OR "aging" OR ageing OR progressive OR "adult onset" OR "advancing age" OR "advanced age" OR elder* OR older OR age OR aged) OR AB("age-related" OR "aging" OR ageing OR progressive OR "adult onset" OR "advancing age" OR "advanced age")) AND (MH "Speech Perception" OR MH "Hearing Disorders" OR MH "Hearing Loss, Partial+" OR TI("speech perception" OR "hearing health care" OR "hearing impair*" OR "hearing deficit*" OR "hearing loss" OR "hearing status" OR "hearing difficult*" OR "hearing preservation") OR AB("speech perception" OR "hearing health care" OR "hearing impair*" OR "hearing deficit*" OR "hearing loss" OR "hearing status" OR "hearing difficult*" OR "hearing preservation")))) AND ((MH "Age Specific Care" OR MH "Age Factors" OR MH "Ageism" OR MH "Aged+" OR MH "Hospitalization of Older Persons" OR MH "Health Services for Older Persons" OR MH "Dental Care for Older Persons" OR MH "Rehabilitation, Geriatric" OR MH "Housing for Older Persons" OR MH "Gerontologic Nursing+" OR MH "Gerontologic Care" OR MH "Assisted Living" OR MH "Aging+" OR TI (geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*) OR AB(geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension*	

(*continued*)

Table A1. (continued)

Websites and databases searched	Search terms	#
	OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*))) NOT (TI("case report*" OR pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age*" OR preschool* OR "pre-school*" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR (month* AND age)) OR (MH "Animals+" NOT MH "Human") OR TI(mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion*" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR Drosophila)) Publication Type: Meta Analysis, Meta Synthesis, Practice Guidelines, Systematic Review	
Cochrane database of SRs	(presbycusis OR presbyacusis OR hearing OR speech OR auditory) in Title Abstract Keyword AND (geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*) in Title Abstract Keyword NOT ("case report*" OR pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age*" OR preschool* OR "pre-school*" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion*" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR Drosophila) in Record Title - (Word variations have been searched)	105
Embase	('age-related hearing loss':ti,ab OR arhl:ti,ab OR presbycusis:ti,ab OR presbyacusis:ti,ab OR (('age-related':ti,ab OR 'aging':ti,ab OR ageing:ti,ab OR progressive:ti,ab OR 'adult onset':ti,ab OR 'advancing age':ti,ab OR 'advanced age':ti,ab OR elder*:ti OR older:ti OR age:ti OR aged:ti) AND ('speech perception'/de OR 'hearing impairment'/exp OR 'speech perception':ti OR 'hearing health care':ti OR 'hearing impair*':ti OR 'hearing deficit*':ti OR 'hearing loss':ti OR 'hearing status':ti OR 'hearing difficult*':ti OR 'hearing preservation':ti))) AND ('aged'/exp OR 'elderly care'/exp OR 'geriatric assessment'/exp OR 'geriatrics'/exp OR 'gerontopsychiatry'/exp OR 'geriatric nursing'/exp OR 'geriatric dentistry'/exp OR 'nursing home'/exp OR 'home for the aged'/exp OR 'age'/exp OR geriatr*:ti,ab OR geront*:ti,ab OR elder*:ti,ab OR old:ti,ab OR older:ti,ab OR oldest:ti,ab OR eldest:ti,ab OR	461

(*continued*)

Table A1. (continued)

Websites and databases searched	Search terms	#
	senior*:ti,ab OR aged*:ti,ab OR aging:ti,ab OR agism:ti,ab OR 'age factor*':ti,ab OR 'age-stratified':ti,ab OR 'age-related':ti,ab OR 'age-associated':ti,ab OR 'aging-related':ti,ab OR 'advancing age':ti,ab OR 'advanced age*':ti,ab OR retired:ti,ab OR retirement:ti,ab OR retiree*:ti,ab OR 'social security':ti,ab OR 'nursing home*':ti,ab OR 'assisted living':ti,ab OR pension*:ti,ab OR senium*:ti,ab OR senil*:ti,ab OR dementia:ti,ab OR grandparent*:ti,ab OR grandmother*:ti,ab OR grandfather*:ti,ab OR grandma*:ti,ab OR grandpa*:ti,ab OR sexagenarian*:ti,ab OR septuagenarian*:ti,ab OR octogenarian*:ti,ab OR nonagenarian*:ti,ab OR centenarian*:ti,ab OR supercentenarian*:ti,ab) AND ([cochrane review]/lim OR [systematic review]/lim OR [meta analysis]/lim OR 'systematic review*':ti OR 'systematic literature review*':ti OR 'meta-analy*':ti OR guideline*:ti OR 'best practice*':ti OR 'good practice*':ti OR consensus:ti OR report:ti OR pathway*:ti OR 'practice parameter*':ti OR statement*:ti OR 'position paper':ti OR 'task force*':ti OR 'expert panel':ti,ab OR recommend*:ti OR synthesis:ti OR 'rapid review*':ti OR 'appropriateness criteri*':ti OR 'classification criteri*':ti OR 'diagnostic criteri*':ti OR pubmed:ti,ab OR medline:ti,ab OR embase:ti,ab OR scopus:ti,ab OR 'web of science':ti,ab OR 'web of knowledge':ti,ab OR cinahl:ti,ab OR psycinfo:ti,ab OR 'google scholar':ti,ab OR sciencedirect:ti,ab OR ebsco:ti,ab OR ovid:ti,ab OR 'cochrane database':ti,ab OR 'cochrane library':ti,ab OR cochrane:jt OR 'search strateg*':ti,ab OR prisma:ti,ab OR 'task force':ff OR committee*:ff OR council*:ff OR association:ff OR 'working group':ff OR society:ff OR consortium:ff OR 'task force':au OR committee*:au OR council*:au OR association:au OR 'working group':au OR society:au OR consortium:au) NOT ('case report*':ti OR pediatric*:ti OR paediatric*:ti OR baby:ti OR babies:ti OR infan*:ti OR preterm:ti OR premature:ti OR birth:ti OR gestat*:ti OR neonat*:ti OR newborn*:ti OR child*:ti OR boy:ti OR boys:ti OR girl:ti OR girls:ti OR 'school-age*':ti OR preschool*:ti OR 'pre-school*':ti OR school*:ti OR developmental*:ti OR student*:ti OR juvenile*:ti OR adolescen*:ti OR teen*:ti OR youth:ti OR 'young age':ti OR congenital*:ti OR (month*:ti AND age:ti) OR ([animals]/lim NOT [humans]/lim) OR mouse:ti OR mice:ti OR rat:ti OR rats:ti OR animal*:ti OR murine:ti OR canine*:ti OR dog:ti OR dogs:ti OR pupp*:ti OR dalmatian*:ti OR feline*:ti OR cat:ti OR cats:ti OR pig:ti OR pigs:ti OR porcine:ti OR swine:ti OR cow:ti OR cows:ti OR cattle:ti OR sheep*:ti OR bovine:ti OR equine:ti OR horse*:ti OR primate*:ti OR monkey*:ti OR chimp*:ti OR avian:ti OR bird*:ti OR chick*:ti OR hen:ti OR owl:ti OR owls:ti OR finch*:ti OR dolphin*:ti OR fish*:ti OR zebra*:ti OR 'zebra fish':ti OR 'sea lion*':ti OR salmon*:ti OR hamster*:ti OR gerbil*:ti OR chinchilla*:ti OR 'fruit fly':ti OR 'fruit flies':ti OR drosophila:ti) AND [english]/lim	
Proquest central	noft((presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss")) AND noft((geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR ageism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*)) AND noft("systematic review*" OR "systematic literature review*" OR	262

(*continued*)

Table A1. (continued)

Websites and databases searched	Search terms	#
	"meta-analy*" OR guideline* OR "best practice*" OR "good practice*" OR consensus OR report OR pathway* OR "practice parameter*" OR statement* OR "position paper" OR "task force*" OR "expert panel" OR recommend* OR synthesis OR "rapid review*" OR "appropriateness criteri*" OR "classification criteri*" OR "diagnostic criteri*" OR pubmed OR medline OR embase OR scopus OR "web of science" OR "web of knowledge" OR CINAHL OR PsycInfo OR "Google Scholar" OR ScienceDirect OR Ebsco OR Elsevier OR ovid OR "cochrane database" OR "cochrane library" OR "search strateg*" OR PRISMA) NOT title("case report*" OR pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age*" OR preschool* OR "pre-school*" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion*" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR Drosophila) Source type: Conference Papers & Proceedings, Scholarly Journals, Standards & Practice Guidelines Language: English	
PubMed	("Presbycusis"[Mesh] OR "age-related hearing loss"[tw] OR arhl[tw] OR presbycusis[tw] OR presbyacusis[tw] OR (("age-related"[tw] OR "aging"[tw] OR ageing[tw] OR progressive[tw] OR "adult onset" OR "advancing age"[tw] OR "advanced age"[tw] OR elder*[ti] OR older[ti] OR age[ti] OR aged[ti]) AND ("Speech Perception"[Mesh] OR "Hearing Loss"[MeSH] OR "speech perception"[tw] OR "hearing health care"[tw] OR "hearing impair*"[tw] OR "hearing deficit*"[tw] OR "hearing loss"[tw] OR "hearing status"[tw] OR "hearing difficult*"[tw] OR "hearing preservation"[tw]))) AND ("Aged"[MeSH] OR "Health Services for the Aged"[mesh] OR "Geriatric Assessment"[mesh] OR "Geriatrics"[mesh] OR "Geriatric Psychiatry"[mesh] OR "Geriatric Nursing"[mesh] OR "Geriatric Dentistry"[mesh] OR "Dental Care for Aged"[mesh] OR "Homes for the Aged"[mesh] OR "Nursing Homes"[mesh] OR "Housing for the Elderly"[mesh] OR "age factors"[mesh] OR geriatr*[tw] OR geront*[tw] OR elder*[tw] OR old[tw] OR older[tw] OR oldest[tw] OR eldest[tw] OR senior*[tw] OR aged*[tw] OR aging[tw] OR agism[tw] OR "age factor*"[tw] OR "age-stratified"[tw] OR "age-related"[tw] OR "age-associated"[tw] OR "aging-related"[tw] OR "advancing age"[tw] OR "advanced age*"[tw] OR retired[tw] OR retirement[tw] OR Retiree*[tw] OR "social security"[tw] OR "nursing home*"[tw] OR "assisted living"[tw] OR pension*[tw] OR senium*[tw] OR senil*[tw] OR dementia [tw] OR grandparent*[tw] OR grandmother*[tw] OR grandfather*[tw] OR grandma*[tw] OR grandpa*[tw] OR sexagenarian*[tw] OR septuagenarian* [tw] OR octogenarian*[tw] OR nonagenarian*[tw] OR centenarian*[tw] OR supercentenarian*[tw]) AND (english[Filter]) AND (guideline[Filter] OR meta-analysis[Filter] OR practiceguideline[Filter] OR systematicreview[Filter] OR "systematic review*"[ti] OR "systematic literature review*"[ti] OR "meta-analy*"[ti] OR guideline*[ti] OR "best practice*"[ti] OR "good practice*"[ti] OR consensus[ti] OR report[ti] OR pathway*[ti] OR "practice parameter*"[ti] OR statement*[ti] OR "position paper"[ti] OR "task force*"[ti] OR "expert panel"[tiab] OR recommend*[ti] OR synthesis[ti] OR	364

(*continued*)

Table A1. (continued)

Websites and databases searched	Search terms	#
Scopus	"rapid review*"[ti] OR "appropriateness criteri*"[ti] OR "classification criteri*"[ti] OR "diagnostic criteri*"[ti] OR pubmed[tiab] OR medline[tiab] OR embase[tiab] OR scopus[tiab] OR "web of science"[tiab] OR "web of knowledge"[tiab] OR CINAHL[tiab] OR PsycInfo[tiab] OR "Google Scholar"[tiab] OR ScienceDirect[tiab] OR Ebsco[tiab] OR Elsevier[tiab] OR ovid[tiab] OR "cochrane database"[tiab] OR "cochrane library"[tiab] OR "Cochrane Database Syst Rev"[jour] OR "search strateg*"[tiab] OR PRISMA [tiab] OR "task force"[ad] OR committee*[ad] OR council*[ad] OR association[ad] OR "working group"[ad] OR society[ad] OR consortium[ad] OR "task force"[cn] OR committee*[cn] OR council*[cn] OR association[cn] OR "working group"[cn] OR society[cn] OR consortium[cn]) NOT ("case report*"[ti] OR pediatric*[ti] OR paediatric*[ti] OR baby[ti] OR babies[ti] OR infan*[ti] OR preterm[ti] OR premature[ti] OR birth[ti] OR gestat*[ti] OR neonat*[ti] OR newborn*[ti] OR child*[ti] OR boy[ti] OR boys[ti] OR girl[ti] OR girls[ti] OR "school-age*"[ti] OR preschool*[ti] OR "pre-school*"[ti] OR school*[ti] OR developmental*[ti] OR student*[ti] OR juvenile*[ti] OR adolescen*[ti] OR teen*[ti] OR youth[ti] OR "young age"[ti] OR congenital*[ti] OR (month*[ti] AND age[ti]) OR (animal[Filter] NOT humans[Filter]) OR mouse[ti] OR mice[ti] OR rat[ti] OR rats[ti] OR animal* [ti] OR murine[ti] OR canine*[ti] OR dog[ti] OR dogs[ti] OR pupp*[ti] OR dalmatian*[ti] OR feline*[ti] OR cat[ti] OR cats[ti] OR pig[ti] OR pigs[ti] OR porcine[ti] OR swine[ti] OR cow[ti] OR cows[ti] OR cattle[ti] OR sheep*[ti] OR bovine[ti] OR equine[ti] OR horse*[ti] OR primate*[ti] OR monkey*[ti] OR chimp*[ti] OR avian[ti] OR bird*[ti] OR chick*[ti] OR hen[ti] OR owl[ti] OR owls[ti] OR finch*[ti] OR dolphin*[ti] OR fish*[ti] OR zebra*[ti] OR "zebra fish"[ti] OR "sea lion*"[ti] OR salmon*[ti] OR hamster*[ti] OR gerbil* [ti] OR chinchilla*[ti] OR "fruit fly"[ti] OR "fruit flies"[ti] OR Drosophila[ti] (TITLE-ABS-KEY (presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss") AND TITLE-ABS-KEY (geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor" OR "age factors" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age" OR "advanced ages" OR retired OR retirement OR retiree* OR "social security" OR "nursing home" OR "nursing homes" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*)) AND (TITLE ("systematic review" OR "systematic reviews" OR "systematic literature review" OR "systematic literature reviews" OR "meta-analysis" OR "meta-analyses" OR guideline* OR "best practice" OR "good practice" OR "best practices" OR "good practices" OR consensus OR report OR pathway* OR "practice parameter" OR "practice parameters" OR statement* OR "position paper" OR "task force" OR "task forces" OR "expert panel" OR recommend* OR synthesis OR "rapid review" OR "rapid reviews" OR "appropriateness criterion" OR "appropriateness criteria" OR "classification criterion" OR "classification criteria" OR "diagnostic criterion" OR "diagnostic criteria") OR TITLE-ABS (pubmed OR medline OR embase OR scopus OR "web of science" OR "web of knowledge" OR cinahl OR psycinfo OR "Google Scholar" OR sciencedirect OR ebsco OR elsevier OR ovid OR	256

(*continued*)

Table A1. (continued)

Websites and databases searched	Search terms	#
	"cochrane database" OR "cochrane library" OR "search strategy" OR "search strategies" OR prisma)) AND NOT (TITLE ("case report" OR "case reports" OR pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age" OR "school-ages" OR "school-aged" OR preschool* OR "pre-school" OR "pre-schools" OR "pre-schooler" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion" OR "sea lions" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR drosophila)) AND (LANGUAGE, "English")	

September to October 2022.
Abbreviation: SR, systematic review.

Appendix B. Stage 2 Literature Search

See **Table B1**.

Table B1. Stage 2 Literature Search: RCTs

Websites and databases searched	Search terms	#
ClinicalTrials.gov	47 Studies found for: **age-related hearing loss OR presbycusis OR presbyacusis OR presbycuses** Also searched for **Age-related hearing loss, Presbycuses, Deafness** and more.	47
TRIPdatabase.com	presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss" Filter: Clinical Trial	10
WHO ICTRP	Age-related hearing loss 38 Presbycusis 33 Presbyacusis 5	76
Google scholar	"randomized controlled trial" "age-related hearing loss"	0
Databases searched	Search Terms	#
Biosis citation index	(TS=(presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss") OR TI=("hearing loss" OR "hearing impair*" OR speech OR auditory)) AND TS=(geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor" OR "age factors" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age" OR "advanced ages" OR retired OR retirement OR retiree* OR "social security" OR "nursing home" OR "nursing homes" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*) AND (TS=("randomized controlled trial*" OR "randomised controlled trial*" OR "randomized control trial*" OR "randomised control trial*" OR "randomized trial*" OR "randomised trial*" OR "control group*" OR "random allocation" OR "randomly allocate*" OR "control trial*" OR "controlled trial*" OR sham OR placebo* OR "single blind*" OR "double blind*" OR "triple blind*" OR "treble blind*") OR TI=(random*)) NOT TI=(pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age" OR "school-ages" OR "school-aged" OR preschool* OR "pre-school" OR "pre-schools" OR "pre-schooler" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion" OR "sea lions" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR drosophila) | Refined by: Languages English	779
CINAHL	CINAHL TITLE SEARCH 167 (((MH "Presbycusis" OR TI("age-related hearing loss" OR arhl OR presbycusis OR presbyacusis) OR AB("age-related hearing loss" OR arhl OR presbycusis OR presbyacusis) OR (TI("age-related" OR "aging" OR ageing OR progressive OR "adult onset" OR "advancing age" OR "advanced age" OR elder* OR older OR age OR aged) OR AB("age-related" OR "aging" OR ageing OR progressive OR "adult onset" OR "advancing age" OR "advanced age")) AND (MH "Speech Perception" OR MH "Hearing Disorders" OR MH "Hearing Loss, Partial+" OR TI ("speech perception" OR "hearing health care" OR "hearing impair*" OR "hearing deficit*" OR "hearing loss" OR "hearing status" OR "hearing difficult*" OR "hearing preservation") OR AB ("speech perception" OR "hearing health care" OR "hearing impair*" OR "hearing deficit*" OR "hearing loss" OR "hearing status" OR "hearing difficult*" OR "hearing preservation")))) AND ((MH "Age Specific Care" OR MH "Age Factors" OR MH "Ageism" OR MH "Aged+" OR MH "Hospitalization of Older Persons" OR MH "Health Services for Older Persons" OR MH "Dental Care for Older Persons" OR MH "Rehabilitation, Geriatric" OR MH "Housing for Older Persons"	47 + 167

(*continued*)

Table B1. (continued)

Websites and databases searched	Search terms	#
	OR MH "Gerontologic Nursing+" OR MH "Gerontologic Care" OR MH "Assisted Living" OR MH "Aging+" OR TI(geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*) OR AB(geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*))) NOT (TI("case report*" OR pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age*" OR preschool* OR "pre-school*" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR (month* AND age)) OR (MH "Animals+" NOT MH "Human") OR TI(mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion*" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR Drosophila))) AND ("randomized controlled trial*" OR "randomised controlled trial*" OR "randomized control trial*" OR "randomised control trial*" OR "randomized trial*" OR "randomised trial*" OR "control group*" OR "random allocation" OR "randomly allocate*" OR "control trial*" OR "controlled trial*" OR sham OR placebo* OR "single blind*" OR "double blind*" OR "triple blind*" OR "treble blind*")	
	CINAHL FILTER SEARCH 47 ((MH "Presbycusis" OR TI("age-related hearing loss" OR arhl OR presbycusis OR presbyacusis) OR AB("age-related hearing loss" OR arhl OR presbycusis OR presbyacusis) OR (TI("age-related" OR "aging" OR ageing OR progressive OR "adult onset" OR "advancing age" OR "advanced age" OR elder* OR older OR age OR aged) OR AB("age-related" OR "aging" OR ageing OR progressive OR "adult onset" OR "advancing age" OR "advanced age")) AND (MH "Speech Perception" OR MH "Hearing Disorders" OR MH "Hearing Loss, Partial+" OR TI ("speech perception" OR "hearing health care" OR "hearing impair*" OR "hearing deficit*" OR "hearing loss" OR "hearing status" OR "hearing difficult*" OR "hearing preservation") OR AB ("speech perception" OR "hearing health care" OR "hearing impair*" OR "hearing deficit*" OR "hearing loss" OR "hearing status" OR "hearing difficult*" OR "hearing preservation")))) AND ((MH "Age Specific Care" OR MH "Age Factors" OR MH "Ageism" OR MH "Aged+" OR MH "Hospitalization of Older Persons" OR MH "Health Services for Older Persons" OR MH "Dental Care for Older Persons" OR MH "Rehabilitation, Geriatric" OR MH "Housing for Older Persons" OR MH "Gerontologic Nursing+" OR MH "Gerontologic Care" OR MH "Assisted Living" OR MH "Aging+" OR TI(geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*) OR AB(geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*))) NOT (TI("case report*" OR pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age*" OR preschool* OR "pre-school*" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR	

(*continued*)

Table B1. (continued)

Websites and databases searched	Search terms	#
	"young age" OR congenital* OR (month* AND age)) OR (MH "Animals+" NOT MH "Human") OR TI(mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion*" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR Drosophila)) Limiters - Publication Type: Randomized Controlled Trial, english	
Cochrane CENTRAL	#1 presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss" 122 #2 ("hearing loss" OR "hearing impair*" OR speech OR auditory):ti 4712 #3 geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor" OR "age factors" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age" OR "advanced ages" OR retired OR retirement OR retiree* OR "social security" OR "nursing home" OR "nursing homes" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*695209 #4 (random*):ti 401927 #5 "randomized controlled trial*" OR "randomised controlled trial*" OR "randomized control trial*" OR "randomised control trial*" OR "randomized trial*" OR "randomised trial*" OR "control group*" OR "random allocation" OR "randomly allocate*" OR "control trial*" OR "controlled trial*" OR sham OR placebo* OR "single blind*" OR "double blind*" OR "triple blind*" OR "treble blind*"1150591 #6 (pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age" OR "school-ages" OR "school-aged" OR preschool* OR "pre-school" OR "pre-schools" OR "pre-schooler" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion" OR "sea lions" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR drosophila):ti186310 #7 #1 OR # 24789 #8 #4 OR #5 1214451 #9 #7 AND #3 AND #8 NOT #6 in Trials 819	819
Embase	('age related hearing loss'/exp OR 'age related hearing impairment'/exp OR 'presbyacusis'/exp OR 'age-related hearing loss':ti,ab OR arhl:ti,ab OR presbycusis:ti,ab OR presbyacusis:ti,ab OR (('age-related':ti,ab OR 'aging':ti,ab OR ageing:ti,ab OR progressive:ti,ab OR 'adult onset':ti,ab OR 'advancing age':ti,ab OR 'advanced age':ti,ab OR elder*:ti OR older:ti OR age:ti OR aged:ti) AND ('speech perception'/de OR 'hearing impairment'/exp OR 'speech perception':ti OR 'hearing health care':ti OR 'hearing impair*':ti OR 'hearing deficit*':ti OR 'hearing loss':ti OR 'hearing status':ti OR 'hearing difficult*':ti OR 'hearing preservation':ti))) AND ('aged'/exp OR 'elderly care'/exp OR 'geriatric assessment'/exp OR 'geriatrics'/exp OR 'gerontopsychiatry'/exp OR 'geriatric nursing'/exp OR 'geriatric dentistry'/exp OR 'nursing home'/exp OR 'home for the aged'/exp OR 'age'/exp OR geriatr*:ti,ab OR geront*:ti,ab OR elder*:ti,ab OR old:ti,ab OR older:ti,ab OR oldest:ti,ab OR eldest:ti,ab OR senior*:ti,ab OR aged*:ti,ab OR aging:ti,ab OR agism:ti,ab OR 'age factor*':ti,ab OR 'age-stratified':ti,ab OR 'age-related':ti,ab OR 'age-associated':ti,ab OR 'aging-related':ti,ab OR 'advancing age':ti,ab OR 'advanced age*':ti,ab OR retired:ti,ab OR retirement:ti,ab OR retiree*:ti,ab OR 'social security':ti,ab OR 'nursing home*':ti,ab OR 'assisted living':ti,ab OR pension*:ti,ab OR senium*:ti,ab OR senil*:ti,ab OR dementia:ti,ab OR grandparent*:ti,ab OR grandmother*:ti,ab OR grandfather*:ti,ab OR grandma*:ti,ab OR grandpa*:ti,ab OR sexagenarian*:ti,ab OR septuagenarian*:ti,ab OR	697

(*continued*)

Table B1. (continued)

Websites and databases searched	Search terms	#
	octogenarian*:ti,ab OR nonagenarian*:ti,ab OR centenarian*:ti,ab OR supercentenarian*:ti,ab) AND [english]/lim AND ('randomized controlled trial'/exp OR 'controlled clinical trial'/exp OR 'pragmatic trial'/exp OR 'equivalence trial'/exp OR 'phase 3 clinical trial'/exp OR 'randomized controlled trial (topic)'/exp OR 'controlled clinical trial (topic)'/exp OR 'randomization'/exp OR 'double blind procedure'/exp OR 'single blind procedure'/exp OR 'placebo'/de OR 'randomized controlled trial*':ti,ab,kw OR 'randomized control trial*':ti,ab,kw OR 'randomised controlled trial*':ti,ab,kw OR 'randomised control trial*':ti,ab,kw OR 'randomized trial*':ti,ab,kw OR 'randomised trial*':ti,ab,kw OR 'random allocation':ti,ab,kw OR 'control group*':ti,ab,kw OR (random* NEAR/3 allocat*) OR (random* NEAR/3 trial*) OR (control* NEAR/3 trial*) OR random*:ti,ab OR sham:ti,ab OR placebo*:ti,ab OR 'single blind*':ti,ab OR 'double blind*':ti,ab OR 'triple blind*':ti,ab OR 'treble blind*':ti,ab) NOT ('case report*':ti OR pediatric*:ti OR paediatric*:ti OR baby:ti OR babies:ti OR infan*:ti OR preterm:ti OR premature:ti OR birth:ti OR gestat*:ti OR neonat*:ti OR newborn*:ti OR child*:ti OR boy:ti OR boys:ti OR girl:ti OR girls:ti OR 'school-age*':ti OR preschool*:ti OR 'pre-school*':ti OR school*:ti OR developmental*:ti OR student*:ti OR juvenile*:ti OR adolescen*:ti OR teen*:ti OR youth:ti OR 'young age':ti OR congenital*:ti OR (month*:ti AND age:ti) OR ([animals]/lim NOT [humans]/lim) OR mouse:ti OR mice:ti OR rat:ti OR rats:ti OR animal*:ti OR murine:ti OR canine*:ti OR dog:ti OR dogs:ti OR pupp*:ti OR dalmatian*:ti OR feline*:ti OR cat:ti OR cats:ti OR pig:ti OR pigs:ti OR porcine:ti OR swine:ti OR cow:ti OR cows:ti OR cattle:ti OR sheep*:ti OR bovine:ti OR equine:ti OR horse*:ti OR primate*:ti OR monkey*:ti OR chimp*:ti OR avian:ti OR bird*:ti OR chick*:ti OR hen:ti OR owl:ti OR owls:ti OR finch*:ti OR dolphin*:ti OR fish*:ti OR zebra*:ti OR 'zebra fish':ti OR 'sea lion*':ti OR salmon*:ti OR hamster*:ti OR gerbil*:ti OR chinchilla*:ti OR 'fruit fly':ti OR 'fruit flies':ti OR drosophila:ti)	
Proquest Central	noft((presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss")) AND noft((geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR ageism OR "age factor*" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age*" OR retired OR retirement OR Retiree* OR "social security" OR "nursing home*" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*)) AND (title(random*) OR noft("randomized controlled trial*" OR "randomised controlled trial*" OR "randomized control trial*" OR "randomised control trial*" OR "randomized trial*" OR "randomised trial*" OR "control group*" OR "random allocation" OR "randomly allocate*" OR "control trial*" OR "controlled trial*" OR sham OR placebo* OR "single blind*" OR "double blind*" OR "triple blind*" OR "treble blind*")) NOT title("case report*" OR pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age*" OR preschool* OR "pre-school*" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion*" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR Drosophila) Source type: Scholarly Journals Language: English	46
PubMed	("Presbycusis"[Mesh] OR "age-related hearing loss"[tw] OR arhl[tw] OR presbycusis[tw] OR presbyacusis[tw] OR (("age-related"[tw] OR "aging"[tw] OR ageing[tw] OR progressive[tw] OR "adult onset" OR "advancing age"[tw] OR "advanced age"[tw] OR elder*[ti] OR older[ti] OR age [ti] OR aged[ti]) AND ("Speech Perception"[Mesh] OR "Hearing Loss"[MeSH] OR "speech perception"[tw] OR "hearing health care"[tw] OR "hearing impair*"[tw] OR "hearing deficit*"[tw] OR "hearing loss"[tw] OR "hearing status"[tw] OR "hearing difficult*"[tw] OR "hearing preservation"[tw]))) AND ("Aged"[MeSH] OR "Health Services for the Aged"[mesh]	624

(*continued*)

Table B1. (continued)

Websites and databases searched	Search terms	#
	OR "Geriatric Assessment"[mesh] OR "Geriatrics"[mesh] OR "Geriatric Psychiatry"[mesh] OR "Geriatric Nursing"[mesh] OR "Geriatric Dentistry"[mesh] OR "Dental Care for Aged"[mesh] OR "Homes for the Aged"[mesh] OR "Nursing Homes"[mesh] OR "Housing for the Elderly"[mesh] OR "age factors"[mesh] OR geriatr*[tw] OR geront*[tw] OR elder*[tw] OR old [tw] OR older[tw] OR oldest[tw] OR eldest[tw] OR senior*[tw] OR aged*[tw] OR aging[tw] OR agism[tw] OR "age factor*"[tw] OR "age-stratified"[tw] OR "age-related"[tw] OR "age-associated"[tw] OR "aging-related"[tw] OR "advancing age"[tw] OR "advanced age*"[tw] OR retired[tw] OR retirement[tw] OR Retiree*[tw] OR "social security"[tw] OR "nursing home*"[tw] OR "assisted living"[tw] OR pension*[tw] OR senium*[tw] OR senil*[tw] OR dementia[tw] OR grandparent*[tw] OR grandmother*[tw] OR grandfather*[tw] OR grandma* [tw] OR grandpa*[tw] OR sexagenarian*[tw] OR septuagenarian*[tw] OR octogenarian*[tw] OR nonagenarian*[tw] OR centenarian*[tw] OR supercentenarian*[tw]) AND (english[Filter]) AND ("Randomized Controlled Trial"[pt] OR "Controlled Clinical Trial"[pt] OR "Pragmatic Clinical Trial"[pt] OR "Equivalence Trial"[pt] OR "Clinical Trial, Phase III"[pt] OR "Randomized Controlled Trials as Topic"[mh] OR "Controlled Clinical Trials as Topic"[mh] OR "Random Allocation"[mh] OR "Double-Blind Method"[mh] OR "Single-Blind Method"[mh] OR Placebos [Mesh:NoExp] OR "randomized controlled trial*"[tw] OR "randomized control trial*"[tw] OR "randomised controlled trial*"[tw] OR "randomised control trial*"[tw] OR "randomized trial*"[tw] OR "randomised trial*"[tw] OR "random allocation"[tw] OR "control group*"[tw] OR "random allocation"[tiab:~3] OR "randomly allocate"[tiab:~3] OR "randomly allocated"[tiab:~3] OR "randomized trial"[tiab:~3] OR "randomised trial"[tiab:~3] OR "control trial"[tiab:~3] OR "controlled trial"[tiab:~3] OR "randomized trials"[tiab:~3] OR "randomised trials"[tiab:~3] OR "control trials"[tiab:~3] OR "controlled trial"[tiab:~3] OR random*[tiab] OR sham[tiab] OR placebo*[tiab] OR "single blind*"[tiab] OR "double blind*"[tiab] OR "triple blind*"[tiab]) AND (english[Filter]) AND (english[Filter]) NOT (pediatric*[ti] OR paediatric*[ti] OR baby[ti] OR babies[ti] OR infan*[ti] OR preterm[ti] OR premature[ti] OR birth[ti] OR gestat*[ti] OR neonat*[ti] OR newborn*[ti] OR child*[ti] OR boy[ti] OR boys[ti] OR girl[ti] OR girls[ti] OR "school-age*"[ti] OR preschool*[ti] OR "pre-school*"[ti] OR school*[ti] OR developmental*[ti] OR student*[ti] OR juvenile*[ti] OR adolescen*[ti] OR teen*[ti] OR youth[ti] OR "young age"[ti] OR congenital*[ti] OR (month*[ti] AND age[ti]) OR (animal[Filter] NOT humans[Filter]) OR mouse[ti] OR mice[ti] OR rat[ti] OR rats[ti] OR animal*[ti] OR murine[ti] OR canine*[ti] OR dog[ti] OR dogs[ti] OR pupp*[ti] OR dalmatian*[ti] OR feline*[ti] OR cat[ti] OR cats[ti] OR pig[ti] OR pigs[ti] OR porcine[ti] OR swine[ti] OR cow[ti] OR cows[ti] OR cattle [ti] OR sheep*[ti] OR bovine[ti] OR equine[ti] OR horse*[ti] OR primate*[ti] OR monkey*[ti] OR chimp*[ti] OR avian[ti] OR bird*[ti] OR chick*[ti] OR hen[ti] OR owl[ti] OR owls[ti] OR finch*[ti] OR dolphin*[ti] OR fish*[ti] OR zebra*[ti] OR "zebra fish"[ti] OR "sea lion*"[ti] OR salmon*[ti] OR hamster*[ti] OR gerbil*[ti] OR chinchilla*[ti] OR "fruit fly"[ti] OR "fruit flies"[ti] OR Drosophila[ti])	
Scopus	(TITLE-ABS-KEY (presbycusis OR presbyacusis OR "age-related hearing loss" OR "progressive hearing loss" OR "late onset hearing loss") AND TITLE-ABS-KEY (geriatr* OR geront* OR elder* OR old OR older OR oldest OR eldest OR senior* OR aged* OR aging OR agism OR "age factor" OR "age factors" OR "age-stratified" OR "age-related" OR "age-associated" OR "aging-related" OR "advancing age" OR "advanced age" OR "advanced ages" OR retired OR retirement OR retiree* OR "social security" OR "nursing home" OR "nursing homes" OR "assisted living" OR pension* OR senium* OR senil* OR dementia OR grandparent* OR grandmother* OR grandfather* OR grandma* OR grandpa* OR sexagenarian* OR septuagenarian* OR octogenarian* OR nonagenarian* OR centenarian* OR supercentenarian*)) AND (TITLE (random*) OR TITLE-ABS ("randomized controlled trial*" OR "randomised controlled trial*" OR "randomized control trial*" OR "randomised control trial*" OR "randomized trial*" OR "randomised trial*" OR "control group*" OR "random allocation" OR "randomly allocate*" OR	163

(*continued*)

Table B1. (continued)

Websites and databases searched	Search terms	#
	"control trial*" OR "controlled trial*" OR sham OR placebo* OR "single blind*" OR "double blind*" OR "triple blind*" OR "treble blind*")) AND NOT (TITLE (pediatric* OR paediatric* OR baby OR babies OR infan* OR preterm OR premature OR birth OR gestat* OR neonat* OR newborn* OR child* OR boy OR boys OR girl OR girls OR "school-age" OR "school-ages" OR "school-aged" OR preschool* OR "pre-school" OR "pre-schools" OR "pre-schooler" OR school* OR developmental* OR student* OR juvenile* OR adolescen* OR teen* OR youth OR "young age" OR congenital* OR mouse OR mice OR rat OR rats OR animal* OR murine OR canine* OR dog OR dogs OR pupp* OR dalmatian* OR feline* OR cat OR cats OR pig OR pigs OR porcine OR swine OR cow OR cows OR cattle OR sheep* OR bovine OR equine OR horse* OR primate* OR monkey* OR chimp* OR avian OR bird* OR chick* OR hen OR owl OR owls OR finch* OR dolphin* OR fish* OR zebra* OR "zebra fish" OR "sea lion" OR "sea lions" OR salmon* OR hamster* OR gerbil* OR chinchilla* OR "fruit fly" OR "fruit flies" OR drosophila)) AND (language AND, "English")	

November 2022 to December 2022.