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Age-related hearing loss: Causes, treatment, and care

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Abstract: Age-related hearing loss (ARHL) is the most common sensory deficit among older adults. ARHL usually begins around 50 years of age and affects approximately 40% of adults over age 65. Many older adults think hearing loss is a normal part of aging and fail to get diagnosed. However, ARHL can significantly impact emotional, physical, and social aspects of daily life. Lack of treatment for hearing loss has been found to lead to cognitive decline, social isolation, and adverse physical effects, such as loss of balance, which can lead to falls. Nurses have a role in recognizing and assessing hearing loss in patients. Simple diagnostic hearing tests can determine if hearing loss is sensorineural or conductive, and treatments can then be customized for the patient. Hearing aids or cochlear implants can improve hearing and increase the patient's quality of life. Assistive listening technology is also available as an alternative for those who cannot afford hearing aids. Understanding the impact of hearing loss, as well as diagnostic and treatment options, will assist the nurse in educating the patient on the importance of treating ARHL. Education should also include proper ear care and hearing device management. This article discusses the risk factors, diagnosis, treatment options, and management of ARHL, as well as nursing considerations and patient education.

Keywords: age-related hearing loss, assistive listening technology, audiogram, cochlear implants, deaf, hearing aids, hearing loss, tuning fork

Case scenario

BT, a 72-year-old widow, was admitted to the hospital with acute decompensated heart failure. During the admission process, the nurse noted that she had a difficult time answering questions appropriately. For example, when registration asked for her address, BT began to discuss where she had purchased the dress she was wearing. When asked about her pills, she stated that she had been ill for about a week. Other questions asked just led to confused looks from the patient. The nurse determined that BT had hearing

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loss and informed the physician. When the physician assessed BT, she was diagnosed with age-related hearing loss (ARHL). When asked how she was coping with this problem, BT said that because she has a hard time understanding what people are saying, she is shunned at family events and by her group of friends. She stated that people get frustrated speaking with her because she misunderstands what they are saying, and her best friend Janice is the only person who takes the time necessary to hold a conversation. BT always thought hearing loss was just a part of aging and was never officially diagnosed.

Introduction

ARHL, also known as presbycusis, is a gradual bilateral hearing loss that usually begins around age 50 and affects approximately 40% of adults over the age of 65 and up to 90% of adults over the age of 80.[1] ARHL is the most common sensory deficit among older adults, the third most common chronic geriatric disease, and the fourth leading cause of disability in the world.[2]

ARHL significantly impacts emotional, social, and physical activities in daily life. If not treated, ARHL can lead to depression and eventual cognitive decline.[3] Isolation is found to be more severe among those with hearing loss: More than 50% of adults older than age 70 experience social isolation due to ARHL.[3] In adults over the age of 65, loneliness due to social isolation leads to a higher rate of mortality.[4]

ARHL is also linked to balance and gait problems, falls, frailty, and safety issues, such as difficulty hearing smoke alarms and other warnings.[1] The vestibular system may be affected with AHRL, and hearing loss may lead to an unsteady gait and loss of balance in those with and without dizziness.[5] One hypothesis is that individuals use hearing to determine their location in space and time. The brain creates a spatial map of the environment around the individual, which allows them to determine their location. This map becomes compromised with hearing loss, leading to gait and balance disturbances and predisposing the older adult to a high risk for falls.[5]

This article discusses the risk factors, diagnosis, treatment options, and management of ARHL, as well as nursing considerations and patient education.

Impact on communication and emotional well-being

For people with AHRL, the effort to hear conversations or sounds can lead to physical exhaustion. The continuous energy expenditure from trying to identify what people are saying causes fatigue, especially in noisy environments.[6] Being unable to hear clearly in public places and social gatherings may also result in emotional stress. The inability to maintain a conversation is stressful and can be frightening. Due to the effort involved, many older adults choose to avoid conversing and social activities.[6]

Frustration in participating in conversations with family and friends can lead to anger, negative self-image, and low self-worth among those with AHRL.[6] Interpersonal conflict arises when family and friends become frustrated during communication. Sometimes, the inability to communicate appropriately can lead to a belief that the patient is confused. Fear of saying the wrong thing leads to more self-isolation and depression. In their research, Tseng et al.[6] found that participants were afraid of saying the wrong thing and, as a result, began to participate less in social interactions. One participant said that her daughter talks to her "as if she were teaching a child to talk," which is most humiliating.[6] Social isolation due to ARHL can lead to depression, cognitive decline, and increased mortality. However, early identification and treatment of ARHL can mitigate the effects of social isolation.[4]

Because communication is vital in the health care setting, nurses need to understand the impact of ARHL when assessing and caring for patients. According to the Americans with Disabilities Act (ADA) "Effective communication is particularly critical in health care settings where miscommunication may lead to misdiagnosis and improper or delayed medical treatment."[7] The nurse has a legal duty to communicate appropriately with the patient.[8]

Risk factors

Some risk factors associated with ARHL are modifiable. Consistent exposure to sounds above 70 decibels damages sensory hair cells in the inner ear and can lead to sensorineural hearing loss (SNL; see *Decibel ratings of common sounds*[9,10]).[9] The longer or more frequently one is exposed to these sounds, the more likely hearing loss will occur. The

Decibel ratings of common sounds[9,10]

Sound	Decibel rating, dBA
Normal speech	60-70
Lawn mower	65-95
Toilet flush	75-85
Motorcycle	95-110
Leaf blower	110
Rock concert	110-120
Siren	110-129
Football game	117
Fireworks	140-160
Jet engine	150

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higher the decibels, the sooner hearing loss will occur.[11]

Some medications have been shown to "poison" the hair cells in the inner ear. Because of this ototoxic effect, the hair cells are unable to convert sound energy to neural impulses (see *Ototoxic medications*[12,13]).[11] Those taking diuretics had a 33% risk of hearing loss and those taking nonsteroidal anti-inflammatory drugs developed a 45% risk of hearing loss.[3] Research suggests that older adults are at an increased risk of hearing loss due to ototoxicity because of their decreased ability to metabolize ototoxic medications. With slower metabolism, these medications are in their system for a longer period, leading to a longer exposure to toxic substances.[3]

Chemical exposure may also lead to ototoxic effects. These include solvents, metals, asphyxiants, pesticides, and cigarette smoke. Older adults can be exposed to chemicals through inhalation, absorption through skin, or by consuming contaminated food or drinks.[13] Reducing exposure to these chemicals may reduce hearing loss.

Research regarding diabetes and hearing loss indicates that older adults with diabetes are more than twice as likely to experience hearing loss as those without diabetes.[14] Diabetes-related damage occurs in the cochlea, where sound energy is converted to nerve impulses. The hair cells in this area atrophy, causing difficulty in hearing low frequencies.[14] Hypertension, arteriosclerosis, and hyperlipidemia also create a high risk for embolism and ischemia in the inner ear, which may lead to hearing loss.[15]

Similarly, risk factors for cardiovascular disease, such as smoking, unhealthy diet, and lack of exercise, are also risk factors for ARHL. Vascular stenoses and occlusions can promote atrophy of the hair cells in the inner ear that work to convert sound energy into nerve impulses.[15]

Anatomy and physiology

Sound waves flow through the outer ear canal and vibrate the tympanic membrane, which separates the outer ear from the middle ear (see *Human ear anatomy*[16,17]). The vibrating tympanic membrane causes the ossicular bones (malleus, stapes, and incus) in the middle ear to vibrate. The stapes is attached to the oval window in the cochlea (shell-like structure), and the vibration is transferred into the inner ear.[16]

The cochlea is filled with endolymph, a fluid that is important for transmitting sounds. The endolymph transfers the vibration to the organ of Corti, also located in the cochlea.[18] The organ of Corti contains stereocilia, known as hair cells. These hair cells convert the sound waves to nerve impulses and send them to the auditory nerve. The auditory nerve sends the impulse to the brain stem for interpretation.[19]

Ototoxic medications[12,13]

Medication category	Examples
Antibiotics	Aminoglycosides, macrolides
Antidepressants	Tricyclics, selective serotonin reuptake inhibitors
Chemotherapy	Carboplatin, cisplatin
Loop diuretics	Furosemide, bumetanide
Pain medications	Nonsteroidal anti-inflammatory drugs
Quinine-based drugs	Drugs that treat malaria, babesiosis, other parasitic infections

Types of hearing loss

The causes of ARHL can be sensorineural, conductive, or both.[20] Damage to the cochlea or the cochlear nerve can cause SNL. In ARHL, SNL is recognized by the loss of ability to hear high-frequency tones, difficulty in auditory processing, and difficulty in speech discrimination.[21] Pathophysiologic changes that occur over time include degeneration of the cochlea and loss of nerve fibers, leading to the decreased ability to capture sounds.[21] This leads to a progressive loss of hearing.

ARHL may also occur due to neural loss and metabolic factors. A loss of approximately 2000 neurons each decade leads to a progressive loss of speech discrimination (including the inability to hear certain consonants) before actual hearing loss occurs. The amount of neural loss is believed to be genetically determined.[2] Metabolic diseases such as diabetes, cardiovascular diseases such as hypertension, and hyperlipidemia are risk factors for ARHL. The resulting damage to mitochondrial DNA and vascular issues damage the inner ear.[3] The stria vascularis, a component of the cochlea, is affected with age. The stria vascularis maintains the chemical balance and metabolic health of the cochlea. With age, it begins to atrophy, reducing the ability to hear low frequencies.[21]

Conductive hearing loss (CHL) occurs when sound waves cannot reach the inner ear. CHL can be caused by the thickening and stiffening of the basilar membrane of

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the cochlea, which slows sound waves from being converted into electrical signals.[20] Other causes of CHL include fluid in the middle ear and blockage in the outer ear. Fluid in the middle ear prevents sound waves from vibrating off the ossicular bones and entering the inner ear. Viral or bacterial infections in the middle ear can lead to fluid accumulation behind the tympanic membrane.[21]

Cerumen impaction is one way the outer ear can become blocked.[22] Approximately one-third of older adults experience cerumen impaction.[23] Older adults have a high prevalence of cerumen impaction because of a decreased ability of the ear to remove cerumen and an increase in hair growth.[23] Some people may be more at risk for cerumen impaction. Using hearing aids or earplugs can stimulate greater cerumen production and block the outflow. In addition, having developmental disabilities with possible difficulty in maintaining proper ear care or having anatomic changes in the ear are also risk factors for cerumen impaction.[23]

If the tympanic membrane is perforated, the surface area to catch sound waves is reduced by decreasing transmission of energy to the ossicles. Causes of perforation include self-cleaning of the ears, infections, loud noise, and barotrauma from airplanes or scuba diving.[24]

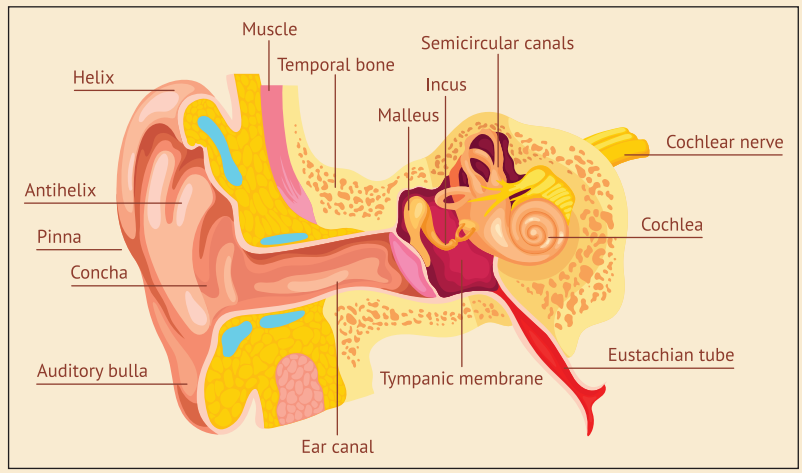
Diagnosing AHRL

ARHL can be diagnosed through several different testing methods.

Otoscopy

Otoscopy is a visual inspection of the ear canal to rule out wax buildup, foreign bodies, or infection. The middle ear can also be assessed for damage to the tympanic membrane or effusion.[25]

Human ear anatomy[16,17]



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Audiometry

Audiometry is considered the criterion standard for hearing tests.[26] Audiometry measures different frequencies and volumes to determine how well an individual can hear. This type of test can determine if a patient has SNL or CHL.[27] It may include a pure tone test and a speech test. Both are performed in a soundproof room.[27] In a pure tone test, the individual wears headphones and signals when they can hear the sound. An audiogram is then created, which measures volume and pitch in each ear (see *Audiogram*[28,29]). In the speech test, the individual hears simple words at different sound levels and is asked to repeat the words.[27]

Tuning fork

The tuning fork test uses vibration from a 512 hertz tuning fork to determine if the patient has CHL or SNL. Two different tests that can be performed with this method: the Rinne test and the Weber test.[30]

While performing the Rinne test, the examiner places a vibrating tuning fork behind the ear (on the mastoid). The patient is directed to tell the examiner when they can no longer hear the vibration. The vibrating tuning fork is then moved to the outer ear being tested, and the patient is asked to tell the examiner when they can no longer hear the vibration. Because air is a better conductor of sound than bone, an abnormal finding would be determined if the patient cannot hear the vibrating tuning fork when it is near the outer ear.[31]

The Weber test determines if the hearing loss is conductive or sensorineural. It is performed by placing a vibrating tuning fork on the forehead. In CHL, the sound should be heard on the affected side. If the hearing loss is sensorineural, the sound would be heard on the opposite side.[32]

Tympanometry

Tympanometry measures how well the tympanic membrane and ossicles vibrate or if fluid is present in the middle ear. A soft probe is put into the ear, and air and a tone are emitted. A microphone attached to the probe measures results. Abnormal results may indicate disorders of the tympanic membrane or ossicles or presence of fluid in the middle ear.[27]

Vestibular testing

An adverse effect of ARHL may be loss of balance or a swaying gait.

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Tests can be performed to determine the extent of balance and gait issues. Videonystagmography tests for nystagmus, a situation in which the eye moves up and down or back and forth on its own. If nystagmus occurs abnormally, the individual has a vestibular or balance problem.[33] Vestibular-evoked myogenic potential testing measures the activity of the otolith organs in the ear and the vestibular nerve in conjunction with certain repetitive sounds in the ear.[34] This test assists in determining the cause of vertigo.

Managing AHRL

The most effective treatment for ARHL is either cochlear implants (CIs) or hearing aids (HAs), depending on the type of hearing loss identified.

CIs

CIs are used for individuals who are severely hard-of-hearing or deaf. Traditionally used for children, CIs are being used more frequently in older adults as well. Studies show that CIs increase the ability to hear more sounds by bypassing the inner ear structure and sending impulses down a different pathway to the brain.[35] CIs have been found to improve the quality of life in older adults by enhancing perception of speech, thereby improving cognition.[35]

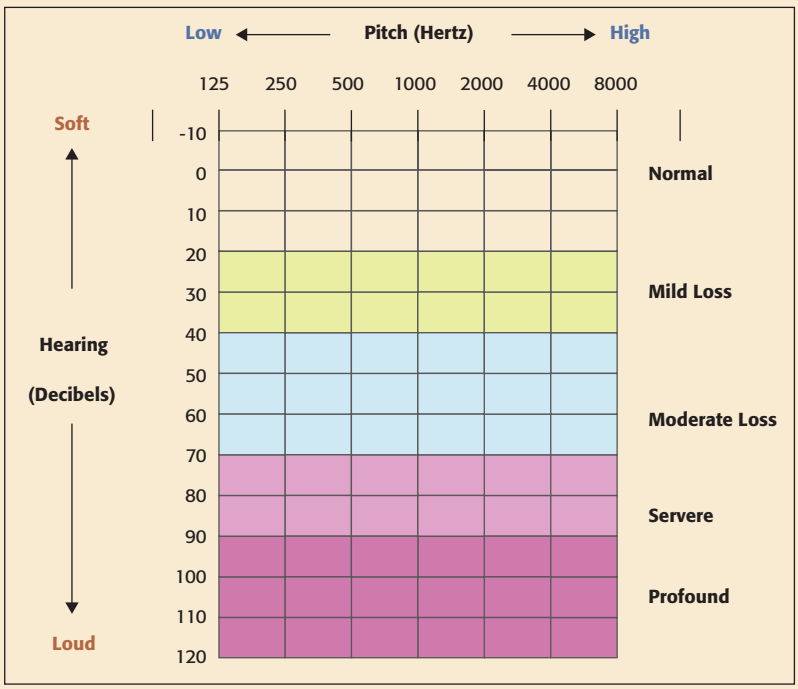
The external portion of the CI device is generally placed behind the ear. The internal part of the device is surgically implanted under the skin. A CI is composed of four parts: (1) a microphone, which captures sounds from the environment; (2) a speech processor, which arranges the sounds; (3) a stimulator, which collects the sounds from the speech processor and turns them into electrical impulses; and (4) electrodes implanted in the cochlea, which send impulses to various parts of the auditory nerve.[35]

HAs

HAs are used to treat SNL caused by damage to the inner ear and auditory nerve. An HA consists of three parts: (1) the microphone, which captures sounds and converts them into electrical signals; (2) the amplifier, which collects and increases the power of these signals; and (3) the speaker, which sends the signals into the ear.[36] There are different styles of hearing aids (see *Hearing aid styles*[37,38]).

- Behind-the-ear (BTE): There are two types of BTE HAs. The original style consists of a plastic case containing electronics that is fitted behind the ear. This case is connected to a custom-fitted earmold that is fitted in the ear canal. This type of hearing aid is designed for ease of use for the older patient.[39] A newer type of BTE is the receiver-in-the-ear HA. The HA fits behind the ear entirely with only a small tube entering the ear canal. The advantage is less buildup of ear wax and damage to the device.[36]
- In the ear (ITE): An ITE HA fits in the outer ear. These can be a full bowl, which completely fills the ear, or a half bowl, which fills half the ear. These HAs are a good option for those who have moderate hearing loss and difficulty handling small items.[36]
- In the canal (ITC): ITC HAs are used for mild-to-moderate hearing issues and are placed in the ear canal, making them less visible. Because of their small size, the individual would need good dexterity to handle this type of HA.[39]
- Contralateral routing of signals/bilateral contralateral routing of signals (CROS/BiCROS): CROS/BiCROS HAs are for individuals who have unequal hearing loss. The plastic case is fitted behind the ear on the better-hearing side. An additional microphone is fitted on the poorer hearing side. All sounds go to the better ear, but the individual can still hear on the poorer side.[39]

Audiogram[28,29]



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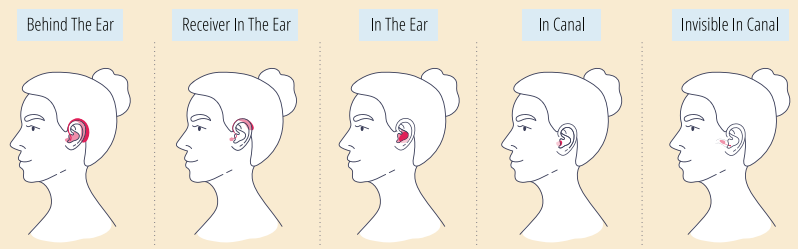
There are two types of electronics in HAs as well: analog and digital. Analog electronics convert sound waves into electrical signals and amplify them. These are custom-made for the individual and can be programmed by computer.[36] Digital electronics convert sound waves into digital code before they are converted into electrical signals. This process enables more detailed customization to the hearer's needs, especially with pitch and loudness.[36]

The use of HAs is reported to reduce depression, increase life expectancy, and promote overall quality of life.[40] With the increasing availability of HAs over the counter (OTC), the consumer now has a choice to purchase these at a lower cost. OTC HAs, however, are not without risks. Many people purchase these hearing aids without a prior hearing exam. Issues such as chronic infection and benign growths, which may be the real reason for hearing loss, would be missed.[41] These HAs are developed for mild to moderate hearing loss only. Other concerns with OTC HAs include sizing issues, as they are not one size fits all[41] and OTC HAs are not as accurate as those prescribed and fitted by a health care professional.[39]

Hearing aid styles[37,38]



Nursing considerations

ARHL affects quality of life in terms of physical health, psychological health, and social engagement. Although nurses play a significant role in determining effective care for people with hearing loss, many nurses admit they do not have expertise in this area and hearing is often overlooked in health assessments.[42]

It is vital in all health care settings that the patient be able to communicate health care concerns to clinicians and other staff. Lack of communication with a patient who is hearing impaired could lead to missed symptoms and inaccurate patient assessment. Thus, nurses need to learn strategies to recognize hearing impairment in their patients.

Nurses should be attentive to nonverbal signals indicating hearing difficulties. Some common signs of hearing loss include mishearing what was asked, asking often to repeat what was said, telling people to stop mumbling, talking very loudly, or not responding or withdrawing from conversations. In contrast, patients with dementia may be confused at what was said and become frustrated, agitated, or depressed.[43]

If the nurse identifies that the patient has hearing difficulties, an acceptable way to communicate with the patient should be determined. Communication aids and services should be provided to patients and their companions. The companion is anyone with whom it is appropriate for the health care worker to communicate.[8] If lip reading is the patient's preferred method, the nurse should communicate with the patient face to face, with the lighting on the nurse's face to make it easier for the patient to read lips and expressions. If needed, the nurse should attempt to obtain clear face masks to facilitate communication. The room should be quiet, and the nurse should lower the tone of their voice, use shorter sentences and clearly enunciate each word. Speak at a normal rate. Remember that conversing can be tiring for patients, so short breaks should be taken.[43]

Hearing loss may affect speech as well. People with hearing loss hear their voice in an altered way. For example, if they have higher pitch hearing loss, their residual hearing will be lower pitch.[44] The tendency is to overcompensate in volume, which sometimes can be mistaken as being rude. Consonants are spoken in a higher pitch. People with hearing loss often struggle to hear higher pitches, and as a result, the consonants in their own sentences are not as precise. They may also stretch their words, leading to a type of drawl. Other voice deviations include breathiness, strain, monotone cadence, and vocal fatigue.[44] Because individuals with ARHL can have difficulty expressing themselves effectively, many do not participate in conversations. As with any indications of hearing loss, the treating clinical audiologist and speech language pathologist should be consulted for further assessment.

When educating the patient, the nurse should verify whether the patient understands what is being said by asking questions, listening, and observing the patient's responses. Speech language pathologists should be consulted for any patient with any speech difficulties and to address communication challenges. When the conversation is more

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Types of TRSs[50,51]

Service	Description
Text-to-voice teletypewriter (TTY)	Traditional service accessed through dialing 711. People type conversation on display screen and communications assistant (CA) will call recipient and relay the conversation back and forth.
Voice carry over	Best for seniors who have their voice but have lost their hearing. They can speak directly to their party and the CA responds to them through text.
Speech-to-speech relay service	For those with speech disabilities. CA interprets for receiving party.
Captioned telephone service	Those with some residual hearing speak to their party directly and receive text captions of what their party is saying.
Internet protocol relay service	Handled like the TTY call, but the conversation between hearing-disabled person and CA is done through the internet instead.
Internet protocol captioned telephone service	Allows the person with hearing disability to listen to and read the text from the receiver on the internet.
Video relay service (VRS)	A video conference where American Sign Language can be used and CA can interpret this for the receiver.

complex, such as discussing diagnoses, tests, informed consent, education, and so forth, the nurse must bring in a qualified interpreter for patients who use sign language. Nonqualified interpreters should not be used because of information accuracy and confidentiality concerns as well as emotional aspects of the situation. If a nonqualified interpreter is used, such as a family member or friend, both the nonqualified interpreter and the patient must agree, and a temporary waiver should be signed according to facility policy.[8] The nurse should also consider consulting a social worker to assist the patient with accessing support services for the hearing impaired.

Patient education is necessary for proper ear health. The nurse should educate patients on ear care and protection. Because cerumen is naturally eliminated from the ear with regular jaw movements, cotton swabs or other devices should not be used to clean the ear. With age, the cerumen is drier and does not move as easily, which may cause itching, discomfort, and muffling of noises. It may be necessary for patients to try ear drops, visit an ear clinic, or see a physician or advanced practice clinician to get their ears cleaned.[45] Patients should also protect their ears from loud noises to prevent further damage, and avoid cigarette use, cigarette smoke, vaping, and marijuana. The chemicals in these substances affect the vascular system in the ears[46] by acting as vasoconstrictors, leading to oxidative stress and inflammation. Alterations in neurotransmitter signaling also occurs.[46] Marijuana leads to chronic neuroinflammation in the inner ear as well as tinnitus, a factor in ARHL.[47]

Proper diet and exercise should be discussed with the patient, focusing on cardiovascular health. Diets should include Vitamins A, B, C, D, E, magnesium, zinc, iron, and selenium, and be low in fat, cholesterol, and carbohydrates.[48] Caffeine should be consumed in moderation because recent studies linked the high use of caffeine with hearing loss.[49]

Patient education should include the benefits of using assistive listening devices (ALDs). Assistive devices enable people with hearing impairments to participate in conversations, attend social events, reduce depression, and remain independent. Their use may also delay cognitive decline.[3,50] There are a range of devices available, including ALDs, alerting devices, telephone devices, and HAs. The purpose of ALDs is to separate speech from background noise.[51] ALDs can work on their own or connect to HAs or CIs to bring sounds directly to the patient's ears.[51] Alerting devices send a flashing light or vibration to make the patient aware that something is happening, such as a fire nearby or someone ringing the doorbell.[50]

Many phones contain amplification devices, or an amplifier can be added to a phone to enhance sound. A phone connected to a digital line can reduce distortion and make phone calls easier to understand.[51] Telecommunication relay services (TRSs) enable those with hearing impairment to use a phone to communicate with others (see *Types of TRSs*[50,51]). There are different types of TRSs for hearing or speech impairment. Providers of these services are reimbursed through state or federal funds.[7] There are also

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apps available for download that assist with phone calls. These apps can use captioning (like closed captioning on TV), transcribe voice to text in many languages, and amplify.[52]

HA management is an important intervention for nurses to perform. Nurses should ensure that the HA is working appropriately; that the patient understands how the HA functions; and that the patient knows how to control the volume, change the batteries, and clean the device. HAs should be kept away from moisture and heat. Further, hair products should not be used when HAs are in the ears. Patients should wear HAs while in the hospital to ensure communication and to prevent delirium and depression. The nurse should ensure that the HAs are kept safe and that batteries are available for their use.[36] Finally, nurses should ensure that the patient understands the importance of following up on hearing issues, including seeing an audiologist for a HA fitting if prescribed.

Conclusion

Connecting to the world is vital for communication, security, and well-being. The ability to socialize and listen to sounds enables navigation of the environment, stimulates the brain, and promotes engagement in ways that improve quality of life. ARHL is the most common sensory deficit in older adults. It can lead to communication difficulties, social isolation, low self-esteem, cognitive difficulties, and even physical manifestations such as balance issues. However, proper assessment and diagnosis will lead to appropriate treatment of the patient. Nurses play a role in recognizing, educating, and assisting patients with hearing loss to live a safe and healthy life. ■

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