Hearing Deficits in the Older Patient
"I Didn't Notice Anything"

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Hearing loss is common in older adults. Patients, clinicians, and health care staff often do not recognize hearing loss, particularly in its early stages, and it is undertreated. Age-related hearing loss or presbycusis, the most common type of hearing loss in older adults, is a multifactorial sensorineural loss that frequently includes a component of impaired speech discrimination. Simple office-based screening and evaluation procedures can identify potential hearing disorders, which should prompt audiologic referral to confirm the diagnosis with audiometric testing.The mainstay of treatment is amplification. For many older adults, accepting the need for amplification, selecting and purchasing a hearing aid, and getting accustomed to its use is a daunting and often frustrating process. There are numerous barriers to hearing aid use, the most common of which is dissatisfaction with its performance across a range of sonic environments. Newer digital hearing aids have many features that improve performance, making them potentially more acceptable to users, but they are expensive and are not covered by Medicare. Hearing aids have been demonstrated to improve hearing function and hearing-related quality of life (QOL), but evidence is less robust for improving overall QOL. Depending upon the etiology of the hearing loss, other medical and surgical procedures, including cochlear implantation, may benefit older adults. Older adults with multiple morbidities and who are frail pose specific challenges for the management of hearing loss. These patients may require integration of hearing assessment and treatment as part of functional assessment in an interdisciplinary, team-based approach to care.

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THE PATIENT'S STORY

Mrs N is a 75-year-old Latina woman evaluated for a 2- to 3-year history of hearing loss, more bothersome to family members than to herself. Mrs N lives with her husband of 49 years in their own home. She previously worked as a private tutor of Spanish and English at a language school. She is independent in activities of daily living. Although she denies having significant hearing problems, when pressed, Mrs N acknowledges having to increase the television volume, often choosing subtitles for greater comprehension, and having some difficulty with telephone conversations. It is difficult for her to understand speech in group settings. Her husband and daughters have noticed that she sometimes completely misunderstands what they are saying and must ask for clarification.

Medical history is significant for varicose veins, hypercholesterolemia and hypertension both controlled by diet, and recent herpes zoster. She is taking no medications. On review of systems, she states that she does not have headaches, visual disturbances, or balance problems. She wears eyeglasses.

On physical examination, the pinnae, canals, and tympanic membranes appear normal. Two years ago, audiometry documented bilateral symmetric moderate to severe sensorineural hearing loss, more pronounced in the higher frequencies, meeting criteria for bilateral hearing aid augmentation. Although her audiologist recommended a hearing aid evaluation at the time of examination, Mrs N and her sister did not think she needed it, so she did not undergo the evaluation. One year later, the audiologist again recommended a hearing aid consultation, but it was only after Mrs N's daughters pressured her repeatedly that she agreed to proceed with a hearing aid fitting.

Mrs N and her daughter were interviewed by a Care of the Aging Patient editor between January 5 and 11, 2011.

Perspectives

Mrs N: *To be truthful, I didn't notice anything* [at first about hearing difficulties]. *My daughters started telling me that I*

See also pp 1147 and Patient Page.

CME available online at www.jamaarchivescme.com and questions on p 1207.

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was not hearing them well. In my book group . . . there is a Southern lady and she speaks softly. She is the only one that I've been noticing I'm having trouble hearing.

Mrs N's Daughter: *There were a lot of conversations where my mother would say, "Hmm?" Then, after a few months, she didn't even notice that she was saying it. There were a lot of conversations where . . . we were having to speak louder but also, in some instances . . . she misunderstood what we were saying.*

PREVALENCE, ETIOLOGY, AND CONSEQUENCES OF HEARING LOSS

Among adults aged 70 years and older in the 2005-2006 cycle of the National Health and Nutrition Examination Survey, the prevalence of hearing loss was 63%, and those with moderate to severe hearing loss comprised 27% of the cohort.[1] Hearing loss increases geometrically with age[2]; in the Framingham Study, the frequency of participants aged 65 to 69 years and 85 to 90 years who reported hearing problems was 34% and 72%, respectively.[3] The World Health Organization estimates that 299 million men and 239 million women have hearing loss.[4] Despite its high prevalence, hearing loss is often unrecognized by patients and clinicians and is undertreated; measured prevalences of hearing-impaired older adults who have never used a hearing aid are as high as 79%.[5-8] Consequences of hearing loss may be substantial because it is associated with social isolation, functional decline, poor quality of life (QOL), depressive symptoms, and cognitive deficits.[9-14]

The severity of hearing loss is based on the volume at which pure tones can be heard on audiometric testing. The American Speech-Language-Hearing Association (ASHA) defines normal hearing as a hearing threshold of 0 to 25 dB; thresholds for mild, moderate, moderately severe, severe, and profound hearing loss are 26 to 40 dB, 41 to 55 dB, 56 to 70 dB, 71 to 90 dB, and 91 dB or greater, respectively.[15]

Hearing loss is commonly classified as sensorineural, conductive, or mixed. Sensorineural hearing loss is caused by cochlear or retrocochlear pathology. Sensorineural loss can occur gradually over years (eg, noise-induced hearing loss), weeks to months (eg, drug-induced ototoxicity), or hours to days (as seen in inner ear disorders such as Meniere disease or labyrinthitis). Conductive hearing loss is caused by mechanical impairment in transmission of sound from the external ear to the inner ear. Prominent causes in older adults include cerumen impaction, otosclerosis, and otitis media.

Presbycusis, commonly referred to as age-related hearing loss, is a multifactorial sensorineural loss affecting high frequencies initially and becoming progressively worse over decades in adults older than 50 years. Presbycusis is the most common form of hearing loss affecting older adults. In addition to age, presbycusis is strongly associated with noise exposure.[16,17] Frequently, a component of central auditory processing disorder accompanies presbycusis, further impairing speech discrimination.[18] Central auditory processing disorder is very common in older adults, with a prevalence as high as 95% among individuals aged 80 years and older.[19,20]

The high prevalence of hearing loss in older adults, its underrecognition, and the complexity of treatment pose several challenges to the primary care clinician. In this review, we use the case of Mrs N to highlight common issues encountered in the primary care of adults with age-related hearing loss—detection, evaluation, and management strategies.

METHODS

We searched PubMed for English-language articles on humans from 1980 through December 1, 2011, using terms focusing on older adults (*aged*, *elderly*, *geriatric,* or *older adult*) with hearing loss (*hearing loss*, *presbycusis,* or *hearing disorder*). For the literature search conducted to produce the eTable (available at http://www.jama.com), we included the previously mentioned terms and cross-referenced them with the terms *hearing aid* or *assistive listening device*, a search that yielded 1742 abstracts. These abstracts were reviewed and selected for consideration based on measured outcomes of hearing function and hearing-related QOL as well as quality of evidence. We used the GRADE system for classifying quality of evidence, in which levels A, B, C, and D indicate high quality, moderate quality, low quality, and very low quality, respectively.[21] Randomized controlled trials, quasi-experimental trials, crossover trials, and meta-analyses of observational studies reporting the previously mentioned outcomes, ie, studies that would start with an evidence quality rating of B or better, were selected for inclusion in the eTable.

DETECTION AND EVALUATION OF HEARING LOSS

Screening

Hearing loss can be detected through assessing patient history or screening. Screening for hearing loss can be accomplished by direct questioning, validated surveys, simple physical examination techniques, or handheld audiometry (**Box 1**).[22-30] The positive and negative likelihood ratios (LRs) of these modalities are generally in the range of 2.5 to 10 and 0.05 to 0.5, respectively, constituting acceptable test performance for screening for hearing loss given its high pretest likelihood in older adults (B).[25]

In the only published randomized controlled trial of screening for hearing loss, hearing aid use was significantly higher in the 3 screened groups (4.1% in those using a questionnaire, 6.3% using handheld audiometry, and 7.4% using both modalities) vs unscreened control participants (3.3%) at 1-year follow-up.[31] In 1996, the United States Preventive Services Task Force (USPSTF) recommended periodic screening of older adults for hearing loss, the frequency of which was left to the practitioner's discretion. Based on a 2011 review,[29] the USPSTF issued a draft "I" recom-

Box 1. Detection and Initial Workup of Hearing Loss

History

Single question[a]

"Would you say you have any difficulty hearing?"[22]

"Do you feel you have hearing loss?"[23,24]

(Positive likelihood ratio [LR] range, 2.4-4.2; negative LR range, 0.33-0.55)[25]

Questionnaire[a]

Hearing Handicap Inventory for the Elderly-Screening Version (has 10 items; score range, 0-40; positive screen, >8-point score)[26,27]

(Positive LR range, 2.4-7.9; negative LR range, 0.25-0.70)[25]

Reports from patient/family/caregiver

Confusion in social situations

Inability to understand speech, especially in noisy environments

Excessive volume of television/radio/computer

Social withdrawal

Anxiety in group settings

Additional history if hearing loss is suspected or detected

Time course of hearing loss

Symptoms of tinnitus, ear pain, otorrhea, or vertigo

History of noise exposure, ear trauma, or head trauma

Presence of any neurologic deficit

Physical Examination and Additional Testing

Hearing tests (performed on each ear separately)[a]

Whisper test at 2 feet (positive test indicated by failure to repeat at least 3 of 6 letter/number combinations)

(Positive LR=7.4; negative LR=0.007)[28,29]

Finger rub at 6 inches (positive test indicated by failure to identify rub in ≥2 of 6 trials)

(Positive LR=10; negative LR=0.75)[29,30]

Watch tick at 6 inches (positive test is failure to identify ticking in ≥2 of 6 trials)

(Positive LR=70; negative LR=0.57)[29,30]

Weber and Rinne tests (inappropriate for screening[25] but may be helpful for determining hearing loss etiology)

Ear examination (check for cerumen impaction [remove by direct curettage or warm water irrigation with or without prior application of cerumenolytic agent] or external or middle ear pathology)

Cognitive screening (if screening results are positive, assess with mental status examination)

Affective disorder testing (for depression and anxiety; perform if history of avoidance, withdrawal, or anxiety in social situations)

Head imaging study (consider if hearing loss is grossly asymmetrical)

Audiometric Testing

Handheld audioscope (insert probe in ear [sealing canal] and have patient indicate if tones can be heard)[a]

(Positive LR range, 3.1-5.8; negative LR range, 0.03-0.40)[25]

Formal audiometry (referral to audiologist to establish diagnosis of suspected hearing loss)

[a]Method reported as effective for screening and as a diagnostic modality.

mendation that there is insufficient evidence to assess the relative benefits and harms of hearing loss screening in adults aged 50 years and older.[32] ASHA produced a comprehensive set of guidelines in 1997, calling for audiometric screening of adults older than 50 years, every 3 years.[33] In 1996, the American Academy of Family Physicians recommended periodic questioning of older adults about hearing impairment.[34] Overall, although the evidence is relatively sparse regarding the efficacy of screening for changing outcomes, we submit that the high prevalence and lack of recognition of hearing loss, as well as the availability of effective treatments for it (discussed later), warrant incorporation of hearing loss screening for older adults in primary care practices, especially given the ease, brevity, low cost, and apparent safety of screening. Hearing loss screening is a required element of the initial Medicare annual wellness visit.[35]

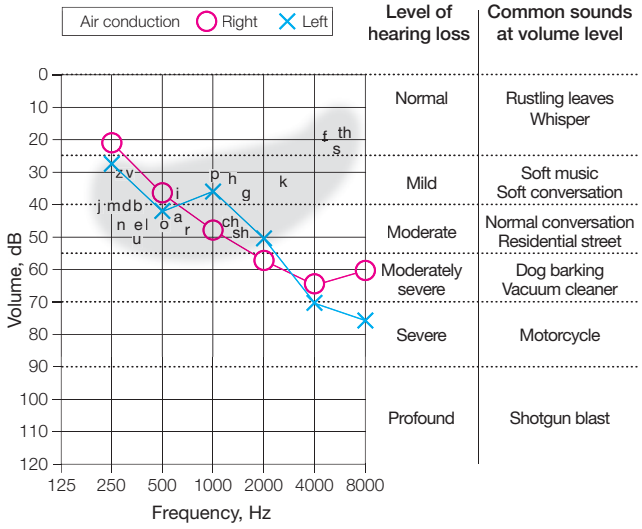
Primary Care Evaluation and Referral

Box 1 presents elements of the initial evaluation of suspected hearing loss. Although not formally studied, it is probably of equal, if not greater, importance to question a family member or caregiver regarding the extent of a patient's hearing loss and functioning. Clinicians should also use the opportunity of obtaining the history to observe a patient's ability to hear or understand speech, especially when not directly facing the examiner.

It is essential to look in the ear. Cerumen accumulation is common in older adults and can result in significant hearing loss if the canal is completely occluded. If so, cerumen should be removed by direct curettage or irrigation with lukewarm water. To facilitate removal, cerumenolytics can be used for several days or 30 minutes prior to irrigation. The ear examination should also look for pathology of the external or middle ear.

All patients with suspected or definite hearing loss should be referred to an audiologist for audiometric testing, which objectively measures hearing function. An audiologist is a master's- or doctoral-level professional specializing in the detection, diagnosis, and treatment of hearing and vestibular disorders. All newly trained audiologists in the United

Figure 1. Audiogram of Patient With Age-Related Hearing Loss



Mrs N's audiogram shows the typical downward sloping pattern, reflecting hearing loss at progressively higher sound frequencies seen in age-related hearing loss. Bone conduction coordinates, which would also be shown in a routine audiogram, are omitted for clarity; in age-related hearing loss, the patterns of bone and air conduction would be very similar. Speech sounds are shown as common sounds at volume level. The shallow U-shaped pattern sometimes referred to as the "speech banana" shows how high-frequency hearing loss primarily affects the ability to hear consonant sounds.[36]

States are required to have a doctoral degree (AuD). Audiologists can attain a certificate of clinical competence in audiology (CCC-A) by ASHA.

Audiometry measures hearing thresholds of pure tones through a frequency range of 250 to 8000 Hz, reported as an audiogram (FIGURE 1).[36] Audiometry also involves word recognition tests to evaluate speech comprehension, bone conduction testing to indicate possible otosclerosis or other conduction deficits, acoustic reflexes to look for ossicular chain abnormalities such as otosclerosis, and tympanometry to assess for middle-ear disease.

Referral to an otolaryngologist is indicated if there is a history of trauma leading to hearing loss, presence of perforated tympanic membrane, persistent and copious ear drainage, hearing loss associated with severe vertigo, or signs of severe infection. Urgent evaluation by an otolaryngologist is indicated for sudden hearing loss. Although most cases of sudden sensorineural loss remain idiopathic even after evaluation, prompt referral may result in minimization of permanent hearing loss. Referral is also indicated when an audiogram shows significant asymmetrical hearing loss or when an abnormal hearing test result does not have an apparent explanation.[37]

THE PATIENT'S STORY (*continued*)

An audio prosthetist instructed Mrs N about various hearing aid models supplied by 1 manufacturer, discussing advantages and disadvantages of unilateral vs bilateral aids. Mrs N purchased 1 hearing aid for her left ear and the prosthetist programmed it for 2 settings, 1 for normal wear and 1 for public settings.

Mrs N: *When I was told the first time that it would be advisable to have a hearing aid, I refused. It was pressure from my family that made the decision for me. If they had not insisted so much, I would not have a hearing aid. Yesterday morning I had a meeting of my church group and again I was sitting next to one of the members who has a strong voice. I was sitting to her right and I could hear her more loudly than I would have wanted to . . . but I could hear the one person who I had not heard very well before.*

Mrs N's Daughter: *I did notice that she seemed to hear better. I also noticed, and I feel badly, she was struggling to adapt to it. It was really uncomfortable for her.*

MANAGEMENT

Communicating With Hearing-Impaired Older Adults

As seen in Mrs N's case, presbycusis preferentially affects the higher frequencies that encompass consonant sounds in language (Figure 1). Consonant sounds largely supply the distinctive nature of speech, so the higher-frequency loss seen in older adults impairs the ability to understand speech as well as to hear it.

The clinician can use several strategies to optimize communication with hearing-impaired older adults. Probably foremost among these is to directly ask the patient to describe the best way to communicate with him or her.[38] Before speaking, it is helpful to gain the patient's attention first, either with a hand gesture or by lightly touching the shoulder. Lip reading and comprehension can be optimized by directly facing the patient, avoiding sources of light behind the examiner, using complete sentences rather than individual words or short phrases, speaking slowly, and perhaps most importantly, not shouting. Shouting tends to increase the inflection of one's voice into the higher frequency register, where hearing-impaired adults have more difficulty understanding speech. Speaking louder can be helpful but the examiner should be conscious of keeping the inflection of the voice similar to conversational speech.

If communication is still difficult after trying these strategies, it may be necessary to speak in a normal conversational tone a few inches from the patient's ear. This has the disadvantage of breaking eye contact and requiring the clinician to move back and forth between the ear and a conventional examiner's position, but can be effective for short exchanges. Using gestures and verbal aids such as message boards or writing questions down may also be helpful. A portable handheld amplifier, with which the patient wears headphones and the examiner speaks into a microphone with adjustable volume, can be extremely effective for communicating with more severely impaired patients.

Amplification

Hearing Aid Use and Effectiveness. The purchase and effective use of a hearing aid is a daunting challenge for the older adult; Mrs N delayed obtaining one for more than a year after it was first recommended. Only about 20% of older adults who could benefit from a hearing aid actually wear one.[39] Owners of hearing aids often use them sporadically or not at all.[1,7] Correlates of hearing aid use include poorer self-assessed hearing function, worse objective hearing function, age, and education (B).[40,41] Many hearing-impaired older adults experience significant difficulties and dissatisfaction with hearing aids, especially over issues of performance across different acoustic environments, comfort, appearance, and cost.[41-44]

Despite the high prevalence of hearing loss, there is little high-quality research on hearing aid effectiveness. Generally, as shown in the eTable, hearing aids have been demonstrated to improve outcomes of speech perception, understanding, and hearing-related QOL, which encompasses social, emotional, and affective functioning related to hearing ability (A). Studies are less consistent in showing improved overall QOL measures with hearing aid use (C). Very few or no studies have investigated the impact of hearing aids on broader geriatric syndromes such as cognitive decline, falls, and immobility.

Types of Hearing Aids. Hearing aids are available in analog or digital forms, but most new models currently on the market are digital. The plethora of styles often makes selection of a hearing aid quite confusing for an older adult. Each type has its advantages and disadvantages (FIGURE 2).

Several countries, including many in Europe, provide substantial or full coverage for hearing aids through governmental insurance, which likely increases use.[45] In the United States, hearing aids are covered by Medicaid in 31 states[46] and Veterans Affairs insurance if the hearing loss is rated as service-connected, but they are not covered by Medicare, and as such, constitute a major out-of-pocket expense for many older adults. Digital hearing aids have numerous performance advantages over analog, including improved sound quality, features for different listening environments, reduced background noise reduction, less acoustic feedback, smaller size, enhanced ability to adjust gain (the amount of signal output [amplification] in relation to the amount of signal input in an electronic amplifier), and better frequency response.[39] Overall, digital hearing aids provide better quality amplification and more customization for the user, albeit at a higher price.

Evidence is mixed on the efficacy of bilateral vs unilateral hearing aids. Although some studies support superior hearing performance with bilateral aids, particularly in terms of sound localization and speech intelligibility,[47-51] others report minor or no differences.[52-54] Some older individuals report that bilateral aids are less comfortable in noisy environments,[55,56] and older adults may have more difficulty adjusting to bilateral aids than younger persons.[54,56] One instance in which unilateral aids may be preferable is when the hearing loss is primarily due to central auditory processing disorder (C).[18,56] The majority of audiologists consider the performance advantages of bilateral aids to outweigh the disadvantages and routinely recommend bilateral aids for new users (B).[57] Of course, paying for 2 aids is a significant drawback of bilateral amplification.

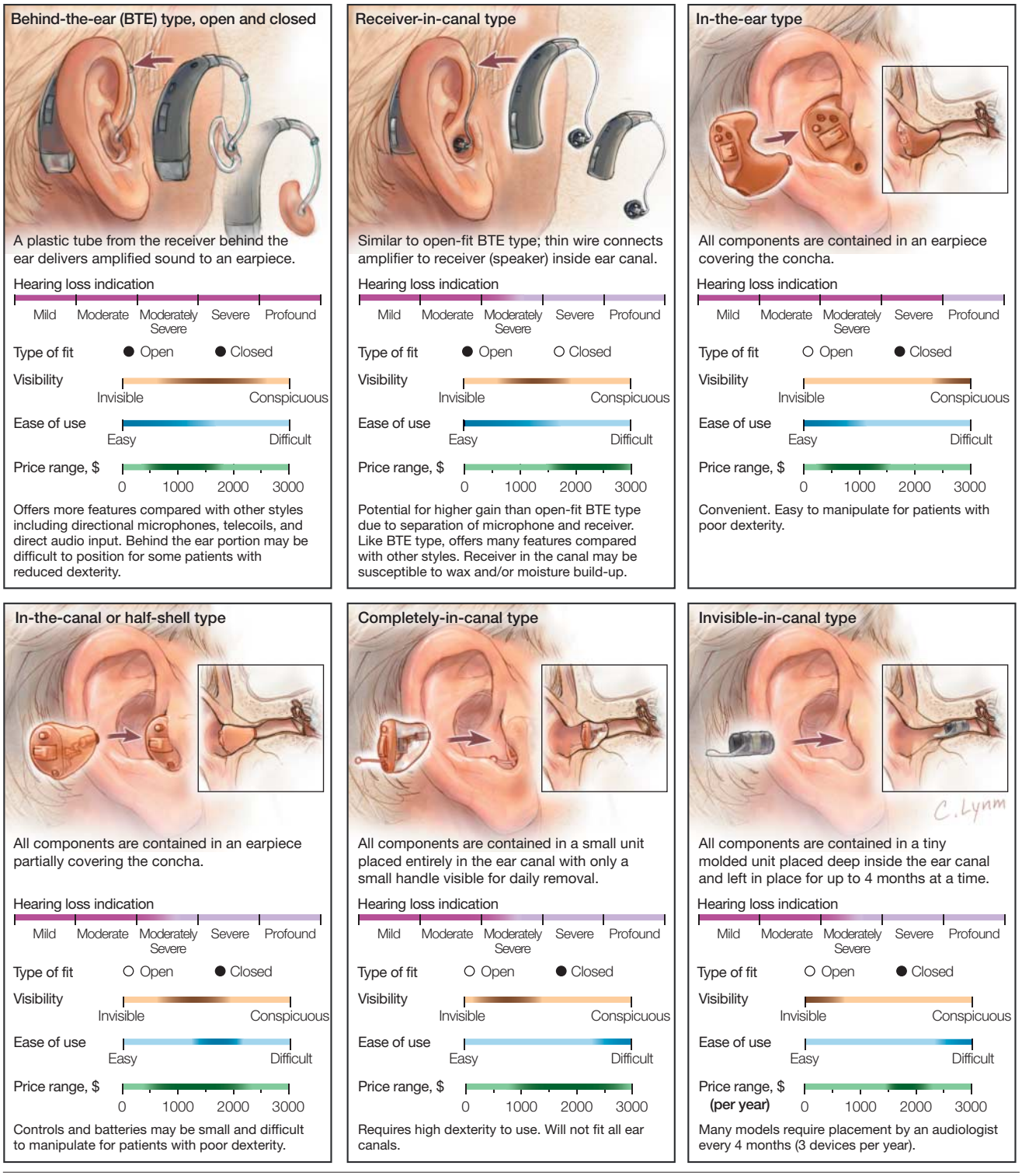
Assistive Listening Devices. There are many types of assistive listening devices (ALDs). Some are useful for hearing-impaired persons who cannot tolerate, afford, or properly manage hearing aids. The most simple of these is a personal amplifier, a pocket-sized box worn by the user containing a microphone that transmits amplified sound through headphones. These devices can be indispensible for facilitating communication with individuals with severe hearing impairment and should be a standard piece of equipment at clinical sites caring for geriatric patients.

Other types of ALDs can be useful adjuncts to hearing aids. These ALDs use technologies that can improve understanding of speech through lowering signal-to-noise ratio with strategies such as frequency modulation (FM), infrared, and induction loop systems. Wireless technology can be applied to these systems for personal communication, group settings, and use of devices such as television, radio, computers, and other forms of audio media. For example, hearing loops are being increasingly used to assist hearing aid users in public performance settings. While hearing aids are very effective in quieter environments with few speakers, they are much less helpful (and more frustrating) in larger and more populated settings. A hearing loop is a thin copper wire placed around the periphery of a room, through which a signal is transmitted to hearing aids equipped with a telecoil. The signal dramatically improves the aural experience primarily by eliminating background noise and reverberations. The Americans With Disabilities Act mandates that all public assembly spaces in which communication is integral (does not include transportation facilities), such as facilities used for entertainment, educational, or civic gatherings, provide assistance to the hearing impaired.[58] Following a common practice in Europe, many sites are accordingly installing hearing loops.

Research on the effectiveness of ALDs in persons who do not wear hearing aids is limited, but supports improved hearing-related outcomes (eTable) (B).

Selecting and Fitting Hearing Aids. In addition to performing audiometric testing, audiologists also fit and manage hearing aids and ALDs. After patients with documented hearing loss have been medically cleared, referral to a certified audiologist is indicated for those who are receptive to the idea of amplification. The audiologist will work with the patient over multiple visits to select an appropriate hearing aid or ALD, educate and coach the patient regarding its proper use, and monitor hearing-related outcomes. As an adjunct to hearing aid or ALD use, a service known as aural rehabilitation, also referred

Figure 2. Types of Hearing Aids



Ratings are based on clinical experience and review of available evidence. Open fit means that the earpiece does not occlude the ear canal. In closed fit types, the canal is completely occluded. The price estimates reflect 2011 prices for the majority of models in each type offered by most vendors; highest-end models can cost as much as $6000. Prices are for a single hearing aid device except for the price of the invisible-in-canal type, which is an annual price reflecting replacement with a new device every 4 months (3 devices per year). It is usually recommended that hearing aids be replaced approximately every 5 years, but many patients wear them for longer periods.

to as audiological rehabilitation or auditory training, can be provided by the audiologist. Aural rehabilitation involves education regarding proper use of amplification devices, coaching on how to manage the auditory environment, training in speech perception and communication, and counseling for coping strategies to deal with the difficulties of hearing aids or ALDs. Limited evidence suggests that individual aural rehabilitation is effective for improving hearing and social functioning.[59,60]

Audio prosthetists, also referred to as hearing aid specialists, hearing instrument specialists, or hearing instrument dispensers, depending upon the site of practice, also fit and manage hearing aids. These individuals are often employed as salespeople by hearing aid and medical supply companies. Educational requirements for licensing of these individuals vary by state and country, but they usually involve 2 to 3 years of training beyond high school. Board certification in hearing instrument sciences can be achieved through the International Hearing Society (BC-HIS).

While it is common for a purchase price to cover a package of services related to fitting hearing aids, patients purchasing them should be advised to inquire about what services and equipment are included in the price. A hearing care professional should be able to itemize the charges by service. It may also be helpful to find out if an individual who dispenses hearing aids works for a specific manufacturer or is able to offer a variety of models from different manufacturers. There is usually (and required by law in some states) a 30- to 60-day trial period during which a hearing aid can be returned for a full refund.[61]

Box 2. Strategies for Promoting Use of Hearing Aids in Patients Who Are Resistant

Set appropriate expectations and inform the patient

> "Hearing aids do not correct hearing like glasses correct vision. They are *aids* to help you hear, but you should not expect them to make you hear the same way you used to."
>
> "When you get your hearing aid, you will probably not like it at first. It usually takes multiple adjustments over the first several months to get it properly set for you."
>
> "Make sure you work closely with your audiologist or audio prosthetist. Promptly report situations in which you are having trouble hearing or understanding speech, any difficulty operating your hearing aid, or any aid-associated discomfort."
>
> "Remember, getting a hearing aid is a process that will probably take several months, but if you stick with it you will be able to hear and understand others better."

Frequently inquire about the patient's hearing aid performance in noisy situations, as that is often the greatest source of hearing aid dissatisfaction

Before and after fitting, gently inquire how the patient feels about hearing aid appearance, as this may influence hearing aid choice (Figure 2) or provide insight into a possible source of dissatisfaction

Suggest participation in group audiologic visits of newly fitted patients if available, which can improve adherence[69-71]

Include a significant other or caregiver in the fitting process, which can improve use[72]

Regularly examine the patient's ears for cerumen impaction or other ear pathology, the correction of which will improve hearing aid function

Medical and Surgical Treatments

Although a full discussion of medical and surgical treatments is beyond the scope of this review, primary care clinicians should be aware of several treatment strategies for different types of adult hearing deficits. For conductive loss, which represents the minority of hearing loss in adults, surgical and medical treatments are typically offered first. For example, foreign bodies in the ear canal and cerumen impactions causing hearing loss can be removed. Chronic middle ear infections causing otitis media may respond to antibiotics and if not, myringotomy and tube placement should be considered. Corticosteroid treatment is recommended for patients with sudden hearing loss.[62] A high-quality randomized study suggests that the route of steroid administration does not affect hearing outcomes.[63] A variety of other types of disorders are addressed primarily surgically: mastoidectomy for infections including cholesteatoma removal, ossicular chain reconstruction for dislocated middle ear bones, and stapedotomy for otosclerosis.

Significant growth is ongoing in surgical treatment of sensorineural hearing loss. Middle ear implant devices have been approved by the US Food and Drug Administration.[64] These devices are surgically implanted on the structures of the middle ear and eliminate the need for an earmold, potentially reducing discomfort and improving cosmesis. In addition, having the implant directly vibrate the ossicles provides theoretical acoustic advantages over hearing aids placed in the ear canal. Bone-anchored hearing aids, another therapeutic option, are implanted in the skull, transmit vibrations directly to the cochlea, and are used when a patient's medical condition (such as chronic ear drainage) does not allow placement of standard hearing aids. Cochlear implantation is also emerging as an option in older adults with profound hearing loss. A growing body of literature supports cochlear implantation as a safe and effective treatment for older adults, with overall results similar in younger vs older adults for unilateral implants (B), and limited evidence on an age association with outcomes of bilateral implants (C).[65]

THE PATIENT'S STORY (*continued*)

Two months after the initial fitting of her first hearing aid, Mrs N did not feel that her QOL had improved. Particularly disturbed by the wide range of volume in her hearing aid, she described the entire process of acquiring it as a

Box 3. Approaches to Treating Hearing Loss in Older Adults With Frailty or Multiple Morbidities

- Routinely include hearing evaluation in team-based geriatric assessment
- Assess, and to the extent possible, improve visual function
- Assess physical, cognitive, and affective status
- For patients with hearing aids and problems with manual dexterity, consider easier-to-use hearing aid models (eg, behind-the-ear or in-the-ear types; Figure 2)
- For hearing-impaired patients with advanced cognitive deficits
  - Prevent loss of hearing aid by attaching a metal loop to its body and tying a thin nylon line through the loop, fasten the other end of the line to the patient's clothing
  - Educate caregivers on proper use of hearing aids
  - Consider use of personal amplifier ("pocket-talker") or other assistive listening device if patient is unable to use a hearing aid
- Treat affective disorders
- Assess for hearing deficits and correct them in patients presenting with geriatric syndromes—falls, incontinence, confusion, immobility, functional decline, sarcopenia, and weight loss

stressor in her life. Nonetheless, she underwent another fitting and agreed to try a new hearing aid that would permit her to exercise control over its volume. She noted that the audio prosthetist told her that the "perfect" hearing aid did not exist, which she found disheartening.

SPECIAL CHALLENGES OF HEARING LOSS IN THE GERIATRIC POPULATION

Acceptance and Proper Use of Hearing Aids

Assisting the hearing-impaired older adult in accepting and properly using hearing aids is a complicated and challenging task for clinicians, audiologists, family members, and caregivers. Merely calling a patient's attention to a hearing problem or detecting it through screening may serve to increase hearing aid use.[31] Encouragement or even outright pressure from family and close friends has been associated with hearing aid acquisition,[66,67] as was the case for Mrs N.

The reasons cited by hearing-impaired older adults for not wearing their hearing aids may be informative for promoting effective hearing aid use. Probably the most common complaint is that hearing aids do not work well across a variety of acoustic settings.[42-44] An older adult wearing a hearing aid may be acutely sensitive to louder sounds, particularly in group situations, causing discomfort and reduced ability to understand speech in social settings. Fortunately, advancements in digital technology have significantly improved sound quality, offering multiple programming options for different environments and reducing feedback.[39] Establishing the optimal settings, programs, and fit of hearing aids for new users requires multiple visits over weeks to months. While multiple visits can entail a considerable transportation burden, audiologists stress the importance of informing the new hearing aid user to expect trial and error attempts over many visits to achieve optimal performance.

Another commonly cited reason for non-use of hearing aids is discomfort.[42-44] Newer hearing aid designs, particularly those that are open fit, are much more comfortable than their predecessors.[68] Older adults concerned about appearance now have the option of less conspicuous or invisible in-canal models (Figure 2). Hearing aids are also available in a variety of colors for matching individual skin tone.

Box 2 presents suggested approaches to the patient resistant to acquiring or using hearing aids.

Amplification in Older Adults With Frailty or Multiple Morbidities

Mrs N: *Taking care of a hearing aid is not as simple as taking care of a hairbrush. If the time comes that I may have to go to a nursing home, who is going to be cleaning that hearing aid? Who is going to make sure that the battery is changed? Who is going to make sure that it is properly inserted?*

With advancing age, hearing loss is increasingly accompanied by coexisting chronic sensory,[73,74] physical,[5,75] cognitive,[75-78] and affective[5,11,74,76] conditions. As such, hearing loss is a common component of the frail, multimorbid functional state experienced by a minority of geriatric patients. In these patients, hearing loss is a frequent contributor to the multifactorial etiology of common geriatric syndromes such as confusion, falls, social withdrawal, and failure to thrive. Accordingly, attending to hearing deficits should be incorporated into a team approach to managing care of these patients. Conversely, comorbidities may impair an older adult's hearing function and ability to properly use hearing aids. For example, visual impairment from cataracts, macular degeneration, or other age-associated visual problems, and perhaps most commonly from not wearing one's glasses, can impair communication by compromising lip reading. Alzheimer disease almost always affects working memory and central auditory processing, making the comprehension of speech even more difficult in individuals with dementia and coexisting hearing loss.[78] Impaired manual dexterity also poses challenges for proper use and maintenance of hearing aids, particularly in the old-old (ie, patients aged >85 years).[79,80] Patients with impaired manual dexterity from arthritis, neuropathy, stroke, and movement disorders such as Parkinson disease frequently have difficulty inserting and removing their hearing aids, adjusting volume controls, and manipulating the battery.[73] Box 3 presents strategies for improving hearing function in older adults with multiple morbidities. These interventions are most effectively delivered via an interdisciplinary team-based strategy.

Hearing loss in nursing home residents is very common, with objectively measured prevalences of 77% and 94% in 2 studies involving 380 residents across 6 facilities.[81,82] It is also largely unrecognized. In 1 study, an audit revealed that 48% of residents with objectively measured moderate-to-severe loss had no documented hearing loss in the medical record.[82] Another study, interviewing 279 residents and 51 staff, documented numerous barriers to effective hearing aid use in the nursing home: 86% of users needed help caring for their aids, more than half of the certified nursing assistants were unaware of hearing problems in impaired residents, and almost half of the staff members had received no training in the proper use and care of hearing aids.[83] In this same study, 69% of residents reported problems with their hearing aids. Long-term care facilities should have staff educational programs and policies for increased detection and improved management of resident hearing problems.

CONCLUSIONS

Mrs N illustrates many of the challenges of managing age-related hearing loss. Her pattern of high-frequency loss was very typical for presbycusis and was definitively diagnosed through audiometry. She had little or no insight into her deficit early in its course and was reluctant to pursue amplification even when recommended by her audiologist. After further worsening of her hearing and pressure from her family, she was fitted with a hearing aid, and although it improved her hearing function, she was dissatisfied with its performance, particularly in group situations. Since then, despite another recommendation that she get bilateral aids, she was fitted with a new unilateral model that permits her to control the volume. She now states that she is satisfied with her hearing aid. Her daughter notes, however, that while Mrs N regularly wears her hearing aid when socializing, she rarely uses it at home. As Mrs N ages and comorbidities ensue, optimizing her hearing function will be increasingly challenging, warranting careful assessment of all her functional domains, consideration of different amplification strategies, and involvement of caregivers in managing her hearing loss.

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REFERENCES

1. Lin FR, Thorpe R, Gordon-Salant S, Ferrucci L. Hearing loss prevalence and risk factors among older adults in the United States. *J Gerontol A Biol Sci Med Sci*. 2011;66(5):582-590.
2. Dillon CF, Gu Q, Hoffman HJ, Ko CW. Vision, hearing, balance, and sensory impairment in Americans aged 70 years and over. *NCHS Data Brief*. 2010; Apr(31):1-8.
3. Gates GA, Cooper JC Jr, Kannel WB, Miller NJ. Hearing in the elderly: the Framingham cohort, 1983-1985, part I. *Ear Hear*. 1990;11(4):247-256.
4. Stevens G, Flaxman S, Brunskill E, Mascarenhas M, Mathers CD, Finucane M; on behalf of the Global Burden of Disease Hearing Loss Expert Group. Global and regional hearing impairment prevalence: an analysis of 42 studies in 29 countries [published online ahead of print December 24, 2011]. *Eur J Public Health*. doi:10.1093/eurpub/ckr176.
5. Chang HP, Ho CY, Chou P. The factors associated with a self-perceived hearing handicap in elderly people with hearing impairment—results from a community-based study. *Ear Hear*. 2009;30(5):576-583.
6. Corna LM, Wade TJ, Streiner DL, Cairney J. Corrected and uncorrected hearing impairment in older Canadians. *Gerontology*. 2009;55(4):468-476.
7. Hartley D, Rochtchina E, Newall P, Golding M, Mitchell P. Use of hearing AIDS and assistive listening devices in an older Australian population. *J Am Acad Audiol*. 2010;21(10):642-653.
8. Popelka MM, Cruickshanks KJ, Wiley TL, Tweed TS, Klein BE, Klein R. Low prevalence of hearing aid use among older adults with hearing loss: the Epidemiology of Hearing Loss Study. *J Am Geriatr Soc*. 1998;46(9):1075-1078.
9. Appollonio I, Carabellese C, Frattola L, Trabucchi M. Effects of sensory aids on the quality of life and mortality of elderly people. *Age Ageing*. 1996;25(2):89-96.
10. Carabellese C, Appollonio I, Rozzini R, et al. Sensory impairment and quality of life in a community elderly population. *J Am Geriatr Soc*. 1993;41(4):401-407.
11. Chia EM, Wang JJ, Rochtchina E, Cumming RR, Newall P, Mitchell P. Hearing impairment and health-related quality of life. *Ear Hear*. 2007;28(2):187-195.
12. Dalton DS, Cruickshanks KJ, Klein BE, Klein R, Wiley TL, Nondahl DM. The impact of hearing loss on quality of life in older adults. *Gerontologist*. 2003;43(5):661-668.
13. Gopinath B, Wang JJ, Schneider J, et al. Depressive symptoms in older adults with hearing impairments. *J Am Geriatr Soc*. 2009;57(7):1306-1308.
14. Hogan A, O'Loughlin K, Miller P, Kendig H. The health impact of a hearing disability on older people in Australia. *J Aging Health*. 2009;21(8):1098-1111.
15. Clark JG. Uses and abuses of hearing loss classification. *ASHA*. 1981;23(7):493-500.
16. Reuben DB, Walsh K, Moore AA, Damesyn M, Greendale GA. Hearing loss in community-dwelling older persons. *J Am Geriatr Soc*. 1998;46(8):1008-1011.
17. Helzner EP, Cauley JA, Pratt SR, et al. Race and sex differences in age-related hearing loss. *J Am Geriatr Soc*. 2005;53(12):2119-2127.
18. Martin JS, Jerger JF. Some effects of aging on central auditory processing. *J Rehabil Res Dev*. 2005;42(4)(suppl 2):25-44.
19. Mazelová J, Popelar J, Syka J. Auditory function in presbycusis: peripheral vs. central changes. *Exp Gerontol*. 2003;38(1-2):87-94.
20. Stach BA, Spretnjak ML, Jerger J. The prevalence of central presbyacusis in a clinical population. *J Am Acad Audiol*. 1990;1(2):109-115.
21. Guyatt GH, Oxman AD, Vist GE, et al; GRADE Working Group. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ*. 2008;336(7650):924-926.
22. Clark K, Sowers M, Wallace RB, Anderson C. The accuracy of self-reported hearing loss in women aged 60-85 years. *Am J Epidemiol*. 1991;134(7):704-708.
23. Nondahl DM, Cruickshanks KJ, Wiley TL, Tweed TS, Klein R, Klein BE. Accuracy of self-reported hearing loss. *Audiology*. 1998;37(5):295-301.
24. Sindhusake D, Mitchell P, Smith W, et al. Validation of self-reported hearing loss. *Int J Epidemiol*. 2001;30(6):1371-1378.
25. Bagai A, Thavendiranathan P, Detsky AS. Does this patient have hearing impairment? *JAMA*. 2006;295(4):416-428.
26. Ventry IM, Weinstein BE. Identification of elderly people with hearing problems. *ASHA*. 1983;25(7):37-42.
27. Wiley TL, Cruickshanks KJ, Nondahl DM, Tweed TS. Self-reported hearing handicap and audiometric measures in older adults. *J Am Acad Audiol*. 2000;11(2):67-75.
28. Swan IRC, Browning GG. The whispered voice as a screening test for hearing impairment. *J R Coll Gen Pract*. 1985;35(273):197.
29. Chou R, Dana T, Bougatsos C, Fleming C, Beil T. Screening adults aged 50 years or older for hearing loss. *Ann Intern Med*. 2011;154(5):347-355.
30. Boatman DF, Miglioretti DL, Eberwein C, Alidoost M, Reich SG. How accurate are bedside hearing tests? *Neurology*. 2007;68(16):1311-1314.
31. Yueh B, Collins MP, Souza PE, et al. Long-term effectiveness of screening for hearing loss. *J Am Geriatr Soc*. 2010;58(3):427-434.

32. Screening for hearing loss in older adults. United States Preventive Services Task Force website. http://www.uspreventiveservicestaskforce.org/uspstf/uspshear.htm. Accessed December 15, 2011.
33. Guidelines for audiologic screening. American Speech-Language-Hearing Association website. http://www.asha.org/docs/html/GL1997-00199.html. Accessed December 15, 2011.
34. Clinical preventive services: hearing difficulties. American Academy of Family Practice website. http://www.aafp.org/online/en/home/clinical/exam/hearing.html. Accessed December 15, 2011.
35. Quick reference information: the ABCs of providing the initial preventive physical examination. Centers for Medicare & Medicaid Services website. https://www.cms.gov/MLNProducts/Downloads/MPS_QRI_IPPE001a.pdf. Accessed December 15, 2011.
36. The audiogram. American Speech-Language-Hearing Association website. http://www.asha.org/public/hearing/Audiogram. Accessed December 15, 2011.
37. Bogardus ST Jr, Yueh B, Shekelle PG. Screening and management of adult hearing loss in primary care. *JAMA*. 2003;289(15):1986-1990.
38. Iezzoni LI, O'Day BL, Killeen M, Harker H. Communicating about health care. *Ann Intern Med*. 2004;140(5):356-362.
39. Natalizia A, Casale M, Guglielmelli E, Rinaldi V, Bressi F, Salvinelli F. An overview of hearing impairment in older adults: perspectives for rehabilitation with hearing aids. *Eur Rev Med Pharmacol Sci*. 2010;14(3):223-229.
40. Fischer ME, Cruickshanks KJ, Wiley TL, Klein BEK, Klein R, Tweed TS. Determinants of hearing aid acquisition in older adults. *Am J Public Health*. 2011;101(8):1449-1455.
41. Gopinath B, Schneider J, Hartley D, et al. Incidence and predictors of hearing aid use and ownership among older adults with hearing loss. *Ann Epidemiol*. 2011;21(7):497-506.
42. Takahashi G, Martinez CD, Beamer S, et al. Subjective measures of hearing aid benefit and satisfaction in the NIDCD/VA follow-up study. *J Am Acad Audiol*. 2007;18(4):323-349.
43. Lockey K, Jennings MB, Shaw L. Exploring hearing aid use in older women through narratives. *Int J Audiol*. 2010;49(8):542-549.
44. Hickson L, Clutterbuck S, Khan A. Factors associated with hearing aid fitting outcomes on the IOI-HA. *Int J Audiol*. 2010;49(8):586-595.
45. Bertoli S, Staehelin K, Zemp E, Schindler C, Bodmer D, Probst R. Survey on hearing aid use and satisfaction in Switzerland and their determinants. *Int J Audiol*. 2009;48(4):183-195.
46. Medicaid benefits: online database. The Kaiser Commission on Medicaid and the Uninsured website. http://medicaidbenefits.kff.org/service.jsp?yr=2&cat=11&nt=on&sv=11&so=0&tg=0. Accessed December 15, 2011.
47. Köbler S, Rosenhall U. Horizontal localization and speech intelligibility with bilateral and unilateral hearing aid amplification. *Int J Audiol*. 2002;41(7):395-400.
48. Simon HJ. Bilateral amplification and sound localization: then and now. *J Rehabil Res Dev*. 2005;42(4)(suppl 2):117-132.
49. Naidoo SV, Hawkins DB. Monaural/binaural preferences. *J Am Acad Audiol*. 1997;8(3):188-202.
50. Noble W. Bilateral hearing aids. *Int J Audiol*. 2006;45(suppl 1):S63-S71.
51. Boymans M, Goverts ST, Kramer SE, Festen JM, Dreschler WA. A prospective multi-centre study of the benefits of bilateral hearing aids. *Ear Hear*. 2008;29(6):930-941.
52. Bertoli S, Bodmer D, Probst R. Survey on hearing aid outcome in Switzerland. *Int J Audiol*. 2010;49(5):333-346.
53. Metselaar M, Maat B, Krijnen P, Verschuure H, Dreschler WA, Feenstra L. Self-reported disability and handicap after hearing-aid fitting and benefit of hearing aids: comparison of fitting procedures, degree of hearing loss, experience with hearing aids and uni- and bilateral fittings. *Eur Arch Otorhinolaryngol*. 2009;266(6):907-917.
54. Koehnke J, Besing JM. The effects of aging on binaural and spatial hearing. *Semin Hear*. 2001;22(3):241-253 doi: 10.1055/s-2001-15629.
55. Schreurs KK, Olsen WO. Comparison of monaural and binaural hearing aid use on a trial period basis. *Ear Hear*. 1985;6(4):198-202.
56. Walden TC, Walden BE. Unilateral versus bilateral amplification for adults with impaired hearing. *J Am Acad Audiol*. 2005;16(8):574-584.
57. Holmes AE. Bilateral amplification for the elderly: are two aids better than one? *Int J Audiol*. 2003;42(suppl 2):2S63-2S67.
58. Guidance on the 2010 ADA Standards for Accessible Design, US Department of Justice. http://www.ada.gov/regs2010/2010ADAStandards/Guidance_2010ADAStandards.pdf. Accessed January 6, 2012.
59. Boothroyd A. Adult aural rehabilitation: what is it and does it work? *Trends Amplif*. 2007;11(2):63-71.
60. Sweetow R, Palmer CV. Efficacy of individual auditory training in adults: a systematic review of the evidence. *J Am Acad Audiol*. 2005;16(7):494-504.
61. American Association of Retired Persons (AARP). *Consumer Guide To Hearing Aids*. Washington, DC: AARP; 2007.
62. Rauch SD. Clinical practice: idiopathic sudden sensorineural hearing loss. *N Engl J Med*. 2008;359(8):833-840.
63. Rauch SD, Halpin CF, Antonelli PJ, et al. Oral vs intratympanic corticosteroid therapy for idiopathic sudden sensorineural hearing loss: a randomized trial. *JAMA*. 2011;305(20):2071-2079.
64. FDA approves first totally implanted hearing system: US Food and Drug Administration, US Department of Health and Human Services. US Food and Drug Administration website. http://www.fda.gov/newsevents/newsroom/pressannouncements/ucm204956.htm. Accessed December 15, 2011.
65. Raman G, Lee J, Chung M, et al. Effectiveness of cochlear implants in adults with sensorineural hearing loss: technology assessment report. Agency for Healthcare Research and Quality, U.S. Department of Health & Human Services. https://www.cms.gov/determinationprocess/downloads/id80TA.pdf. Accessed December 15, 2011.
66. Duijvestijn JA, Anteunis LJ, Hoek CJ, Van Den Brink RH, Chenault MN, Manni JJ. Help-seeking behaviour of hearing-impaired persons aged > or=55 years. *Acta Otolaryngol*. 2003;123(7):846-850.
67. Laplante-Lévesque A, Hickson L, Worrall L. Factors influencing rehabilitation decisions of adults with acquired hearing impairment. *Int J Audiol*. 2010;49(7):497-507.
68. Gnewikow D, Moss M. Hearing aid outcomes with open- and closed-canal fittings. *Hear J*. 2006;59(11):66-72 doi: 10.1097/01.HJ.0000286220.14835.13.
69. Collins MP, Souza PE, O'Neill S, Yueh B. Effectiveness of group versus individual hearing aid visits. *J Rehabil Res Dev*. 2007;44(5):739-749.
70. Hickson L, Worrall L, Scarinci N. A randomized controlled trial evaluating the active communication education program for older people with hearing impairment. *Ear Hear*. 2007;28(2):212-230.
71. Preminger JE, Yoo JK. Do group audiologic rehabilitation activities influence psychosocial outcomes? *Am J Audiol*. 2010;19(2):109-125.
72. Stark P, Hickson L. Outcomes of hearing aid fitting for older people with hearing impairment and their significant others. *Int J Audiol*. 2004;43(7):390-398.
73. Erber NP. Use of hearing aids by older people: influence of non-auditory factors (vision, manual dexterity). *Int J Audiol*. 2003;42(suppl 2):2S21-2S25.
74. Lupsakko T, Mäntyjärvi M, Kautiainen H, Sulkava R. Combined hearing and visual impairment and depression in a population aged 75 years and older. *Int J Geriatr Psychiatry*. 2002;17(9):808-813.
75. López-Torres Hidalgo J, Boix Gras C, Téllez Lapeira J, López Verdejo MA, del Campo del Campo JM, Escobar Rabadán F. Functional status of elderly people with hearing loss. *Arch Gerontol Geriatr*. 2009;49(1):88-92.
76. Cacciatore F, Napoli C, Abete P, Marciano E, Triassi M, Rengo F. Quality of life determinants and hearing function in an elderly population: Osservatorio Geriatrico Campano Study Group. *Gerontology*. 1999;45(6):323-328.
77. Lin FR, Metter EJ, O'Brien RJ, Resnick SM, Zonderman AB, Ferrucci L. Hearing loss and incident dementia. *Arch Neurol*. 2011;68(2):214-220.
78. Lunner T. Cognitive function in relation to hearing aid use. *Int J Audiol*. 2003;42(suppl 1):S49-S58.
79. Desjardins JL, Doherty KA. Do experienced hearing aid users know how to use their hearing aids correctly? *Am J Audiol*. 2009;18(1):69-76.
80. Stephens SD, Meredith R. Physical handling of hearing aids by the elderly. *Acta Otolaryngol Suppl*. 1990;476:281-285.
81. Bingea RL, Raffin MJ, Aune KJ, Baye L, Shea SL. Incidence of hearing loss among geriatric nursing-home residents. *J Aud Res*. 1982;22(4):275-283.
82. Garahan MB, Waller JA, Houghton M, Tisdale WA, Runge CF. Hearing loss prevalence and management in nursing home residents. *J Am Geriatr Soc*. 1992;40(2):130-134.
83. Cohen-Mansfield J, Taylor JW. Hearing aid use in nursing homes, part 2. *J Am Med Dir Assoc*. 2004;5(5):289-296.