Noise & Health

Please follow the instructions in this letter carefully.

Attached is a PDF page proof of your article, which is scheduled for publication in a forthcoming issue of NAH. Its purpose is for the essential correction of errors only, to check the accuracy and positioning of tablesand figures and/or approval that no further corrections are required.

Proof corrections

- Please add corrections or answers to any queries by typing or writing them clearly on a print-out of the PDF page proof or mention the corrections separately with details [Page number, paragraph number, right/left column, line number, corrections (Replace "….." with "…..")]
- Please check the accuracy of items such as author details
- Please check the accuracy and positioning of tables and figures
- Please check the accuracy of items such as the title and running heads
- Please check for the corruption of special characters such as symbols and Greek letters

Reprints

- Please print out the attached Reprint Order Form and fill in the appropriate details.
- Complete the form in clear block letters and return it by post/courier to arrive **within 5 days of receipt.**
- Please ensure that your full name, address and telephone details are supplied

Return your corrections to:

E-mail: proofs@medknow.com

If corrections are done in hard copy, please return to:

MEDKNOW PUBLICATIONS PVT LTD,
A-109, Kanara Business Centre, Off Link Rd, Ghatkopar (E), Mumbai - 400 075, INDIA

Last Date to Return the Proofs

02/01/2009

Hearing loss in veterans and the need for hearing loss prevention programs

Gabrielle H. Saunders, Susan E. Griest[1]

National Center for Rehabilitative Auditory Research, Portland VA Medical Center, [1]Department of Otolaryngology, Oregon Health and Science University, USA.

Abstract

Currently, there are more than 445,000 veterans receiving compensation for hearing loss associated with military service, and 395,000 receiving compensation for service-related tinnitus. In addition to compensation payments, service-related hearing disorders cost the US Department of Veterans Affairs in terms of provision of hearing aids, hearing aid-related services, and clinical services at its 220 facilities nationwide. It is imperative that hearing conservation among military personnel and veterans be addressed. In this paper, we describe the rationale for and the development of a multimedia Hearing Loss Prevention Program aimed at preventing the progression of hearing loss among veterans associated with social, recreational, and nonmilitary occupational noise exposure. The program was developed based on the principles outlined in the *Health Belief Model* of Rosenstock (1966) and the *Health Promotion Model* of Pender *et al.* (2002).

Keywords: veterans, hearing loss prevention, health promotion, multimedia program

Introduction

The issue of noise exposure in the military was of such considerable concern to Congress that in 2002 it directed the Veterans Administration to contract with the Institute of Medicine National Academies to conduct a review of noise exposure in the military using data from World War II to the present. The report examined the extent to which hearing loss could be expected among members of the armed forces, it assessed sources of hazardous noise during military service, and attempted to estimate the levels of noise exposure causing hearing loss. Further, the time course of hearing loss following noise exposure was examined, as were risk factors associated with noise damage and the compliance of the military services to hearing conservation programs (HCPs). The report confirmed the concerns of Congress in concluding that exposure to hazardous noise in the military is considerable and problematic.[1] The military is aware of the problem and is thus addressing it through HCPs and new hearing protection technology. A lesser-addressed subject is the impact of noise exposure during military service on the hearing of veterans in civilian life and ways to prevent further damage from noise. In this paper, we describe a new multimedia hearing loss prevention program that aims to educate veterans about hearing, hearing loss, and the dangers of exposure to noise, with a view to changing their attitudes and behaviors toward use of hearing protection.

Noise-related hearing loss and tinnitus among veterans is prevalent. The Veterans Benefits Administration Annual Benefit Report of fiscal year 2006[2] shows that hearing loss and tinnitus are the two most prevalent service-connected disabilities. The term 'service-connected' refers to "disability or death, that such disability was incurred or aggravated, or that the death resulted from a disability incurred or aggravated, in line of duty in the active military, naval, or air service".[3] Veterans who have a service-connected disability may receive a monthly payment (compensation) from the Department of Veterans Affairs (VA) if their disability meets specific criteria defined in US code title 38 – Veterans benefits.[3] There are currently 444,583 veterans receiving compensation for defective hearing and 395,324 receiving compensation for tinnitus.[4] It is estimated that there are almost one million more veterans with service-connected hearing loss and/or tinnitus who do not meet the criteria for receiving compensation. The cost of compensation for hearing and tinnitus-related disabilities in fiscal year (FY) 2006 was over USD 1.2 billion. The VA has additional expenditures associated with dispensing of hearing aids and other audiological services. In FY 2007, the VA dispensed 348,920 hearing aids at an estimated cost of USD 141.3 million, and provided audiological services at a cost of approximately USD 147.1 million. It is thus clear that hearing loss resulting from military service is a huge financial and clinical burden for the VA.

Noise Exposure During Military Service

Noise exposure in the military is associated with combat and with work in industrial-types of environments such as shipbuilding yards and aircraft maintenance. Noise levels during combat are especially hazardous and difficult to control because the sources are not always predictable, and because personnel have concerns that hearing protection devices (HPDs) will jeopardize their safety by distorting localization cues and by attenuating important cues from other sources. Military noise sources and their levels have been compiled and published by the Army hearing program[5] and by Berger, Neitzel, and Kladden.[6] A few examples are listed here: in the cockpit of Chinook and Black Hawk helicopters the sound levels reach 102.5 and 106 dB, respectively. Fighter jet launch noise levels from an aircraft carrier reach 152 dB(A). Noise levels inside an Abrams tank and in armored personnel carriers average to 114 dB(A) when traveling at 30 mph and 117 dB(A) at 40 mph. Machine guns and pistols have peak noise levels greater than 150 dB(C).

All branches of the military have HCPs that have existed since 1948 when the Air Force first issued its hearing conservation guidelines. In 1955, the Navy/Marine Corps developed its first HCP, and in 1956 the army did likewise.[1] Since then, these programs have been improved and better monitored. Department of Defense (DoD) programs are required to meet or exceed Occupational Safety and Health Administration (OSHA) 1983 standards for hearing conservation,[7] except military personnel and unique military equipments, systems, and operations.[8] To this end, the services use a more stringent exchange rate than the 5 dB specified by OSHA;[7] the Navy uses a 4 dB exchange rate, while the Army and Air Force use a 3 dB exchange rate. The exchange rate is the relationship between sound level and dose, for example, for every 5 dB increase in sound intensity, the duration of safe exposure time is halved.[9]

One issue examined in the Institute of Medicine of the National Academies Report of 2006 was the adequacy of military HCPs, with a view to 'identifying when hearing conservation measures were adequate to protect the hearing of service members'. They examined the extent to which the services aim to control the noise environment, the availability, use and effectiveness of hearing protection, audiometric monitoring of personnel, and evaluation of program effectiveness. It was found that the Navy effectively used noise control to reduce noise levels on submarines by up to 30 dB, but that no other branches of service have been as successful in managing noise levels, in part, because noise control is not an option for all environments. In terms of hearing protection, the Institute of Medicine of the National Academies report discusses the fact that hearing protection could come in the form of limiting time of exposure to hazardous noise, or in the form of hearing protection devices (HPDs). Unfortunately, in a combat zone, the former is not possible to enforce; therefore, the military is reliant on use of HPDs. Such devices are available to all personnel. Today's technology permits up to 50 dB of attenuation when ear plugs are worn in combination with ear muffs, and sometimes even more at frequencies above 2 kHz.[10] This level of attenuation provides adequate protection for almost all environments, a major exception being the flight deck of an aircraft carrier, which, *"is perhaps the single most noise-hazardous work environment in the Department of the Navy. Dozens of personnel work in close proximity to multiple aircraft generating 140 dB(A) or more of recurring noise during workdays that may exceed 14 hours"*.[11]

As mentioned above, a major barrier to the use of hearing protectors during combat is the concern that hearing protection will attenuate or distort sound cues critical to survival. This, at least in part, most likely explains why studies have found that between 30 and 50% of troops do not optimally use the protection they are provided with.[11-14] As published by National Institute for Occupational Safety and Health (NIOSH), the noise reduction rating of HPDs as a function of minutes not worn dramatically decreases the protection they provide. For instance, not wearing an HPD with an effective NRR of 30 for just 30 minutes will reduce its effectiveness by 17 dB.[14] Similarly, poorly fitted HPDs also result in decreases in attenuation.[15] The Institute of Medicine of the National Academies Report[1] found that audiometric monitoring in the military is difficult to assess. They found annual audiograms available for only about half of the service members in HCPs during the period 1988–2003. The committee encountered similarly scattered data when assessing the approaches taken within the military to evaluate its own HCPs. A variety of approaches have been taken, and a database has been developed, known as the Defense Occupational and Environmental Health Readiness System - Hearing Conservation (DOEHRS-HC) database. The committee felt that at this time the DOERS-HC has as yet unrealized potential to improve evaluation of hearing conservation programs. Combining data from all aspects of the military HCPs, the committee concluded that *"hearing conservation programs in the military are currently not adequate to protect the hearing of military service members, and have not been adequate for the period since World War II. This has important human health, personnel readiness and financial implications."* They emphasize that, although the programs are strong, additional staff, training, and noise controls are needed.

The result of noise exposure is cochlear damage. Although on leaving the military it may not manifest itself as permanently elevated thresholds, there is some evidence that ears with past noise exposure, and thus likely cochlear damage, show greater effects of auditory aging.[16,17] Therefore, protecting individuals, such as veterans, with known past noise exposure from further noise, is critical.

Noise Exposure in Civilian Life

In addition to obvious sources of occupational noise exposure such as in the construction, logging, mining, and farming industries, there are other occupations not always considered to be a risk for noise-induced hearing loss (NIHL). For example, police car sirens measure 97 dB(A) inside the vehicle, jazz band concerts and rehearsals average 98 dB(A), and night club disc-jockeys are exposed to average levels of 103 dB(A).[6] The annual cost of disability payments for the estimated 30 million workers who were exposed to hazardous noise was estimated to be USD 242.4 million in 2001.[18]

A number of different standards have been suggested to address noise in the workplace in US, such as those by the OSHA, the Mine and Safety Health Administration (MSHA), the Federal Railroad Administration (FRA), and the DoD. The standard that is most often cited is that developed by OSHA in 1983, for workplace noise monitoring, audiometric testing, provision of hearing protection, training, and recording.[7] However, there are many other common sources of noise to which people are exposed for long periods of time that are not covered under these regulations, and which often exceed safe levels, such as sporting events, entertainment venues, sport vehicles, and even public transport. More specifically, the equivalent sound level experienced over a period of time Leq from a recorder placed on the right shoulder of a spectator at a hockey game found levels of 99.5 dB(A) for the 3.5-hour duration of the game, and of 96.9 dB(A) for game 6 of the US World Series in 1987.[19] Similarly, the average sound level at rock and pop concerts has been shown to be about 95 dB(A), with a range of 73–109.4 dB(A),[20] while personal listening devices can reach outputs of 91–121 dB(A) at maximum settings.[21] Classical musicians are also often exposed to sound levels greater than 85 dB(A) for long periods of time, resulting in a high prevalence of tinnitus and temporary threshold shifts.[22] Noise levels under motorcycle helmets have been measured on the open road at 78–90 dB(A) when traveling at 30 mph, to 114–116 dB(A) when traveling at 120 mph,[23,24] depending upon the specific motorcycle and helmet used. A recent survey of noise levels on the New York city transit system revealed maximum levels of 106, 112, and 89 dB(A) on subway platforms, inside subway cars, and at bus stops, respectively.[25] Children's toys are also sources of noise. Toy mobile phones have been shown to reach levels of 122 dB(A) at the ear, toy guns reach 150–160 dB(C), and squeaky infant toys and toy vehicles have been measured as producing sounds of 78–108 dB(A) measured at a distance of 10 cm from the user.[26]

The general population is often uninformed about the damage recreational noise can do to the auditory system, as evidenced by a number of studies. For instance, a 17-item questionnaire that assessed knowledge, habits, attitudes and perception of NIHL, and use of hearing protection, completed by two-hundred adults revealed that 17% of respondents thought hearing loss caused by noise can be cured by medication, 10% thought it could be cured by bed rest, and 4.5% by a doctor. Only 42% of respondents answered "yes" to the statement "Listening to my favorite music at very loud levels is potentially harmful to my hearing", while about 34% of respondents said they would not know where to purchase HPDs from.[27] There are similar reports showing that adolescents and teenagers are usually uninformed about the potential damage noise can do to the auditory system.[28,29]

It seems that even when individuals are aware that noise can damage hearing, few choose to use protective devices. For instance, a study of mill workers reported that even though 93% of the workers knew about the hazards of noise on hearing and knew of protection methods, only 27% possessed hearing protectors, and of these, only 28% wore them all the time.[30] In another study it was found that 72% of young adults said they never wore hearing protection when exposed to loud sounds, even though 85% were aware that noise can damage hearing.[27] Likewise, of 204 rock-concert goers who completed a survey prior to entering a concert venue, 48.5% said they preferred to stand/sit in the loudest areas of the venue and 80% said they never wore hearing protection at concerts, even though more than 70% thought it was somewhat likely or very likely that the level of the music at concerts would damage their hearing.[31] Similarly, only 14% of the individuals who completed an online survey on the use of hearing protection at music venues reported wearing hearing protection routinely, and only 20% reported an intention to use protection in the future. However, when informed that there was the potential for permanent hearing loss, the number intending to use hearing protection increased to 66%.[29] These studies demonstrate the necessity of educating the public, in particular younger generations, which includes young veterans, about the hazards of exposure to loud noise.

Impacts of Hearing Impairment

Hearing loss impairs communication, and it is consequently associated with functional disability leading to depression, social isolation, anxiety, paranoia, and poor self-esteem.[32-35] Even marginal hearing loss negatively affects a person's sense of independence and well being.[36] Hearing loss affects both partners in intimate relationships by causing feelings of frustration, anger, and antagonism between partners,[37,38] reduces interpersonal communication,[39] and results in poor social and psychological well being on the part of the unimpaired partner.[40] In the workplace, hearing-impaired individuals report feelings of panic, embarrassment and incompetence,[41] and fear for their future employability.[42] Untreated hearing impairment has been associated with a decline in cognitive function,[43] health-related quality of life, and functional capacity to conduct tasks of everyday living.[44] Thus, there is a very real need to educate the public about the reality of NIHL and its psychological and social implications.

Hearing Conservation Programs

As noted above, OSHA, MSHA, FRA, and DoD have had regulations for hearing conservation in the workplace for over ten years. They provide standards for workplace noise monitoring, audiometric testing, provision of hearing protection, training, and recording. Yet, adherence to these standards is poor. For example, in a workplace assessment of ten foundries in the state of Washington, noise levels were measured over seven-hour periods, and management and employees were interviewed about noise monitoring, the availability and use of HPDs and informational materials, training on HCPs, and audiometry practices. Noise levels were found to routinely exceed 85 dB(A) and often were in the 90–95 dB(A) range. None of the ten companies evaluated had made any effort to decrease noise levels, nor were there plans to do so in the future. Management did not have copies of OSHA regulations for hearing conservation, nor had any of the individuals interviewed ever read them. Further, although HPDs were available to workers, little training on use and fitting was provided. Three companies did not provide annual training or audiometric testing, and training at the other seven companies was limited to the presentation of an interactive video in English only. Moreover, those employees who showed a significant threshold shift at annual examinations were never informed of it.[45] Equally disturbing findings were reported from a Michigan state surveillance program for occupational NIHL in which 1378 individuals with NIHL were interviewed about the hearing conservation practices at their workplaces. If an interview revealed no baseline or regular hearing tests at a company, state inspection was recommended. Interviews determined that 46% of the sample was not provided with regular hearing testing; follow-up revealed that of the 43 companies inspected, 23 had noise levels above the Michigan state OSHA regulations; of these, 17 had no HCP, or a deficient one.[46]

Outside the workplace, HCPs are even more lacking, as evidenced by a review of HCPs in schools which found that despite recommendations from experts over many years,[47-49] "basic hearing conservation information that could prevent countless cases of NIHL remains absent from most school curricula".[50] The authors report that although twenty nine organizations produce and disseminate hearing conservation curricula and materials targeted at school-aged children, few schools use such resources at all.

Effectiveness of hearing conservation programs

Studies examining the effectiveness of HCPs are limited, but tend to show positive findings such as increased knowledge about hearing health, and increased current and intended use of HPDs.[51-53] More specifically, employees who participated in HCPs at five fabrication plants showed less deterioration in hearing thresholds after five years than did a control group not exposed to occupational noise.[53] Similarly, regular use of HPDs increased from 20 to 85% among a group of firefighters who were provided with an educational program about NIHL,[51] and intended use of HPDs was almost twice as great for agriculture students who participated in a HCP than among a control group that did not (81% *vs* 43%).[52]

Theoretical basis of preventive health behaviors

In 1966, Rosenstock published the *Health Belief Model* (HBM) that was developed in order to explain individual differences in uptake of health services by the public.[54] The model was initially based on four constructs:

- Perceived susceptibility: the feeling of being vulnerable to a condition and the extent to which the individual believes he/she is at risk of acquiring the condition.
- Perceived severity: the belief in the seriousness of the consequences incurred if affected by the condition both medically (death, disability, pain) and socially (effects on family life, personal relations, etc).
- Perceived benefits: the belief that intervention will result in positive benefits.
- Perceived barriers: the barriers an individual believes he/she needs to overcome in order to effectively conduct some form of intervention. This includes costs, negative side effects, social stigma, time needed, etc.

Two additional constructs were added later:

- Perceived efficacy: the belief in the extent to which the intervention will be effective at treating/preventing the condition.
- Cue to action: a cue that prompts an individual to take action. This could be internal such as symptoms of a health problem or external such as media communications, interpersonal communications, or information from healthcare providers.

Data show that, to varying degrees, these constructs are effective at predicting health-related behaviors, such as prenatal care visits,[55] breast cancer self-examination,[56] continued enrollment in diabetes-related pharmaceutical services,[57] and Hepatits B vaccination.[58]

The HBM was adapted by Pender and colleagues[59] to explain why individuals engage in preventive health behaviors, such as participation in a HCP or use of HPDs. These authors added to the model a number of factors thought to modify the impact of the HBM construct and named their version the *Health Promotion Model* (HPM). Additions include demographic characteristics, biologic characteristics, interpersonal influences, situational factors, and behavioral factors. Lusk and colleagues conducted a number of studies examining the HPM in relation to use of hearing protection in occupational settings. The model has been shown to be effective for predicting use of hearing protection among factory workers,[60] construction workers,[61] and farm workers.[62]

The National Center for Rehabilitative Auditory Research

(NCRAR) has developed a program based upon theoretical principles laid out in the HBM and the HPM that aims to educate individuals about hearing loss and noise damage, with the goal of changing knowledge, attitudes, and intended behaviors toward use of hearing protection in occupational and recreational settings.

The National Center for Rehabilitative Auditory Research Hearing Loss Prevention Program

The NCRAR HLPP will be available in two forms, one that specifically targets active duty military personnel, and one that targets veterans and other older individuals that is in part completed. Veterans may not be aware of hearing conservation and do not necessarily realize the impact that recreational and leisure noise can have upon hearing ability, tinnitus, and the resultant quality of life. In particular, we want to inform veterans and active duty military personnel of the cumulative nature of noise damage. The HLPP is a multimedia, computer-based, self-administered program that provides education and the opportunity for users to screen their own hearing ability. The program was developed based on the following specifications:

- The educational section of the program can be viewed within 20 minutes, making it practical for use in, for example, a hospital waiting area.
- The program is modular in design so that users can select components in which they are specifically interested. According to learning theory, this should result in optimal outcome because adults tend to learn best when information is practical and relates meaningfully to their lives.[63]
- The program is self-administered (*i.e.*, users do not require instruction in its use).
- The program is low maintenance and does not require upkeep from healthcare professionals.
- The presentation volume level is adjustable to accommodate hearing impaired individuals, since approximately 31% of individuals over age 65 are hearing impaired, with the percentage rising to between 40 and 50% of individuals over age 75.[64] The program automatically reverts back to a calibrated level for the hearing screening module.
- The visual components of the program are clearly visible in accordance with published guidelines[65] because more than 26 million people over age 40 are affected with some type of visual disorder and more than four million individuals in the US aged 55 or older are currently experiencing severe vision loss.[66] The guidelines include use of large san serif font, light text on a dark background, and large spaces between lines of text.
- The reading level of the program is between Grades 5 and 8 in order that the program be comprehensible to most of the adult population. More specifically, approximately 44% of people in the US over age 65 years have read up to grade 5 or below, while another 30% have read approximately between grades 5 and 8.[67] Throughout the HLPP, written content is supplemented with verbal commentary. Although the two are highly correlated, verbal comprehension level is generally higher then reading level, especially in adults who have had little literacy education.[68]

The program consists of an eye-catching, looping video designed to draw users' attention; on-screen instructions to ensure that headphones are placed on the correct ears, and that the volume is at a comfortable listening level; six educational modules; and a hearing screening module. The program has been developed to permit easy addition of future modules. Touch screen technology is used throughout the program. Module 1 is a video called "How to Protect your Hearing" which gives an overview of hearing protection and is intended to cover basic information, so that if an individual stops using the program after this first module, he or she has at least heard key educational messages. Module 2 is called "Which Protection is right for you?" and consists of interactive computer screens and two short videos. The interactive screens provide information about different types of hearing protectors with examples of what each type is most suited for. The videos teach the user how to insert/fit the protectors. Module 3, "When to Protect your Hearing" is a video that teaches the user about typical sound levels in the environment. Module 4, named "How Loud is too Loud?" is an interactive module in which the user selects specific listening situations, is shown their typical sound levels, safe exposure times, and the appropriate type of hearing protection to use when one is exposed to those sounds. Module 5 is a video titled "Why Protect your Hearing?" which addresses some of the negative impacts of hearing loss on quality of life and interpersonal interactions. Module 6 is a multifaceted module known as "What Happens when you Hear?" that provides information about the anatomy and physiology of a healthy, and noise-damaged, auditory system via animated clips developed by American Speech Language and Hearing Association.[69] An interactive section of Module 6 provides an introduction to the physics of sound and includes a glossary of terms used throughout the program. Finally, in Module 7 users can screen their hearing for high frequency pure tone perception. The program administrator can select the frequencies to be screened, the testing step-size, and the testing algorithm. In table 1, we list each construct of the HBM, the way in which that construct could be associated with hearing and hearing protection, and the module in our program that addresses that construct.

Computer-based interventions aimed at modifying health-related behaviors have been found to be effective at changing the beliefs, attitudes, and behaviors of individuals in terms of cigarette smoking cessation,[70,71] breast cancer screening,[72] dietary fat reduction,[73] and hearing conservation.[60,74] Regarding hearing conservation, individuals at the University of Michigan developed a multimedia hearing conservation program that aims to increase use of hearing protection among factory workers and others who encounter high levels

Table 1: Adaptation of Health Belief Model constructs in the hearing loss prevention program

Concept	Participation in a HLPP behaviors	How HLPP addresses it?
Perceived susceptibility	Belief that exposure to noise will damage hearing	Module 3: When to Protect your Hearing? Module 4: How Loud is too Loud? Module 6: What Happens When you Hear? These modules variously describe how the ear is damaged by noise and the levels at which damage occurs
Perceived severity	Belief that hearing impairment has negative consequences functionally, socially, and/or psychologically	Module 5: Why Protect your Hearing? This module describes the ways in which hearing loss affects many aspects of quality of life
Perceived benefits	Belief that preventing hearing loss will benefit the individual at some level, whether functionally, socially, and/or psychologically	Module 3: When to Protect your Hearing Module 5: Why Protect your Hearing? These modules contrast successful and unsuccessful communication to demonstrate the importance of good hearing during communication
Perceived barriers	Belief that hearing protection is expensive, difficult to use, uncomfortable, ineffective, and/or has some other negative attributes	Module 2: Which Protection is right for you? Module 4: How Loud is Too Loud? These modules describe different types of hearing protectors, and how and when to use them
Self-efficacy	The individual's belief that he/she can effectively use hearing protection and/or has the capacity to change his/her sound environment/listening habits	Through out the program the same three simple solutions for preventing noise damage are specified: "Turn it down", "Move away", "Wear hearing protection"
Cues to action	Awareness of hearing difficulties/tinnitus, health-related campaigns addressing hearing protection, input from family or friends	Module 7: Test your Hearing It is hoped that the hearing screening findings will provided an added cue to action if hearing loss is already present

of noise in their occupational setting.[75] Their studies have shown the program to be effective at increasing use of HPDs among construction workers[74] and factory workers[60] and of changing attitudes toward hearing protection among a group of operating engineers.[76] It is thus expected that the NCRAR program will be equally effective for changing the attitudes, intentions, and behaviors of veterans.

The next phase of development for the HLPP will be an evaluation of the program's effectiveness. Initially, the system will be placed in the waiting area of a busy VA hospital, but ultimately it could be located anywhere targeted individuals might have the time available to participate. A small portable kiosk will house the computer and monitor. This kiosk will be sound-attenuating in order to provide privacy and a quiet environment needed for the hearing screening module. A formative evaluation will be conducted first with the intent of improving the product and ensuring that the goals of the program are being met.[77,78] This evaluation will involve observation of user behavior while completing the program, informal testing of users to determine whether the program is effectively meeting its objective, and one-on-one interviewing to answer questions such as: What message did the program give? Was each module easily understood? Were any sections of the program confusing? Which sections did users find interesting? Which sections did they find boring? Did users find the program informative? Did they encounter difficulties navigating the program? What improvements and additional content areas would users like to see? Was the program of an appropriate length? Once formative evaluation is complete, a summative evaluation will occur in the form of a structured study. This study will assess whether the program changes users' knowledge and attitudes about hearing loss and hearing protection, intended behaviors regarding use of hearing protection and avoidance of noise, and actual behaviors regarding use of hearing protection and avoidance of noise.

Summary

Noise exposure during military service is a major problem that has resulted in considerable financial and clinical burden for the Veterans Administration. Development of a HCP specifically targeting the veteran population should be a valuable tool for educating veterans about the hazards of noise and for changing their intented and actual behaviors toward use of HPDs during civilian life.

Acknowledgment

This study was funded by the VA RRandD National Center for Rehabilitative Auditory Research and from the Paul B. Magnuson Award for Outstanding Achievement in the Rehabilitation Research and Development Service (RRandD) awarded to Dr. Stephen Fausti in 2004.

Address for correspondence:
Dr. Gabrielle H. Saunders,
National Center for Rehabilitative Auditory Research
Portland VA Medical Center
3710 S.W. U.S. Veterans Hospital Road (NCRAR)
Portland, OR 97239 U.S.A.
E-mail: gabrielle.saunders@va.gov

References

1. Institute of Medicine of the National Academies, Noise and Military Service Implications for Hearing Loss and Tinnitus. In: Humes LE, Joellenbeck LM, Durch JS, editors. Washington, DC: The National Academy Press; 2006.
2. Veterans Benefits Administration Annual Benefits Report Fiscal Year 2006. Department of Veterans Affairs. Available from: http://www.vba.va.gov/2006_abr.pdf [last accessed on 2006 Apr 16].
3. Electronic Code of Federal regulations. Title 38: Pensions, Bonuses and Veterans' Relief. Section 3.1 Definitions. United States Government. Available from: http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr and sid=b7848f12d7dcf6f67bc534e5941142ce and rgn=div5 and view=text and node=38:1.0.1.1.4 and idno=38#38:1.0.1.1.4.1.53.1 [last accessed on 2008 Apr 17].
4. Annual Benefits Report Fiscal year 2006. US Department of Veteran Affairs Veterans Benefits Administration. Available from: http://vbaw.vba.va.gov/bl/20/opai/pa/abr/2006_abr.pdf [last accessed on 2008 Aug 18].
5. Noise Levels of Common Army Equipment. Army Hearing Program. Available from: http://chppm-www.apgea.army.mil/hcp/NoiseLevels.asp [last accessed on 2008 Apr 29].
6. Noise Navigator® Sound Level Database with Over 1700 Measurement Values. Berger EH, Neitzel R, and Kladden CA. Available from: www.e-a-r.com/pdf/hearingcons/NoiseNavigatorDatabase.xls. [last accessed on 2007 Nov 14].
7. Occupational Safety and Health Administration, Occupational Noise Exposure: Hearing Conservation Amendment. Final Rule. Federal register, in 29 C.F.R. 1910.95. 1983, OSHA: Washington DC. p. 48 (46) 9738-9785.
8. Occupational safety and health administration. Basic program elements for federal employee occupational safety and health programs and related matters; Subpart I for recordkeeping and reporting requirements. 29 CFR Part 1960. Department of Labor:2004
9. Common hearing loss prevention terms. National Institute for Occupational Safety and Health. Available from: http://www.cdc.gov/niosh/hpterms.html. [last accessed on 2008 Aug 19].
10. Berger EH. Hearing Protection Devices. In: Berger EH, Royster LH, Royster JD, Driscoll DP, Layne M, editors. The Noise Manual. American Industrial Hygiene Association. Fairfax, VA: 2000. p. 379-454.
11. Rovig GW, Bohnker BK, Page JC. Hearing health risk in a population of aircraft carrier flight deck personnel. Mil Med 2004;169:429-32.
12. Gwin LP, Lacroix PG. A prevalence study of hearing conservation in the United States Naval Submarine Force. Mil Med 1985;150:652-6.
13. Berger EH. Hearing protection utilization around the world. Spectrum 2000;17:18.
14. National Institute for Occupational Safety and Health. Preventing occupational hearing loss: a practical guide. Publication 96-110. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH):1996
15. Berger EH, Franks JR, Lindgren F. International review of field studies of hearing protector attenuation, in scientific basis of noise-induced hearing loss. In: Axelsson A, *et al*, editors. New York, NY: Thieme Medical Publishers Inc;
16. Gates GA, Schmid PP, Kujawa SG, Nam B, D'Agostino R. Longitudinal threshold changes in older men with audiometric notches. Hear Res 2000;141:220-8.
17. Kujawa SG, Liberman MC. Acceleration of age-related hearing loss by early noise exposure: evidence of a misspent youth. J Neurosci 2006;26:2115-23.
18. Work-Related Hearing Loss. NIOSH. Available from: http://www.cdc.gov/Niosh/01-103.html [last accessed on 2008 Aug 18].
19. Axelsson A, Clark W. Hearing Conservation programs for nonserved occupations and populations. Occup Med 1995;10:657-62.
20. Mercier V, Luy D, Hohmann BW. The sound exposure of the audience at a music festival. Noise Health 2003;5:51-8.
21. Fligor BJ, Cox LC. Output levels of commercially available portable compact disc players and the potential risk to hearing. Ear Hear 2004;25:513-27.
22. Laitinen H. Factors affecting the use of hearing protectors among classical music players. Noise Health 2005;7:21-9.
23. Lower MC, Hurst DW, Claughton AR, Thomas A. Sources and levels of noise under motorcyclists' helmets. Proc Inst Acoust 1994;16:319-25.
24. McCombe AW. Hearing loss in motorcyclists: Occupational and medicolegal aspects. J R Soc Med 2003;96:7-9.
25. Gershon RR, Neitzel R, Barrera MA, Akram M. Pilot survey if subway and bus stop noise levels. J Urban Health 2006;83:802-12.
26. Axelsson A. The risk of sensorineural hearing loss from noisy toys and recreational activities in children and teenagers. Biological Effects 1998:2;78-90.
27. Crandell C, Mills TL, Gauthier R. Knowledge, behaviors, and attitudes about hearing loss and hearing protection among racial/ethnically diverse young adults. J Natl Med Assoc 2004;96:176-86.
28. Vogel I, Brug J, Hosli EJ, van der Ploeg CP, Raat H. MP3 players and hearing loss: Adolescents' perceptions of loud music and hearing conservation. J Pediatr 2008;153:400-4.
29. Chung JH, Des Roches CM, Meunier J, Eavey RD. Evaluation of noise-induced hearing loss in young people using a web-based survey technique. Pediatrics 2005;115:861-7.
30. Ologe FE, Akande TM, Olajide TG. Noise exposure, awareness, attitudes and use of hearing protection in a steel rolling mill in Nigeria. Occup Med (Lond) 2005;55:487-9.
31. Bogach II, House RA, Kudla I. Perceptions about hearing protection and noise-induced hearing loss of attendees of rock concerts. Can J Public Health 2005;96:69-72.
32. Appollonio I, Carabellese C, Frattola L, Trabucchi M. Effects of sensory aids on the quality of life and mortality of elderly people: A multivariate analysis. Age Ageing 1996;25:89-96.
33. Carabellese C, Appollonio I, Rozzini R , Bianchetti A, Frisonni GB, Frattola L, *et al*. Sensory impairment and quality of life in a community elderly population. J Am Geriatr Soc 1993;41:401-7.
34. Kochkin S, Rogin CM. Quantifying the obvious: The impact of hearing instruments on the quality of life. Hear Rev 2000;7:6-34.
35. Mulrow CD, Aguilar C, Endicott JE, Tuley MR, Velez R, Charlip WS, *et al*. Quality-of-life changes and hearing impairment: A randomized trial. Ann Intern Med 1990;113:188-94.
36. Scherer MJ, Frisina DR. Characteristics associated with marginal hearing loss and subjective well-being among a sample of older adults. J Rehabil Res Dev 1998;35:420-6.
37. Scarcini N, Worrall L, Hickson L. The effect of hearing impairment in older people on the spouse. Int J Audiol 2008;47:141-51.
38. Hetu R, Jones L, Getty L. The impact of acquired hearing impairment on intimate relationships: Implications for rehabilitation. Audiology 1993;32:363-81.
39. Hallberg LR. Occupational hearing loss: Coping and family life. Scand Audiol Suppl 1996;43:25-33.
40. Wallhagen MI, Strawbridge WJ, Shema SJ, Kaplan GA. Impact of self-assessed hearing loss on a spouse: A longitudinal analysis of couples. J Gerontol B Psychol Sci Soc Sci 2004;59;S190-6.
41. Erdman S, Crowley J, Gillespie G. Considerations in counseling for the hearing impaired. Hear Instr 1984;35:50-8.
42. Morata TC, Themann CL, Randolph RF, Verbsky BL, Byrne DC, Reeves ER. Working in noise with a hearing loss: Perceptions from workers, supervisors, and hearing conservation program managers. Ear Hear 2005;26:529-45.
43. Cacciatore F, Napoli C, Abete P, Marciano E, Triassi M, Rengo F. Quality of life determinants and hearing function in an elderly population: Osservatoria Geriatrico Campano study group. Gerontology 1999;45:323-8.
44. 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;43:661-8.
45. Daniell WE, Swan SS, McDaniel MM, Camp JE, Cohen MA, Stebbins JG. Noise exposure and hearing loss prevention programmes after 20 years of regulations in the United States. Occup Environ Med 2006;63:343-51.
46. Reilly MJ, Rosenman KD, Kalinowski DJ. Occupational noise-induced hearing loss surveillance in Michigan. J Occup Environ Med 1998;40:667-74.

47. National Institutes of Health Consensus Statement. Vol. 8. Noise and Hearing Loss, 1992. p. 1-24.
48. Niskar AS, Kieszak SM, Holmes AE, Esteban E, Rubin C, Brody DJ. Estimated prevalence of noise-induced hearing threshold shifts among children 6 to 19 years of age: The Third National Health and Nutrition Examination Survey, 1988-1994, United States. Pediatrics 2002;108:40-3.
49. Roeser RJ. Industrial hearing conservation programs in the high schools (Protect the Ear Before the 12th Year). Ear Hear 1980;1:119-20.
50. Folmer RL, Griest SE, Martin WH. Hearing conservation education programs for children: A review. J School Health 2002;72:51-7.
51. Ewigman BG, Kivlahan CH, Hosokawa MC, Horman D. Efficacy of an intervention to promote use of hearing protection devices by firefighters. Public Health Rep 1990;105:53-9.
52. Knobloch MJ, Broste SK. A hearing conservation program for Wisconsin youth working in agriculture. J School Health 1998;68:313-8.
53. Lee-Feldstein A. Five-year follow-up study of hearing loss at several locations within a large automobile company. Am J Ind Med 1993;24:42-54.
54. Rosenstock IM. Why people use health services. Milbank Mem Fund Q 1966;44:94-127.
55. Zweig S, LeFevre M, Kruse J. The Health Belief Model and attendance for prenatcal care. Fam Pract Res J 1988;8:32-41.
56. Champion VL. The relationship of breast cancer self-examination to Heath belief Model variables. Res Nurs Health 1987;10:375-82.
57. Pinto SL, Lively BT, Siganga W, Holiday-Goodman M, Kamm G. Using the Health Belief Model to test factors affecting patient retention in diabetes-related pharmaceutical care services. Res Social Adm Pharm 2006;2:38-58.
58. Lin WC, Ball C. Factors affecting the decision of nursing students in Taiwan to be vaccinated against Hepatitis B infection. J Adv Nurs 1997;25:709-18.
59. Pender NJ , Murdaugh CL, Parsons MA. Health promotion in nursing practice. 2nd ed. Upper Saddle River, NJ: Prentice Hall; 2002.
60. Lusk SL, Ronis DL, Kazanis AS, Eakin BL, Hong O, Raymond DM. Effectiveness of a tailored intervention to increase factory workers' use of hearing protection. Nurs Res 2003;52:289-95.
61. Lusk SL, Kerr MJ, Kauffman SA. Use of hearing protection and perceptions of noise exposure among construction workers. Am Ind Hyg Assoc J 1998;59:466-70.
62. McCullaugh M, Lusk SL, Ronis DL. Factors influencing use of hearing protection among farmers. Nurs Res 2002;51:33-9.
63. Dirkx JM, Prenger SM. A guide for planning and implementing instruction for adults: A theme-based approach. San Francisco: Jossey-Bass; 1997.
64. Statistics about Hearing Disorders, Ear Infections, and Deafness. National Institute on Deafness and Other Communication Disorders (NIDCD). Available from: http://www.nidcd.nih.gov/health/statistics/hearing.asp. [last accessed on 2008 Feb 26].
65. Echt KV. Designing web-based health information for older adults: Visual considerations and design directives, in Older Adults, Health Information, and the World Wide Web, In: Morrell RW, editor. Mahwah, NJ: Erlbaum; 2002. p. 61-87.
66. U.S. Department of Veterans Affairs. Blind rehabilitation gold ribbon panel report. Department of Veterans Affairs Blind Rehabilitation Service:Washington, D.C.: 1999.
67. Kirsch IS, Jungeblat A, Jenkins L, Kolstad A. Adult Literacy in America. ***Provide journal details***????.
68. The "Scientific" Understanding of Reading and the "Reading Potential" of Adults Assessed by Measuring Listening and Reading Abilities. Sticht T. Available from: http://www.nald.ca/fulltext/sticht/feb02/page1.htm. [last accessed on 2008 Jun 13].
69. How Sound Affects the Inner Ear. American Speech Language Hearing Association. Available from: http://www.asha.org/NR/rdonlyres/76B303F9-932F-46E3-A6A8-F049C5CA70D4/0/ani_ear.wmv. [last accessed on 2008 Aug 8].
70. Prochaska JO, DiClemente CC, Velicer WF, Rossi JS. Standard, individualized, interactive, and personalized self-help programs for smoking cessation. Health Psychol 1993;12:399-405.
71. Stretcher VJ. Computer-tailored smoking cessation materials: A review and discussion. Patient Educ Couns 1999;36:107-17.
72. Champion VL. Strategies to increase mammography utilization. Med Care 1994;32:118-29.
73. Campbell MK, DeVellis BM, Stretcher VJ, Ammerman AS, DeVellis RF, Sandler RS. Improving dietary behavior: The effectiveness of tailored messages in primary care settings. Am J Public Health 1994;84:783-7.
74. Lusk SL, Hong O, Ronis DL, Eakin BL, Kerr MJ, Early MR. Effectiveness of an intervention to increase construction workers' use of hearing protection. Hum Factors 1999;41:487-94.
75. Eakin BL, Brady JS, Lusk SL. Creating a tailored, multimedia, computer-based intervention. Comput Nursing 2001;19:152-60.
76. Hong O, Csaszar P. Audiometric testing and hearing protection training through multimedia technology. Int J Audiol 2005:44:522-30.
77. Weston C, McAlpine L, Bordonaro T. A model for understanding formative evaluation in instructional design. Educ Technol Res Develop 1995;43:29-48.
78. Worthen B, Sanders J, Fitzpatrick J. Program evaluation: Alternative approaches and practical guidelines. New York, NY: Longman; 1997.

Source of Support: Nil, **Conflict of Interest:** None declared.