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Age-Related Hearing Loss: Quality of Care for Quality of Life

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Age-related hearing loss (ARHL), known as presbycusis, is characterized by progressive deterioration of auditory sensitivity, loss of the auditory sensory cells, and central processing functions associated with the aging process. ARHL is the third most prevalent chronic condition in older Americans, after hypertension and arthritis, and is a leading cause of adult hearing handicaps in the United States. The prevalence of ARHL is expected to rise for the next several decades with the increasing aging Baby Boomer population. Nevertheless, ARHL remains an often undetected, underestimated and neglected condition in the geriatric population due to a slow development process of the disease. If left untreated, the impact of ARHL on patients, significant others, and the society as a whole would be significant. The purpose of this review is to raise the awareness of ARHL, to update our current understanding of ARHL with a focus on age-related deficits in auditory and cognitive processing of speech, and to explore strategies of prevention, identification, amplification, and aural rehabilitation. The ultimate goal is to improve the quality of hearing health care and the overall quality of life of the Baby Boomer generation.

Key Words: Auditory processing of speech, Cognitive processing of speech

Age-Related Hearing Loss: Characteristics, Prevalence, and Impact

Age-related hearing loss (ARHL), known as presbycusis, is characterized by progressive deterioration of auditory sensitivity, loss of the auditory sensory cells and central processing functions associated with the aging process. The hallmarks of ARHL include reduced audibility of high frequencies; reduced speech understanding, specifically in noise and reverberant environments; interference with the perception of rapid changes in speech; and impaired sound source localization (R. D. Frisina, 2009). Furthermore, extraneous concentration for hearing leads to fatigue and an increasing need for recovery (Anderson Gosselin & Gagne, 2011). Interaction with significant others could be disrupted due to communication deficit and breakdown, so-called third-party disability (Hickson & Scarinci, 2007).

Age-related hearing loss is the third most prevalent chronic condition in older Americans after hypertension and arthritis, and is a leading cause of adult hearing handicaps in the United States (Cruickshanks et al., 1998). Between 25% and 40% of the population aged 65 years or older is hearing impaired. The prevalence rises with age, ranging from 40% to 66% in people older than 75 years and more than 80% in people older than 85 years (Yueh, Shapiro, MacLean, & Shekelle, 2003). The prevalence of ARHL is expected to rise for the next several decades with the increasing population of aging Baby Boomers. Nevertheless, ARHL remains an often undetected, underestimated, and neglected condition in the geriatric population due to a slow development process of the disease (Wallhagen & Pettengill, 2008). Only 20% people with ARHL seek help (Donahue et al., 2010). Among this group, only 11% own hearing aids, 24% of whom never used their aids (Hartley et al., 2010). The mean age for first-time hearing aid users is 75 year (Kochkin, 2009). If left untreated, the impact of the ARHL to patients, significant others, and the society as a whole would be significant.

Evidence has shown that ARHL is one of the risk factors negatively associated with higher distress, depression, somatization, and loneliness (Gopinath et al., 2009; Nachtegaal et al., 2009; Shiovitz-Ezra & Ayalon, 2010). ARHL significantly decreases the autonomy of affected older persons by increasing their reliance on community or family support (Schneider et al., 2010). Furthermore, the cost of hearing aids, specifically high-quality digital ones, adds a financial burden to the increasing ARHL-affected population as well as to the society as a whole (Donahue et al., 2010). ARHL is thus associated with the important adverse effects on the quality of life in older/elderly individuals, and these effects are perceived as severe handicaps even by individuals with only mild to moderate degrees of hearing loss (Chia et al., 2007; Dalton et al., 2003). Thus, early prevention, detection, identification, and treatment are crucial for those patients who are hearing impaired. Just recently, much attention has been drawn toward understanding ARHL and associated declines of the central factors for speech processing and understanding (Arlinger, Lunner, Lyxell, & Pichora-Fuller, 2009). These central factors are fundamentally important for the development of legitimate diagnostic and intervention strategies, selection of appropriate treatment options, and improvement of the quality of hearing health care for the geriatric population.

ARHL: Aging-Related Deficits in Auditory and Cognitive Processing of Speech

Convergence of Auditory and Cognitive Functions

Based on a consensus statement guided by the World Health Organization's International Classification of Functioning, Disability, and Health (WHO-ICF; http://www.who.int/classifications/icf/en/), the fully described auditory functions includes four processes—hearing, listening, comprehending, and communicating—reflecting the WHO-ICF functioning levels of both activity and participation (Danermark et al., 2010). Beyond auditory processing, cognitive processing is crucial to the basic functions of listening, comprehending, and communicating (Edwards, 2007). Thus, the ARHL-associated changes occur in at least three levels, including the peripheral auditory system, central auditory system, and cognitive functions. In hearing-impaired geriatric patients, the age-related declines of peripheral and central auditory processing interact with the diminished cognitive functions and support, leading to reduced auditory perception of speech.

Age-Related Decline of the Auditory Processing of Speech

The most important aspects of the central auditory processing of speech are temporal and binaural processing (Bernstein, 2001). There are three types of temporal distortions commonly encountered by the geriatric population in everyday listening situations: time compression (fast speech), noise, and reverberation (Helfer & Wilber, 1990). Older people frequently show poorer recognition of rapid speech or time-compressed speech than younger listeners do. In general, research findings support the notion that the problems of older listeners in recognizing time-compressed speech are associated with difficulty in processing the brief, limited acoustic cues for consonants that are inherent in rapid speech (Gordon-Salant & Fitzgibbons, 2001). The selective slowing of speech segments may improve recognition performance by elderly listeners. Indeed, a study showed that the performance by elderly listeners and listeners with hearing loss was improved with selective time expansion, particularly when applied to consonant segments (Gordon-Salant, Fitzgibbons, & Friedman, 2007). This evidence can direct the improvements and modifications of audiology practice, aural rehabilitation, and hearing aid technology.

Great difficulty in listening to speech in noise is often a chief complaint from hearing-impaired elderly patients. A study showed that, when audibility and cognitive functioning were not affected, the older individuals demonstrated speech-recognition-in-noise dysfunction in comparison with young adults, suggesting a central auditory dysfunction (D. R. Frisina & Frisina, 1997). A recent study examined the relationship between the neuroanatomical structure of cognitive brain regions and the ability to perceive speech in noise in older adults (Wong, Ettlinger, Sheppard, Gunasekera, & Dhar, 2010). This study showed that older adults who had worse hearing sensitivity and ability of speech perception in noise than younger adults showed a decline in the relative volume and cortical thickness of the left ventral and dorsal prefrontal cortex, suggesting that, in addition to peripheral structures, the central nervous system also contributes to the ability to perceive speech in noise.

Cognitive Processing of Speech in ARHL

Studies showed that hearing loss is independently associated with incident all-cause dementia (Lin et al., 2011) and that the central auditory function was affected by even mild memory impairment (Gates, Anderson, Feeney, McCurry, & Larson, 2008). Cognitive components that are involved in the speech processing include selective attention, working memory and long-term memory, speed of processing, inhibitory function, and executive functioning, and these functions significantly decrease with aging, and with reduced brain structure size and white matter integrity (Isingrini, Perrotin, & Souchay, 2008; Park & Reuter-Lorenz, 2009; Pichora-Fuller, 2003). Studies showed that elderly listeners exhibited poorer performance than younger listeners on the sentence recall task, but not on the word recall task, indicating that added memory demands have a detrimental effect on elderly listeners' performance (Gordon-Salant & Fitzgibbons, 1997). In addition, speech comprehension declines more rapidly in older adults than in younger adults as speech rate increases (Baudouin, Vanneste, & Isingrini, 2004; Janse, 2009). The slowed information processing may be a part of elderly listeners' problem keeping up with fast speech. Reduced speech understanding in noise or reverberant environment may be also associated with age-related declines of the selective attention and central processing resources in older adults (Anderson Gosselin & Gagne, 2011).

The effects of aging on how suprathreshold speech signals are perceived and used by elderly listeners, especially in realistic acoustic environments, are thus rather complex. Evidence supports that the declined auditory and cognitive functions indeed play roles in reduced speech perception and speech-in-noise perception in the geriatric population. The deficits of the central components associated with ARHL may explain the limited success in elderly hearing aid users who have difficulties in understanding fast speech and conversations in noisy situations. Therefore, multidisciplinary approaches should be taken in the assessment and management of the hearing-impaired geriatric patients.

Quality of Care for ARHL: Prevention, Identification, Amplification, and Aural Rehabilitation

Prevention

Prevention strategies for ARHL in the Baby Boomer generation should include the awareness of noise exposure and ototoxicity (Dobie, 2008; Triggs & Charles, 1999). The incidence of adverse drug reactions is significantly higher in persons older than 65 years than in younger population groups (Sloan, 1992). Older adults with chronic health conditions who take multiple medications, so-called polypharmacy, are at greater risk for drug–drug interactions (Hunter & Cyr, 2006; Kaufman, 2011; Klotz, 2009) and, no doubt, ototoxicity (Triggs & Charles, 1999). Health care professionals should thus be aware of the risks and fully evaluate all medications at each patient visit to prevent polypharmacy from occurring (Klotz, 2008; Planton & Edlund, 2010). Primary care providers should also teach older adults proper auditory hygiene and provide information regarding support groups to the family or caregiver as needed (Ko & Ko, 2010).

Early Detection and Identification

Age-related hearing loss is a major public health issue. With the increasing population of aging Baby Boomers, primary care providers can expect to see an increasing older patient population who suffer from chronic health problems such as ARHL. Evidence showed that hearing screening can identify untreated hearing loss and lead to interventions to improve hearing-related functions and the quality of life (Chou, Dana, Bougatsos, Fleming, & Beil, 2011). It is the primary care provider's responsibility to perform prompt auditory screenings, to recognize the early clinical signs and symptoms of hearing loss, and to make appropriate referrals to otologists and professional audiologists for further diagnosis and intervention.

Amplification: Benefits and Limitations

Interventions, such as hearing aids and surgeries (bone-anchored hearing aids, cochlear implant), could help to improve patient's quality of life (Acar, Yurekli, Babademez, Karabulut, & Karasen, 2011; Humes, Wilson, Barlow, Garner, & Amos, 2002; Sprinzl & Riechelmann, 2010). The aging-related change in absolute hearing sensitivity is a principal factor affecting older listeners' speech perception in quiet situations. Hearing aids, which have been the traditional treatment for improving speech perception in older adults, are likely to offer considerable benefit in quiet listening situations because the amplification can serve to compensate for the loss of audibility. However, such devices may be less beneficial in more natural environments (e.g., noisy background, multiple talkers, reverberant environment) because these devices are less effective for improving the speech perception difficulties that result from the aging-related declines of the central auditory and cognitive processing of speech as described previously. In addition, older adults with high-frequency hearing loss cannot take full advantage of the increase in audible speech information provided by the amplification because the hearing aids did not restore speech audibility across the full bandwidth of speech for some individuals (Ahlstrom, Horwitz, & Dubno, 2009). Furthermore, aging-associated losses of the dexterity and visual acuity can greatly affect successful use of hearing aids in the geriatric population (Humes, Wilson, & Humes, 2003; Incel et al., 2009). For these reasons, many older adults with hearing impairments continue to have substantial communication difficulties even after being fitted with hearing aids, and many simply choose not to wear hearing aids (Hartley et al., 2010). Hearing aid benefits, although significant, thus turn out poorer than expected. An integrative approach to designing test batteries that can assess both sensory and cognitive abilities needed for processing spoken language offers the most promising approach for developing advanced hearing aid technologies and intervention strategies to improve speech perception in older adults.

Design and fitting of new listening technologies depend on new knowledge concerning underlying auditory and cognitive processing deficits that are not explained by the simple loss of audibility. Beyond operations that mimic auditory processing executed by the cochlea, such as filtering, amplification, and compression, hearing aid technologies have begun to incorporate more complex operations that emulate aspects of higher level auditory and cognitive processing such as attention, memory, and speech (Gordon-Salant, 2005; Humes, 2007). Advanced hearing aid technologies may incorporate individual differences in cognitive processing resources, such as working memory capacity, in order to monitor the individual "cognitive workload" on a real-time basis, and determine the level at which the listening situation starts to challenge working memory resources, make collaborative efforts between the audiological and the cognitive psychology disciplines by optimizing signal processing, and finally to minimize the negative impact of sensory impairment on cognitive function (Cox & Xu, 2010; Lunner, Rudner, & Ronnberg, 2009). However, the amplification is not a sole solution to improve communication effectiveness and the quality of life in older patients who are hearing impaired.

Beyond Amplification, Aural Rehabilitation

The aural rehabilitation refers to services and procedures available for facilitating adequate receptive and expressive communications in individuals with hearing impairment (ASHA, 1984). These services focus on adjusting patients and their significant others to each individual hearing deficit, developing realistic expectations toward the amplification, making the best use of hearing aids, exploring assistive listening devices that may help, and providing listening strategies to improve communication effectiveness. Services can be individual, in small groups, or a combination of both (http://www.asha.org/public/hearing/Adult-Aural-Rehabilitation/). Furthermore, intensive auditory and cognitive training may be effective in modifying the aging-independent brain plasticity, for example, by enhancing the selective attention in speech in noise, speech processing and discrimination, working memory, and executive functioning (Dahmen & King, 2007; Sweetow & Sabes, 2006; Syka, 2002; Willis et al., 2006).

Recent studies showed that aural rehabilitation and auditory training have positive consequences to cognitive and social function in older communicators (Burk & Humes, 2008; Humes, Burk, Strauser, & Kinney, 2009). However, fewer than 10% of audiologists offer auditory training to hearing-impaired patients, and the compliance with a cohort of home-based auditory therapy trainees was less than 30% (Sweetow, Sabes, Sweetow, & Sabes, 2010). Appropriate assessments of hearing impairments, activity limitations, participation restrictions, and personal factors applicable in a rehabilitation context are crucial for a successful audiological rehabilitation. It was suggested that the auditory rehabilitation should be incorporated at the very beginning of the professional interaction and the training program should be individualized (Sweetow et al., 2010). Evidence-based clinical research is needed to assess factors that are associated with the cost and effectiveness and the benefits, and whether these benefits actually improve the quality of life (Boothroyd, 2010).

Because an older adult's satisfaction with amplification may be influenced by original expectations and attitudes, sufficient information provided from the prefitting counseling could improve the benefits of hearing aids in older hearing-impaired adults (Kiessling et al., 2003; Saunders, Lewis, & Forsline, 2009). Comorbidities of the aging-associated chronic degenerative diseases such as stroke, arthritis, degenerative bone/joint diseases, and losses of the dexterity and visual acuity may limit physical mobility (Crews, 2005) and prevent timely delivery of the quality hearing care. Recently, tele-audiology has demonstrated a significant potential in areas such as education and training of hearing health care professionals, paraprofessionals, parents, and adults with hearing disorders; screening for auditory disorders; diagnosis of hearing loss; and intervention services (Swanepoel de et al., 2010). Global connectivity is rapidly growing with increasingly widespread distribution to underserved communities where audiological services may be facilitated through Internet models such as Skype, Facebook, and Twitter. The tele-audiology services via interface with Internet models could be especially beneficial to the older/elderly patients who lose their mobility.

In summary, ARHL is a major public health problem and detrimentally impact the quality of life for millions of the affected geriatric patients. With the increasing Baby Boomer population, the incidence of ARHL is expected to rise rapidly within the next several decades. The consequences of ARHL—reduced environmental stimulations, social isolation, and depression, to list a few—may aggravate cognitive decline. Comorbidities including cognitive impairment may further exacerbate central auditory processing decline, associated hearing deficits, and poor speech understanding. Although auditory amplification vastly improves the communication abilities in most hearing-impaired individuals, associated declines of multisensory mechanisms may contribute to a patient's difficulty to cope in everyday settings. Losses of visual acuity and dexterity, cognitive decline, and other aging-related comorbidities are just some of the confounding obstacles preventing hearing professionals from delivering timely, effective quality care for the elderly population who are hearing impaired. Health care professionals with a special interest in serving the geriatric population need to understand the fundamental ARHL-associated changes that affect auditory and cognitive processing of speech and aural communication. This growing knowledge should guide audiological and aural rehabilitative practice to facilitate brain plasticity and acclimatization to speech sound input processes by hearing devices, to enable a full engagement in the activities of daily living, and, ultimately, to improve the overall quality of life in this growing population.

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