

## Clinical Relevance for the Veteran

### Selected complex auditory disorders

Maurice H. Miller, PhD; Jerome D. Schein, PhD

**Purpose of the Work.** This article offers an overview of recent advances in the diagnosis, treatment, and rehabilitation of four complex auditory disorders, all of which involve sensorineural hearing loss but have, in addition, other significant extra-auditory attributes unique to that condition. These conditions are noise-induced hearing loss, idiopathic sudden sensorineural hearing loss, otosclerosis, and Ménière's disease. **Procedures.** Extensive review of the literature provides the bases for the discussions of each condition, with attention to diagnostic and treatment advances that presently lack widespread adoption and/or confirmation. **Results.** The field of audiologic rehabilitation has profited from recent research that promises important advances in the diagnosis, treatment, and rehabilitation of the four conditions reviewed. **Relevance to the Veteran Population.** As veterans age, their exposure to a variety of audiologic disorders increases. The four conditions reviewed merit vigorous research leading to improved audiologic management, both because of their severity and because of their likely increased prevalence among veterans.

*Maurice H. Miller, PhD*

### Hearing loss and aging: New research findings and clinical implications

Sandra Gordon-Salant, PhD

**Purpose of the Work.** This review presents results of recent investigations of the effects of aging on auditory function. The focus is age-related changes in hearing sensitivity, speech understanding performance, and the ability to process brief acoustic events. A section is included that discusses the benefits and limitations of treatment methods for age-related hearing impairment. **Subjects.** The subjects of the investigations are generally over the age of 65 and have normal hearing or age-related hearing loss. For some investigations, the performance of subjects over 65 years is compared with that of younger adults (18–40 years) who have similar hearing ability. **Results.** Hearing loss among elderly people affects their ability to understand speech in ideal listening environments (quiet),

as well as in poor acoustic environments. Elderly people also experience difficulty understanding rapid speech, accented English, and speech with few contextual cues. These communication problems are likely associated with a combination of factors, including hearing loss, cognitive decline, and a reduced ability to process very brief individual sounds or sequences of sounds with unusual timing. Hearing aids benefit elderly people in hearing and understanding speech in quiet and some noise environments, but they do not appear to alleviate the communication difficulties imposed by many other difficult listening situations. Assistive listening devices and new signal processing techniques may ultimately prove useful for improving communication in these more challenging conditions. **Relevance to the Veteran Population.** An estimated 9.3 million veterans are over the age of 65. Approximately 13.5% of those between the ages of 65–74 and 25.2% of those older than 75 years report a hearing condition that requires a hearing aid. The data presented in this article suggest that this age group most likely has more veterans who have significant hearing loss and other auditory processing limitations and could benefit from treatment of hearing aids, aural rehabilitation, and use of assistive listening devices.

*Sandra Gordon-Salant, PhD*

### Some effects of aging on central auditory processing

Jeffrey S. Martin, MA; James F. Jerger, PhD

**Purpose of the Work.** This article reviews the central auditory component of presbycusis (age-related hearing loss). We review the impact of age-related changes in cognitive function and central auditory processing. We pay special attention to understanding speech in noisy environments, which is often difficult for older adults. We also discuss the usefulness of popular intervention strategies, hearing aids, and assistive listening devices. **Subjects and Procedures.** We review research comparing younger and older adults' deficits in temporal processing, and we summarize our behavioral and electrophysiological findings on the effects of aging on dichotic listening performance. **Results.** Age-related deficits in interhemispheric information processing may contribute to some listening problems in seniors. **Relevance to the Veteran Population.** A large

number of veterans are older and may experience presbycusis hearing loss.

*Jeffrey S. Martin, MA*

### **Hearing health and care: The need for improved hearing loss prevention and hearing conservation practices**

Stephen A. Fausti, PhD; Debra J. Wilmington, PhD;  
Patrick V. Helt, MA; Wendy J. Helt, MA;  
Dawn Konrad-Martin, PhD

**Purpose of the Work.** This article discusses the growing public health concern of noise- and ototoxic-induced hearing loss. This work proposes audiometric screening, hearing protection, and conservation strategies and discusses the future of preventive antioxidant therapies. **Subjects and Procedures.** People from all age groups experience hearing loss, but the focus of this work is on adults, particularly veterans who are exposed to excessive occupational noise and/or medical treatment with ototoxic medications. Screening techniques should include high-frequency audiometry and otoacoustic emission tests. Prevention should involve hearing loss prevention programs, hearing protection, and preventative and/or rehabilitative therapy. **Results.** A survey of the prevalence of noise-induced and ototoxic hearing loss has revealed a rapidly progressing public health concern. The literature reviewed suggests that increased technological advances in the workplace have increased harmful levels of noise and that a wide variety of medications with ototoxic potential are being used and developed. Evidence supports the use of high-frequency audiometric screening for early detection of hearing loss before speech frequencies are affected. Hearing protection programs, education on the risks of ototoxic medication, and the development of antioxidant therapy to prevent or counteract cochlear damage are suggested ways to reduce or eliminate occupational noise- and ototoxic-induced hearing loss. **Relevance to the Veteran Population.** Due to the intensity and magnitude of military operations, the extension of training and tours of duty, and the increase in the number of combat forces, hearing loss has escalated in the veteran population to become the third most prevalent service-connected disability. Noise- and ototoxic-induced hearing loss adds to the normal age-related hearing loss in a population whose number of older adults is increasing. Thus, hearing impairment costs the Veterans Health Administration over \$400 million annually. Hearing loss also compromises safety, leads to job

and revenue loss, and causes psychosocial and physical problems. Education, hearing loss prevention programs, and knowledge of the risks of ototoxic medications will alleviate hearing disability and improve quality of life for veterans.

*Stephen A. Fausti, PhD*

### **Evaluation of human middle ear function via an acoustic power assessment**

Jont B. Allen, PhD; Patricia S. Jeng, PhD;  
Harry Levitt, PhD

**Purpose of the Work.** The middle ear (ME) is involved in nearly every test of hearing. Thus, it is critical to ascertain the status of the ME at the outset of any audiological evaluation. The ME is a highly sensitive and complex mechanism and is subject to a wide range of disorders, such as otosclerosis, otitis media, ossicular discontinuities, and eardrum perforations. **Procedures.** Measurements of ME acoustic power flow (reflectance, absorption, and transmittance) and normalized impedance (acoustic resistance, acoustic reactance, and impedance magnitude) were compared for their utility in clinical applications. **Results.** Transmittance was found to have several important advantages over other measures of acoustic power flow. The acoustic impedance measures (resistance and reactance) provided important additional information about ME status and supplemented transmittance measurements. Together these measurements can help identify unusual conditions, such as eardrum perforations. **Relevance to the Veteran Population.** Disorders of this type are commonly encountered in the veteran population.

*Jont B. Allen, PhD*

### **Speech signals used to evaluate functional status of the auditory system**

Richard H. Wilson, PhD; Rachel McArdle, PhD

**Purpose of the Work.** This article reviews how understanding of speech (speech recognition) can measure hearing loss. The authors discuss how speech recognition in quiet and noise differs for listeners with and without hearing loss, how the presentation level of speech affects recognition, how aging and hearing loss affect speech recognition, and what materials and techniques describe speech recognition. **Subjects.** Listeners (including veterans and older adults) with and without hearing loss.

**Results.** Listeners with hearing loss who have good speech recognition in quiet do not always have good word recognition in noise. Listeners with hearing loss who have poor speech recognition in quiet usually have poor speech recognition in noise. In general, listeners have better speech recognition when presentation level of speech is higher. This is not always true for listeners with some types of hearing loss (e.g., some kinds of cochlear hearing loss). Older people typically have poorer speech understanding, most likely because of less sensitivity to sound in the peripheral auditory system. **Relevance to the Veteran Population.** The most common complaint of veterans with hearing loss is the lessened ability to understand speech, especially in background noise.

*Richard H. Wilson, PhD*

#### **Clinical management of tinnitus using a “progressive intervention” approach**

James A. Henry, PhD; Martin A. Schechter, PhD;  
Carl L. Loovis, PhD; Tara L. Zaugg, MA;  
Christine Kaelin, MBA; Melissa Montero, BS

**Purpose of the Work.** Chronic tinnitus is experienced by 10%–15% of the population, of which only about 20% require clinical intervention. Those requiring intervention have different levels of need ranging from the provision of basic information to long-term, individualized treatment. We address this clinical need by outlining a five-level “progressive intervention” approach to tinnitus management that would provide a systematic framework for treatment by audiologists. **Subjects and Procedures.** We have completed two randomized clinical trials that support the progressive-intervention approach to tinnitus management. For the first trial, 123 patients received individualized treatment at baseline and at 3, 6, 12, and 18 mo with either Tinnitus Masking or Tinnitus Retraining Therapy (TRT). For the second trial, 290 patients were randomized to receive (1) four weekly sessions of group educational (TRT-based) counseling, (2) four weekly sessions of a traditional support group (no education provided), or (3) no intervention. Outcome measures were obtained at baseline and at 1, 6, and 12 mo. **Results.** The first study (individualized treatment) resulted in significant improvement for both the Masking and TRT groups. Greater improvement was seen for the TRT group, especially for patients who started treatment with the most severe tinnitus. For the second study, the 4 wk of group educational counseling resulted in significant improvement that was maintained

for the 12 mo outcome period. Neither the traditional support group nor the no-treatment group experienced any changes in outcomes. **Relevance to the Veteran Population.** This research has the goal of validating methods of treatment for tinnitus that Department of Veterans Affairs audiology clinics could use. Because these clinics are generally overcrowded with patients, it is critical that any new methodology also be very efficient. Our progressive-intervention model directly addresses the need for efficiency. Findings from our studies indicate that different levels of intervention are required for veterans who experience chronic tinnitus. We are also developing methods of screening to determine if, and how much, intervention is required. Use of this multilevel approach can significantly improve the quality of life for many veterans who suffer from tinnitus.

*James A. Henry, PhD*

#### **Bilateral amplification and sound localization:**

**Then and now**  
Helen J. Simon, PhD

**Purpose of the Work.** This article describes the history, recent research, pros, and cons of bilateral hearing aids. **Subjects and Procedures.** A number of different research studies are described. The results of localization experiments with people who use either one or two hearing aids are discussed. **Results.** An important conclusion of the studies from our laboratory is that although most listeners with moderate hearing loss have good to excellent accuracy of localization, unfortunately, some will always have difficulty localizing sound, possibly as a result of monaural amplification or poorly fit bilateral hearing aids. In addition, decreased localization ability may be seen in the unaided situation, especially with individuals with one hearing aid. **Relevance to the Veteran Population.** The Department of Veterans Affairs (VA) audiology clinics will see more than 340,000 veterans during the first years of the 21st century. Of these, an estimated 270,000 will be fitted with hearing aids and 200,000 of those will use two. Because of the clear advantages of two hearing aids to sound localization and speech intelligibility in noisy settings for many listeners, the majority of hearing aid candidates continue to advocate for bilateral fittings. The results of our work will be important for the VA Audiology Service’s evaluation of hearing aid fittings.

*Helen J. Simon, PhD*

### Directional hearing aids: Then and now

Todd A. Ricketts, PhD

**Purpose of the Work.** This work describes the history, recent research, pros, and cons of directional microphone hearing aids, including the potential interaction with bilateral versus unilateral fittings. **Subjects and Procedures.** A number of different research studies by the author are described in this paper. **Results.** The results show that the use of bilateral directional mode is beneficial in many noisy listening environments. In addition, localization accuracy was significantly poorer in the aided omnidirectional microphone mode than in the unaided condition. Localization for unaided and directional conditions, however, was not significantly different. **Relevance to the Veteran Population.** Department of Veterans Affairs (VA) audiology clinics will see over 340,000 veterans the first years of the 21st century. Of these, an estimated 270,000 will be fitted with amplification, 200,000 of those bilaterally (estimate extrapolated from the first quarter 1997 VA Clinical Quarterly Report). Given clear binaural advantages related to localization and speech understanding in noise present for many listeners, bilateral fittings continue to be advocated for the majority of hearing-aid candidates. Given the clear advantages provided by directional hearing-aid modes in terms of speech understanding in many noisy environments, combined with the potential disadvantages in other situations, hearing aids that can be switched between directional and omnidirectional mode are advocated for many hearing aid candidates. The results of this work will be important for VA Audiology Service evaluations for hearing aid fittings.

*Todd A. Ricketts, PhD*

### An evaluation of digital cellular handsets by hearing aid users

Linda Kozma-Spytek, MA, CCCA; Judith Harkins, PhD

**Purpose of the Work.** Audible interference from digital cellular telephones (cell phones) has been a long standing problem for hearing aid users. We conducted an experiment to determine how well hearing aid wearers are able to use commercially available digital cell phones. **Subjects and Procedures.** Hearing aid users evaluated the usability of six digital cellular handsets. **Results.** The results suggest that certain transmission technologies create more annoyance from interference than others, and that the type of hearing aid-to-telephone coupling (micro-

phone or telecoil) can influence a user's susceptibility to interference. However, the results also suggest that interference alone does not fully predict the usability of a cell phone for hearing aid users. These findings have implications for the American National Standards Institute C63.19 test and measurement standard that is used to rate cell phones' compliance with the FCC ruling and the education of consumers with regard to their expectations for cell phone use. **Relevance to the Veteran Population.** This study suggests that digital cell phone usability by hearing aid wearers can be affected by transmission technology and type of coupling and that interference alone does not fully predict usability. We believe that the data presented here can be used in the future to validate new hearing aid compatibility standards and reduce annoyance because of interference from digital cell phones for hearing aid wearers.

*Linda Kozma-Spytek, MA, CCCA*

### Measuring hearing aid outcomes—Not as easy as it seems

Gabrielle H. Saunders, PhD; Teresa H. Chisolm, PhD;  
Harvey B. Abrams, PhD

**Purpose of the Work.** This article reviews and summarizes studies associated with measurement of hearing aid outcomes to provide the reader with rationales for measurement and examples of tools, as well as alert the reader to potential pitfalls and complications. **Subjects and Procedures.** The article summarizes a number of studies that use a variety of subject pools and study procedures. **Results.** Many tools are available for measurement of hearing aid outcomes; some of these are disease-specific, while others are not. Each is sensitive to a different aspect of outcome and has a different purpose. The article shows that many factors can complicate interpretation of outcomes data, and the clinician should account for these when interpreting test results. **Relevance to the Veteran Population.** Assessment of hearing aid outcomes is important to the veteran and to the Department of Veterans Affairs because it justifies the fitting of hearing aids and demonstrates to patients whether they are benefiting from a hearing aid. If no benefit is being shown, this alerts clinicians that they must alter the fit of the hearing aid. Thus, measurement of outcomes has direct clinical relevance to the veteran and to clinical practice.

*Gabrielle H. Saunders, PhD*

### Central auditory system plasticity and aural rehabilitation of adults

Arlene C. Neuman, PhD

**Purpose of the Work.** Recent advances in our ability to measure electrical activity in the auditory system have made it possible for us to study changes in the central auditory system from hearing loss, hearing aid use, or auditory training. This article summarizes these investigations, identifies the limitations associated with these studies, and relates new information about auditory system plasticity to the auditory performance of hearing-impaired persons with and without hearing aids. **Procedures.** Studies that investigated auditory system plasticity were reviewed with special focus on studies of adults with acquired sensorineural hearing loss and adults who had learned new auditory tasks. **Results.** The findings of these studies were related to current information about the auditory performance of people with hearing loss. The potential application of measurement techniques for evaluating performance with hearing aids and the efficacy of auditory training were discussed. **Relevance to the Veteran Population.** This summary of the research on auditory system plasticity in adults with acquired hearing loss should be of value to researchers and clinicians who routinely interact with veterans with hearing loss but are unfamiliar with the methodology and results of such investigations. The studies help explain the consequences of auditory deprivation and may have implications for improvement with hearing aids and auditory training. The measurement techniques used to study auditory system plasticity are potentially useful in aural rehabilitation research and clinical practice.

*Arlene C. Neuman, PhD*

### Hair cell regeneration: An exciting phenomenon . . . But will restoring hearing and balance be possible?

Jonathan I. Matsui, PhD; Brenda M. Ryals, PhD

**Purpose of the Work.** This article reviews the current state of science with regard to the use of hair cell regeneration as a cure for permanent hearing loss. **Procedures.** We discuss some of the key recent findings in sensory hair cell regeneration and what they mean for audiologists and other hearing healthcare practitioners. **Results.** Sensory hair cells of the inner ear are susceptible to damage from many sources including aging, genetic defects, and environmental stresses such as loud noises or chemotherapeutic drugs. Unfortunately, the consequence of this damage in humans is often permanent hearing/balance problems. The discovery that hair cells can regenerate in birds and other non-mammalian vertebrates has fueled a wide range of studies that are designed to find ways of restoring hearing and balance after such damage. **Relevance to the Veteran Population.** The Department of Veterans Affairs (VA) Office of Policy and Planning estimates that nearly 300,000 veterans have service-connected hearing loss. This number is a conservative estimate of the actual number of hearing impaired veterans since many veterans have nonservice-connected hearing loss and hearing loss in general is under-diagnosed. In 1999, approximately 85,000 veterans were fitted for hearing aids at VA medical centers. Since the large majority of these hearing losses involve the loss of hair cells as a primary underlying etiology, regeneration of these hair cells represents a major potential cure. If hair cell regeneration were possible in humans and if these regenerated hair cells restored even some portion of the hearing, then the benefit in human potential and actual cost savings is enormous.

*Jonathan I. Matsui, PhD*