Phyllis Berryman, RN, MBA, COHN-S/CM, FAAOHN
Eileen Lukes, PhD, RN, COHN-S, CCM, FAAOHN

What Makes a Successful Hearing Conservation Program?

by Bonnie Rogers, DrPH, COHN-S, LNCC, FAAN, Denai Meyer, RN, MSN, Carol Summey, RN, COHN-S/CM, Dawn Scheessele, RN, Terry Atwell, RN, Judith Ostendorf, MPH, COHN-S, CCM, FAAOHN, Susan A. Randolph, MSN, RN, COHN-S, FAAOHN, and Kathleen Buckheit, MPH, COHN-S/CM/SM, FAAOHN

ABSTRACT

Although preventable, hearing impairment is one of the most prevalent disabilities in Western societies. In the United States, approximately 30 million individuals are at risk for noise-induced hearing loss and 22 million individuals between the ages of 20 and 69 have permanently damaged their hearing by exposure to loud sounds or noise in their environment. Both work-related and recreational noise exposure affect an individual's hearing. Legislation in 1969 and later in 1983 established standards mandating that all workers exposed to noise levels at or greater than 85 dBA time-weighted average be placed in a hearing conservation program that includes provision of hearing protective devices. This article discusses components of an effective hearing conservation program, and the roles and functions of interdisciplinary team members in making a hearing conservation program successful.

Hearing impairment, due to changes in either the structure or function of the ears resulting in hearing outside the normal range, continues to be one of the most prevalent disabilities in Western societies. In the United States, approximately 30 million individuals are at risk for noise-induced hearing loss (NIHL) in the workplace, in recreational settings, and at home (National Institute on Deafness and Other Communication Disorders [NIDCD], 2004). Twenty-two million Americans between the ages of 20 and 69 have permanently damaged their hearing by exposure to loud sounds or noise in their environment (NIDCD).

The National Institute for Occupational Safety and Health (NIOSH) continues to rate NIHL among the top 10 work-related health problems (Borchgrevink, 2003), and estimates that nearly 30 million workers are exposed to hazardous noise on the job with an additional 9 million at risk for hearing loss from other agents such as solvents or metals (Lusk, 2002; NIOSH, 2004). NIOSH (1998, 2001) reports that NIHL is one of the most common occupational diseases and the second most self-reported occupational illness or injury. Industry-specific studies reveal that:

- 44% of carpenters and 48% of plumbers have reported a perceived hearing loss.
- 49% of male, metal or nonmetal miners will have a

ABOUT THE AUTHORS

Dr. Rogers is Director, NC Occupational Safety and Health Education and Research Center and the Occupational Health Nursing Program, University of North Carolina, School of Public Health, Chapel Hill, NC. Ms. Meyer is nurse manager and occupational health nurse, Flight Medicine Clinic, Kirtland Air Force Base, Albuquerque, NM. Ms. Summey is a certified occupational health nurse/case manager, Invista, Spartanbury, SC; and student, Occupational Health Nursing Program, University of North Carolina, Chapel Hill, NC. Ms. Scheessele is a registered nurse, Presbyterian Company Care, Carrier Corporation, Charlotte, NC. Ms. Atwell is an occupational health nurse and certified occupational hearing conservationist, Propex, Bainbridge, GA; and student, Occupational Health Nursing Program, University of North Carolina, Chapel Hill, NC. Ms. Ostendorf is Clinical Assistant Professor and Ms. Randolph is Clinical Assistant Professor, School of Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC. Ms. Buckheit is Continuing Education Director, NC Occupational Safety and Health Education and Research Center, University of North Carolina, Chapel Hill, NC.

Ms. Berryman is Senior Consultant, Medical Management, Integrated Disability Management Department, FinCor Solutions, Lansing, MI. Dr. Lukes is Health Services Southern Regional Manager, The Boeing Company, Mesa, AZ.

doi:10.3928/08910162-20090716-02

hearing impairment by age 50 (vs. 9% of the general population), rising to 70% by age 60.

- 90% of coal miners experience moderate to significant hearing loss by retirement.

Although any worker can be at risk for NIHL in the workplace, workers in many industries have higher exposures to dangerous levels of noise. Industries with high numbers of exposed workers include agriculture, mining, construction, manufacturing, utilities, transportation, and the military (NIOSH, 2001). High-powered motorized equipment, air-powered tools, and striking, drilling, and digging machines are examples of hazardous noise sources in these industries.

Recent studies report that employees continue to develop NIHL despite occupational hearing conservation programs (HCPs) (Borchgrevink, 2003). The Bureau of Labor Statistics (BLS, 2006) reported that within the manufacturing sector, hearing loss, with an incidence rate of 15.7 cases per 10,000 workers, was the most common nonfatal occupational illness. However, BLS data may actually represent an underreporting of occupational injuries; therefore, the numbers reported for NIHL are probably low. For example, during the period from 1991 to 2000, data from the NIOSH/Michigan SENSOR program demonstrated that manufacturing accounted for nearly 51% of permanent hearing loss cases and construction industry sectors accounted for 15% of cases (Rosenman & Reilly, 2002). Companies with HCPs reported the largest number of workers with NIHL (Rosenman & Reilly).

NOISE AND HEARING LOSS

Many conditions can lead to sensorineural hearing loss:

- Congenital hearing loss, which is caused by genetic factors, birth trauma, or prenatal infection or toxic exposure and present at birth.
- Sudden hearing loss due to viral infections, trauma, or vascular drugs.
- Hearing loss due to neoplastic disease from acoustic neuroma or other types of tumors, which has a gradual onset and is accompanied by tinnitus.
- Progressive hearing loss from Meniere's disease, which has an unknown etiology and is accompanied by tinnitus and vertigo.
- Hearing loss from ototoxicity resulting from toxic exposure to chemotherapy agents, salicylates, quinine, or furosemide and being accompanied by tinnitus, vertigo, and nystagmus.
- Presbycusis, or age-related hearing loss, which has a gradual onset.
- Hearing loss from conditions due to infection (e.g., herpes, meningitis, mumps, or syphilis) or systemic disease (e.g., renal failure or vasculitis).
- NIHL, which has a gradual onset and is commonly accompanied by tinnitus.

Occupational deafness was first documented among metalworkers in the 16th century (Alberti, 1591; Centers for Disease Control and Prevention, 1986). Since then, workers have experienced excessive hearing loss in many occupations associated with noise. Noise is defined as any unwanted auditory signal that interferes with the detection and discrimination of sound (U.S. Department of Labor, 2008). Noise can be described in terms of intensity (perceived as loudness) and frequency (perceived as pitch). Both the intensity and the duration of noise exposure determine the potential for damage to the nerve cells of the inner ear. Even sounds perceived as "comfortably" loud can be harmful (Rabinowitz, 2000).

NIHL is an irreversible, sensorineural condition that progresses with chronic exposure. After presbycusis (age-related hearing loss), NIHL is the most common form of sensorineural hearing deficit and is 100% preventable (Rabinowitz, 2000). Although hearing ability declines with age in all populations, exposure to noise produces hearing loss greater than that resulting from the natural aging process. This loss is caused by damage to nerve cells of the inner ear (cochlea) and, if excessive, cell death (Rosen, 2001). Unlike some conductive hearing disorders, sensorineural damage cannot be treated medically. Although loss of hearing may result from a single exposure to a very brief impulse noise or explosion, such traumatic losses are rare. In most cases, NIHL is insidious and usually severe enough to permanently affect an individual's ability to hear and understand speech under everyday conditions.

Sound intensity is measured as sound pressure levels in decibels (dB) on the A scale. Normal conversation is measured at a moderate noise level of 50 to 70 dBA, whereas the extreme noise level of a rock concert can be measured from 100 to 140 dBA (Table 1) (House Ear Institute, n.d.). Noise can cause permanent hearing loss at chronic exposures equal to an average of 85 dBA or higher for an 8-hour period. Furthermore, a 3-dB increase represents a doubling of the sound intensity (Rabinowitz, 2000). Therefore, 4 hours of noise exposure at 88 dBA provides the same noise "dose" as 8 hours at 85 dBA, and a single gunshot, approximately 140 to 170 dBA, has the same sound energy as 40 hours of 90-dBA noise. According to the NIDCD (2008a), regular noise exposure of 110 dBA for more than 1 minute risks permanent hearing loss.

According to the NIOSH Hearing Loss Research program (National Research Council, 2006), epidemiologic data related to occupationally induced hearing loss have been almost nonexistent. The Hearing Loss Research program efforts have taken two tracks—surveillance of noise-induced hearing threshold shifts and development of reference population databases. Researchers at NIOSH found that until 2004, no national system to determine how many workers had developed occupationally induced hearing loss and no reliable system for tracking the results of hearing loss prevention programs were in place (National Research Council). On the basis of NIOSH recommendations, the Occupational Safety and Health Administration (OSHA) implemented a method to record incidences of occupational hearing loss on the OSHA 300 Log. If the hearing loss is gradual, it is reported as an occupational illness; if it is a sudden, traumatic hearing loss, it is recorded as an occupational injury (Royster & Royster, 1990). Consequently, it is now possible to track occupational hearing loss and categorize the incidence of

such hearing loss as a function of the work sector (e.g., manufacturing, mining, or transportation), age, gender, and other ototoxic factors (e.g., concomitant exposure to solvents or vibrations) (National Research Council).

Once thought to be only a problem of aging, Wallhagen, Strawbridge, Cohen, and Kaplan (1997) have indicated that Americans are losing hearing earlier in life and that men 35 to 60 are more frequently affected. NIHL may result from both sudden and chronic noise exposure. Sudden impulse noise may include an explosion or gunshot, the roar of a crowd at a sporting event, high-level noise-related equipment such as textile machinery, or environmental noise exposure from lawn mowers, weed eaters, chain saws, and leaf blowers (Niskar et al., 2001). Hearing impairment may also result from repeated exposure to high levels of noise from recreational activities (e.g., speed boating, snowmobiling, loud music, or concerts) (Hearing Industries Association, 2004). As a chronic insult, NIHL may be the consequence of years of noise exposure causing subtle, progressive damage, or the individual may be hypersensitive to noise. Regardless of the cause, NIHL is directly related to noise levels, proximity to the harmful sound, duration of exposure, and individual susceptibility (Hearing Industries Association).

Increasingly, noise has become more of a hearing hazard for young children and adolescents. Borchgrevink (2003) reports that 12.5% of U.S. children age 19 and younger (young workers) show a noise-"notch" in one or both ears. A noise-notch, or dip, is labeled on an audiogram when hearing levels are within the normal range at lower frequencies, dip or notch at the 4,000-Hz frequency where consonant sounds are heard, and return to normal range at higher frequencies (House Ear Institute, n.d.). According to Borchgrevink, although a noise-notch or dip seems to be related to acute leisure noise exposure (e.g., toy pistols or amplified music), population studies show the characteristic NIHL- "notch" is also found in individuals who do not report noise exposure incidents or activities. The American Medical Association (2008) has long recognized the problem of NIHL and that the misuse of headphones or other personal listening devices can pose a threat to listeners' hearing. This is critically important in the work environment because employees often wear personal listening devices at work. In its report, the American Medical Association states that personal listening devices are capable of reaching 125 dB (American Speech-Language-Hearing Association, 2006). However, the American Medical Association also points out that epidemiological data on NIHL caused by personal listening devices are currently lacking. Still, Niskar et al. (2001) suggest that the cumulative effect of exposure to these noise sources is beginning to affect the hearing ability of young people and that earlier screening and monitoring of youth and younger workers is just as crucial as it is for older workers. Whether this is done by audiometric screening in schools and colleges or counseling of young adults by primary care providers during routine wellness examinations, earlier identification of hearing loss would be beneficial.

Table 1

Sound Intensity Levels

Decibel Level (dB)	*Source*
140	Threshold of pain: gunshot, siren at 100 feet
135	Jet take off, amplified music
120	Chain saw, jackhammer, snowmobile
100	Tractor, farm equipment, power saw
90	Occupational Safety and Health Administration limit—hearing damage if excessive exposure to noise levels above 90 dB
85	Inside acoustically insulated tractor cab
75	Average radio, vacuum cleaner
60	Normal conversation
45	Rustling leaves, soft music
30	Whisper
15	Threshold of hearing
0	Acute threshold of hearing—weakest sound

Note. *Data from House Ear Institute (n.d.).*

Noise regulation came in 1969 with the Walsh-Healey Act, which established a maximum noise exposure of 90 dB during an 8-hour workday (Rosen, 2001). However, the high prevalence of hearing loss and hearing impairment due to excessive noise exposure prompted OSHA to add the Hearing Conservation Amendment to the Noise Standard in 1983 (OSHA, 1983; U.S. Department of Labor, 1971). This amendment requires that employees exposed to noise levels at or greater than 85 dBA 8-hour time-weighted average (TWA) be included in a workplace HCP and use hearing protection devices (HPDs) at noise levels at or above 90 dBA (OSHA). The employer must provide baseline and annual audiometric testing for all exposed employees for monitoring and detecting early hearing changes before clinically significant hearing loss occurs. Recognized strategies for protecting workers against noise include engineering controls to reduce noise levels, administrative controls to reduce noise exposure duration, and personal HPDs to diminish work-related NIHL (Daniell et al., 2002). Limiting noise exposure to 85 dBA is still estimated to result in hearing loss in 15% of exposed workers (Lusk, 2002). This persistent loss of hearing in exposed workers may be partly due to workers' inconsistently wearing adequate HPDs (Lusk). Another factor may be the lack of empirical evidence to determine "safe" noise levels, the levels at which hearing change would not occur (Royster & Royster, 1990).

Royster and Royster (1990) point out that no studies

Table 2

Estimated Excess Risk of Material Hearing Impairment as a Function of Average Daily Noise Exposure During a 40-Year Working Lifetime

Reporting Organization	*Average Daily Noise Exposure (dBA)*	*Excess Risk (%)*
International Organization for Standardization	90	21
	85	10
	80	0
Environmental Protection Agency	90	22
	85	12
	80	5
National Institute for Occupational Safety and Health	90	20
	85	15
	80	3

Note. *Data from the National Institute for Occupational Safety and Health (2008a).*

demonstrate the effect of longer than 8-hour work shifts on hearing loss. Work shifts extending more than 8 hours result in a TWA compression of all noise exposure as if exposure happened in 8 hours, ignoring worker risk of increased potential hearing loss. The resulting TWA is higher and presents a greater risk of developing noise-induced hearing damage (Royster & Royster). Therefore, employees working 10- or 12-hour shifts, and not enrolled in a HCP until the 85-dBA noise level is met, may already have been overexposed to excessive noise. Consequently, Royster and Royster suggest it is beneficial to reevaluate the 8-hour TWA and permissible exposure levels for those workplaces that institute extended work shifts rather than the standard 8-hour shift. Changing the OSHA permissible exposure levels by lowering the action level from 85 to 80 dBA would increase HCP enrollment of workers with less noise exposure, promote a lower rate of hearing loss, and capture more noise-sensitive employees (Cooper, 2007). Table 2 provides the estimated excess risk of hearing impairment as a function of average daily noise exposure during a 40-year working lifetime (NIOSH, 2008b).

DEVELOPMENT OF A SUCCESSFUL HCP

Studies have shown that benefits from a HCP include reduced risk for NIHL, improved labor-management relations, greater worker job satisfaction and productivity, better worker quality of life, reduced worker fatigue and irritability, reduced accident rates and illnesses, less lost work time, fewer workers' compensation claims, and reduced loss of trained and experienced personnel (Salazar, 2006). At a minimum, OSHA requires a HCP to include noise surveys and monitoring, employee education, training, and motivation, HPDs, audiometric testing, and recordkeeping. Berger (2003) also includes noise control as an important component. Each of these components is considered essential to a successful and effective HCP.

Noise Surveys and Monitoring

The employer must implement a noise monitoring program if noise exposures equal or exceed the action level (85 dBA), and employees must be notified of the monitoring results (U.S. Department of Labor, 2008). Noise surveys and data analysis involve measuring workplace noise levels and monitoring worker exposure levels to identify potential noise-hazardous areas and actual worker overexposure to noise (Royster, Royster, Driscoll, & Layne, 2000). These surveys should be performed over a period of time to determine peaks and variability in noise levels (Rosen, 2001) and must integrate all continuous, intermittent, and impulsive noise levels (U.S. Department of Labor). Once the noise levels have been measured, they can be compared to the permissible exposure levels to determine if control strategies should be implemented to reduce noise exposure. They will also determine if a HCP needs to be implemented and who needs to be in the program.

Employee Education, Training, and Motivation

Education and motivation are keys to any successful HCP. Of the components of an effective HCP, the education and motivation component may not receive the attention it deserves (Berger, 2003). This program component requires involvement and commitment of not only management and health professionals, but, most importantly, also employees. Introductory education is often conducted during orientation for new workers and as part of annual regulatory compliance. Consequently, it is important that the educational content be relevant and presented with sincerity so that resulting participation in the HCP will be significant. Ongoing motivational efforts to establish and nurture a culture of safety are needed to create an effective HCP.

The HCP should have a key coordinator who believes in the value of hearing conservation. Education and motivation are the main tools the coordinator uses to develop and maintain the program. If an existing HCP lacks cohesion and support, the coordinator must educate top management about the benefits of improving the HCP. The involvement of the coordinator in education, motivation, and all other components of the HCP will go a long way toward changing employees' attitudes and behaviors regarding hearing conservation. It is especially important for the coordinator to be involved in each component, particularly if outside consultants are used for audiometric testing or other HCP services. Whether the coordinator provides all services for a HCP in a small company

or supervises in-house or external personnel to administer the HCP for a large firm, the unifying drive provided by the coordinator is essential for a successful program (Berger, 2003).

The educational process should be ongoing and include regular activities to present and review HCP information throughout the year. Although the format used will vary from group meetings to one-on-one conversations to newsletter articles, certain principles apply to each technique: keep it simple, short, meaningful, and motivating (Berger, 2003). Bull (2006) asserts that although one-on-one training is more effective than group sessions, the latter is an effective way to initiate education and discussion and involve employees in hearing conservation activities. Employees tend to forget the importance of the HCP if audiometric monitoring and educational sessions are held only during 1 month each year. If various activities are conducted throughout the entire year, workers will be reminded about hearing conservation in different ways (Berger; Karmy & Martin, 1982).

The most successful educational efforts are simple in content and presentation and must be designed to capture employees' attention and interest. The employer must institute an annual education and training program for all exposed employees and ensure participation. At a minimum, the employee must be informed of the effects of noise on hearing, the purpose of and instruction for use of HPDs, and audiometric testing. An outline of hearing conservation education for employees is provided in the Sidebar. Terminology should be easy to understand, and examples applicable to the employee's daily life should be emphasized. Although the anatomy and physiology of the ear and cochlea should be discussed, overemphasizing these concepts may make the risk of NIHL seem more remote (Berger, 2003).

Educational efforts should be presented in short sessions to sustain the employee's interest; two shorter educational sessions might be offered rather than one longer session. For group presentations, an ideal length is 15 to 25 minutes, not to exceed 30 minutes. The same is true for printed material. If a newsletter article exceeds a few paragraphs, potential readers may stop at the headline. It is best to stress facts employees need to know, such as their risk of NIHL, the components of the HCP, how they can prevent hearing loss, sources of exposure, and the employer's HCP policies.

The educational message must focus on motivating employees to participate fully in the HCP. The ultimate motivator is avoidance of progressive hearing loss. The educational program must make real-life problems associated with hearing loss clear to employees so they are willing to protect their ability to understand spoken communication and safety warnings, avoid social isolation from friends and family, and continue to enjoy leisure activities. For example, employees should be told that a temporary hearing shift can occur from an initial unprotected exposure to a fireworks display. This type of exposure can interfere with hearing temporarily, but the ability will eventually rebound. However, continued unprotected exposures to noise over a longer period of time can result in permanent hearing loss (Mango, 1991). Having an employee who has suffered NIHL, particularly from

Employee Education About Hearing Conservation

Characteristics of noise
- Unwanted sounds such as those produced by cars, motorcycles, workplace machinery, concerts, vehicles, and equipment
- Frequency/pitch; intensity/volume/amplitude
- Duration/exposure time
- Relationship of noise and sound
- Sound intensity levels
- Measurement of noise: sound level meters and units of measurement (decibels)

Anatomy and physiology of the ear and noise damage
- Normal ear: outer, middle, inner ear
- How sound is transmitted: nerve impulses and cochlea/cilia
- Damage to hearing:
  - Conductive—generally outer/middle ear and reversible
  - Sensorineural—inner ear, which includes noise-induced hearing loss and presbycusis and is irreversible

Source of noise
- Occupational
- Recreational
- Home
- Personal listening devices

Effects of noise
- Hearing impairment
- Fatigue
- Social isolation/reduced leisure enjoyment
- Speech misperception
- Susceptibility issues (e.g., age, gender, or medications)

Warning signs/symptoms of noise-induced hearing loss
- Temporary threshold shifts in hearing
- Ear discomfort after exposure
- Tinnitus/ringing/buzzing sensation in ears
- Difficulty hearing in noisy environments

Hearing protection control/devices
- Engineering controls
- Administrative controls
- Hearing protection devices
  - Selection
  - Types: earplugs, earmuffs
  - Use demonstration
- Noise reduction rating

Audiometric testing
- Purpose
- Test procedures
- Results interpretation

repeated work-related noise exposure, can have a significant impact (Murray-Johnson et al., 2004). It should be stressed that hearing loss is painless, progressive, permanent, and preventable.

It is important to maintain the goodwill of the foremen, supervisors, and managers whose support is needed for an effective HCP (Stapleton & Royster, 1985). Every effort should be made to minimize production disruption and maintain flexible program schedules. Advance notice of educational activities, audiogram scheduling, and HPD fitting sessions needs to be given so managers can schedule substitute workers if necessary.

Several authors (Berger, 2003; Stapleton & Royster, 1981) support a hierarchical sequence in providing education and motivation: first, top management and consultants; next, HCP team members, including audiometric technicians and personnel who issue and reissue HPDs; then, foremen and front-line supervisors; and finally, the employees who wear HPDs and others included in the HCP. By involving each level of the hierarchy in sequence when a HCP is initiated or revised, the company's program can be organized and implemented through administrative channels.

Managers must have basic knowledge about the requirements for an effective HCP and policies needed to handle administrative problems that might develop. Managers' active support is needed to establish an effective HCP. For example, supervisors, foremen, and front-line employees will take HPD enforcement seriously only if managers set the example and wear HPDs when they visit production areas, however briefly. Education for management should stress the effects of noise on employees' health and productivity, the company's legal obligation for the HCP, the cost-benefit of an effective HCP, and why strict guidelines for HCP procedures minimize NIHL incidence. Management should consider using an incentive system to improve use of HPDs, such as recognizing units or departments with the highest compliance in hearing protection.

Consultants who assist in any aspect of the HCP should be educated concerning company health and safety rules to avoid potential conflicts with company policy. The HCP team members will be implementing the components of the program and need specific training in how to carry out their duties in each component. Training can be acquired at professional meetings, through NIOSH, and through the Council for Accreditation in Occupational Hearing Conservation (CAOHC), with certification available to those who successfully complete CAOHC courses.

Because foremen and supervisors receive questions from workers about hearing conservation, they need detailed information to handle concerns. Educational sessions for supervisors also provide an opportunity for them to discuss HCP policies and clarify their roles in implementing the program. They especially need to understand why poorly fitted or improperly or inconsistently worn HPDs are ineffective and how to recognize when employees are wearing HPDs improperly so this can be corrected. In addition, compliance with the use of HPDs should be monitored.

Finally, educational programs should be held for all employees included in the HCP. In addition to educational information about noise and hearing concepts, prevention and control of NIHL, and the components of the HCP, emphasis should be placed on wearing HPDs. Tsukada and Sakakibara (2008) reported that the use of HPDs among 68 male workers in a Japanese electronics manufacturing plant increased from 46% to 66% during a 2-month period after individual training was provided. Furthermore, the educational opportunities that are most effective in motivating employees to change attitudes and behaviors occur during personal contacts when workers receive their annual audiograms and are fitted or refitted with HPDs (Royster & Royster, 1990). At this point, employees are usually interested in their own health status and are especially receptive to constructive feedback. After one-on-one encounters, the next most effective educational format involves meetings with small groups of 10 or fewer workers.

When developing a HCP, policies and procedures should be written so that all employees can assume appropriate roles and meet expectations, especially front-line supervisors because they have direct responsibility for and constant contact with workers. Employee meetings should be scheduled with the plant manager to demonstrate company commitment, provide details about policies and procedures pertaining to the HCP, and discuss enforcement strategies. Ongoing education and training with management involvement must be emphasized to convince every employee that hearing protection is important.

An example of an effective strategy for worksite instruction is applying the training directly to the worker's daily job. Workers can play an active role in the instruction by teaching content and giving specific examples related to hearing hazards and protection. Workers can be asked to discuss past experiences, their knowledge about hearing protection, the experience of working in high-noise environments, and what actions, if any, are routinely taken to address noise exposure. Exposed workers should be involved in gathering noise data and designing engineering controls to reduce noise in their work areas. Applying material learned to the work performed aids in the retention of the content as well as the development of new skills. Employees may be more receptive to learning about hearing protection and conservation when workers who were exposed to high noise levels and did not use HPDs consistently are currently wearing hearing aids and speak about the importance of hearing protection.

A variety of approaches can be used in teaching content. For the HCP, group instruction has been effective in providing uniform teaching related to hearing protection, potential noise exposure in the workplace, and noise control. However, the trainer must carefully structure the content so main points are not confused or lost. Instructors can gauge the learners' interest and comprehension of the subject matter through questions and answers, discussions, and feedback. This approach can be followed by individual instruction that may be more effective because training materials can be tailored to an employee's

learning needs (Bessette, 2007). Success of the HCP can be measured by conducting audits to ensure that program goals and outcomes are met.

In any adult learning situation, the trainer should be sincere and energetic when educating and motivating learners. When supervisors and management actively participate in the HCP by wearing required hearing protection in affected areas, participating in required training, and holding employees accountable for following written policies, the importance of complying with the HCP is demonstrated.

It is essential that health care professionals and trainers understand the principles of adult learning. In any training activity, adult learners must be treated with respect and given an opportunity to share their wealth of experience. Adults acquire and apply knowledge in a variety of ways. Lieb (1991) described adults as being practical and focused regarding information that is most useful to them and their work. Effective instruction is dependent on how well the trainer understands how adults learn best. Knowles (1984) identified four focus areas for adult education: independent learning, usefulness of past experiences, readiness to learn, and problem-oriented learning.

Independent learning emphasizes the importance of including workers in the instruction, allowing them the freedom to direct themselves rather than being passive recipients. This approach requires the instructor to determine what learners already know about a topic, what they need to know about the topic to improve job performance, or what more they would like to learn (Rogers, 2003). Working adults have relevant life experiences that can be drawn upon to clarify the subject matter being taught. This strategy can also present an opportunity to assess employee baseline knowledge and focus on areas of special concern (Rogers).

Readiness to learn or participate means that the learner must see a reason for learning, be willing to consider new knowledge or behavior change, and recognize the applicability of the material learned to work or other responsibilities. Therefore, instructors must identify objectives that are relevant to adult participants before teaching begins (Lieb, 1991).

Problem-oriented learning focuses on educational programs that have clearly defined elements to achieve a specific goal. This approach is most effective when learning relates directly to an individual's concerns. For example, employees may be more apt to wear hearing protection after listening to the testimony of a worker who has profound hearing loss due to exposure to high noise levels on the job (The Quest for Hearing Health, 2001).

Hearing Protection

Noise control uses both engineering and administrative controls to eliminate or reduce hazardous workplace noise (NIOSH, 1999b). Engineering controls include changes in technology and modification of equipment, materials, or processes to eliminate or substantially reduce hazardous noise levels. Examples of this include replacing riveting with welding, applying mufflers to pneumatic drills, redesigning or relocating noisy machinery, maintaining and repairing noisy equipment, and purchasing noise-controlled products (Rosen, 2001; Witt, 2006). Administrative controls include policies on HPD compliance, education and training of workers about how to correctly use hearing protection, and rotation of workers to limit noise exposure. When these controls are insufficient to eliminate the risk of exposure, HPDs such as earplugs and earmuffs must be used.

The risk of hearing loss is reduced by appropriate use of HPDs (Rabinowitz, 2000). Lusk (2002) found that many workers inconsistently use hearing protection when exposed to high noise levels, with compliance ranging from 18% to 77%, even though OSHA mandates 100% compliance. As many factors can affect hearing, including noise exposure at home, at work, and during recreational or leisure activities, it is important to emphasize that hearing is a personal asset and that individuals must be aware of exposure situations to avoid or how exposure risk can be mitigated. In the work environment, this can be accomplished by choosing the correct HPD for the job and wearing it correctly. According to OSHA regulations, HPDs must be provided at no cost to employees working in noise levels at or above 85 dB. Employees should be instructed about the proper use of HPDs, including types, proper fit, and care. Most importantly, employees should have a choice of hearing protection. HPDs should have acceptable attenuation or noise-reduction ratings that will reduce the documented noise levels in the facility. The noise-reduction rating is a single-number rating method that describes a hearing protector based on the degree to which the overall noise level is reduced (NIOSH, 1999a). The noise-reduction rating may not accurately reflect actual noise reduction, but it is a useful tool for comparing products.

Not all ears are the same and not all earplugs fit all ears. Therefore, having a wide selection of earplugs (e.g., premolded [preformed], moldable [foam earplugs], or custom-fit molded earplugs) that are individualized to the employee is essential. For the most part, earplugs are comfortable, convenient, easy to use, and effective in protecting hearing. However, moldable earplugs require more time to fit because they have to be rolled and formed to fit the ears. They may also be difficult to remove because they expand in the ears, forming a seal. Moldable earplugs can irritate the ear canal due to the type of material used to make them and can be more easily misplaced because they are not usually attached to a string (University of Rochester Medical Center, 2008). Custom-fit molded earplugs are more expensive, but can be more economical in the long run because they are more comfortable and likely to be worn. They should be used for any employee who has difficulty with fit.

Employees must be taught proper insertion techniques for HPDs and given a demonstration of how to wear devices correctly. An earplug that is clearly visible from the front indicates poor insertion (Witt, 2006). Each worker should perform the tug test to demonstrate a "vacuum effect" from the earplug, indicating an acceptable seal prohibiting any noise from seeping in around the

earplug. If the employee is unable to correctly insert the earplug, time must be taken to re-demonstrate the insertion technique of roll, pull, and hold. Employees should also practice listening through protective devices. The effectiveness of any HPD depends on an adequate seal to attenuate the sound; thus, a proper fit is critical.

Alternative hearing protection includes canal caps on a flexible band and earmuffs, which offer about the same attenuation for all users. These devices are less likely to be misplaced or lost, may be worn if the employee has a minor ear infection, are easy to put on and take off, and fit most head sizes. However, earmuffs are less portable and heavier, difficult to use with other personal protective equipment, more uncomfortable in hot, humid conditions, less convenient for use in confined spaces, and may interfere with the position of safety or prescription eyeglasses.

Hearing protection should be accessible to every employee in the HCP. If HPDs are easy to obtain, employees may be more focused on wearing the protectors and, in turn, will be more compliant (Bessette, 2008). HPDs will not be effective unless employees wear them correctly; therefore, the most important aspect of choosing a device is worker comfort and confidence in its use (Rosen, 2001).

Audiometric Monitoring

Audiometric screening and monitoring is an essential component of the HCP. Prior to the audiometric testing, employees can be given a prescreening tool to complete (NIDCD, 2008b) that will assist in identifying hearing loss (Fig. 1). In addition, a careful history of symptoms such as hearing loss, discharge, tinnitus, and vertigo should be obtained, followed by a canal check to assess the presence of cerumen blockage or middle ear disease (Rabinowitz, 2000). Audiometric testing is necessary to confirm any hearing deficit. A baseline audiogram should be recorded for each employee against which all subsequent tests will be measured and become a permanent part of the health record. Employees should receive an explanation about what to expect during testing and how hearing is measured. Audiometers should be calibrated in accordance with OSHA regulations and a record of the calibrations kept on site. In addition to calibrating equipment, ambient noise levels must be low enough to meet American National Standards Institute standards (U.S. Department of Labor, 2002a). This is an especially important consideration for mobile testing units, which may park in high-noise areas.

Audiograms are administered annually after the initial baseline testing as long as the employee continues to work in high-noise areas. This preventive screening can identify early hearing deterioration. A change in hearing, recorded during the annual screening process, may be a temporary threshold shift (TTS), which is an average change of 10 dB or more in frequencies 2,000, 3,000, and 4,000 Hz when compared to baseline (NIOSH, 1999a). If there is a shift of 10 dB or more on the annual test, the test may be repeated within 30 days. However, if the shift remains, it becomes classified as a standard threshold shift (STS). At this time, states under federal OSHA jurisdiction are required to perform a second step to determine recordability. If the employee's total hearing level is 25 dB or more above audiometric zero when averaging levels at 2,000, 3,000, and 4,000 Hz in the same ear as the STS, the shift must be recorded on the OSHA log within 7 calendar days of retest (U.S. Department of Labor, 2002b). If a retest is not done, the results of the first test stand, and must be recorded within 37 days of the original test. States under OSHA-approved state plans must meet at least the federal requirements for recordability; however, they may have stricter criteria. The worker must be notified by letter within 21 days of the test that a STS has occurred and an appointment with a health care provider is needed to determine if the cause of the shift is conductive or sensorineural, the latter usually noise-induced. The employee can be referred to an otolaryngologist, audiologist, or other appropriate specialist for an evaluation. If the shift is determined to be work-related, the worker must be provided with HPDs, trained in HPD care and use, and required to wear HPDs. If the shift is determined not to be work-related by the specialist, the employee's name may be removed from the OSHA log.

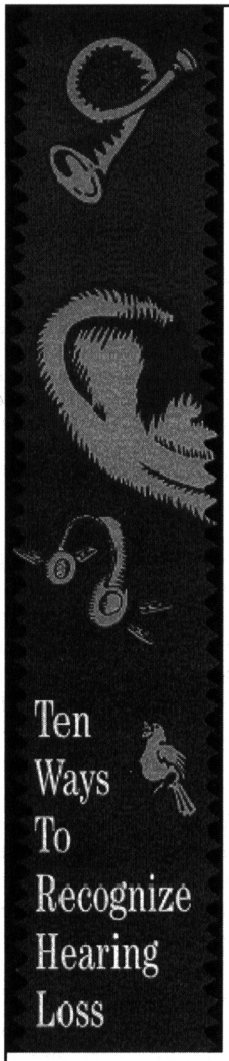
Audiometric screening validates whether the HCP is successful. When no threshold shifts, either temporary or permanent, occur other than those due to aging or an organic pathology such as ear infections, the HCP has succeeded in preventing NIHL. Audiometric screenings provide an annual evaluation of the effectiveness of HPDs as well as early detection of hearing loss in workers (Royster et al., 2000). Figure 2 is a sample audiogram, the results of which should be discussed with employees following their annual tests.

Hearing tests or audiograms can be done by trained personnel in-house at the company or through the use of mobile units. Perhaps the greatest advantage to in-house testing is that scheduling can be evenly distributed throughout the year rather than during a limited time frame offered by a contract vendor. Consequently, in-house testing will minimally impact the company's manufacturing productivity. In addition, occupational and environmental health nurses employed by the company not only can perform the test, but are also knowledgeable about employees' overall health and can regularly educate employees regarding hearing health. However, companies may choose to contract audiometric testing with an outside vendor for several reasons. For small companies, it may be cost-prohibitive to purchase the audiometric booth and equipment, as well as to provide the necessary routine maintenance and hire temporary staff to perform the testing. In addition, an outside vendor can compare a company's overall hearing results with those of similar companies or in similar industries and provide data for benchmarking. Whether the testing is performed in-house or by an outside vendor, audiometric testing must be done in accordance with OSHA standards (Byrne, 2005).

Recordkeeping

The purpose of recordkeeping is to assist employers in recognizing and correcting workplace hazards by tracking

Figure 1. Individuals who answer "yes" to three or more of these questions may want to see an otolaryngologist or an audiologist for a hearing evaluation. (Source: National Institute on Deafness and Other Communication Disorders, 2008b.)



The following questions will help you determine if you need to have your hearing evaluated by a medical professional:

Do you have a problem hearing over the telephone?

Yes ◯ No ◯

Do you have trouble following the conversation when two or more people are talking at the same time?

Yes ◯ No ◯

Do people complain that you turn the TV volume up too high?

Yes ◯ No ◯

Do you have to strain to understand conversation?

Yes ◯ No ◯

Do you have trouble hearing in a noisy background?

Yes ◯ No ◯

Do you find yourself asking people to repeat themselves?

Yes ◯ No ◯

Do many people you talk to seem to mumble (or not speak clearly)?

Yes ◯ No ◯

Do you misunderstand what others are saying and respond inappropriately?

Yes ◯ No ◯

Do you have trouble understanding the speech of women and children?

Yes ◯ No ◯

Do people get annoyed because you misunderstand what they say?

Yes ◯ No ◯

work-related injuries and illnesses and their causes (U.S. Department of Labor, 2008). Recordkeeping is not a separate function of the HCP but is an integral part of all components of the program; it is the "glue" that holds the HCP together (Royster et al., 2000). According to Royster et al., management and staff often give more attention to creating the HCP program, staffing, purchasing proper equipment and supplies, and arranging for workers to participate in the program than to developing and maintaining an adequate recordkeeping system. An effective and efficient recordkeeping system is one that documents all significant interactions between workers and the high-noise environment as well as between workers and the HCP team (Royster et al.). Records of education and training, audiometric tests, audiometer calibration, audiometric technician certification, and sound surveys are crucial to the success of the HCP. These data determine if audiometric results are comparable from test to test, audiometric equipment is properly maintained, and technicians are qualified to perform such tests. A thorough review of all audiometric records plays a critical role in whether the HCP will succeed or fail because the program begins by assessing both employees and the work environment (Royster et al.). In addition, it is essential to document all possible employee noise exposures including nonoccupational noise from speed boats, snowmobiles, gunfire, lawn mowers, loud music, or concerts (Royster et al.) to identify alternate noise sources.

THE HCP TEAM

The "team approach" adopted by CAOHC is the backbone of a successful HCP (Royster & Royster, 1990; Royster et al., 2000). Interdisciplinary expertise is needed to comprehensively plan, implement, and evaluate the HCP. Although company size will determine team size (Royster et al.), the HCP team should consist minimally of a CAOHC-certified occupational and environmental health nurse to coordinate the team, conduct audiometric testing, and provide monitoring and surveillance of exposed workers; an audiologist to review the audiograms for possible NIHL; an occupational health physician to diagnose, treat, and refer workers to an otolaryngologist if needed; an industrial hygienist to identify and measure

Frequency of test tone in hz ▼								Left ear thresholds					Right ear thresholds	
500	*1000*	*2000*	*3000*	*4000*	*6000*	*8000*		*500*	*1000*	*2000*	*3000*	*4000*	*6000*	*8000*
0	*-5*	*0*	*10*	*5*	*0*	*5*		*5*	*0*	*10*	*15*	*30*	*40*	*35*

Figure 2. Sample audiogram. Hearing threshold scale: -10 to 25 dB is normal hearing; 26 to 40 dB is mild loss; 41 to 55 dB is moderate loss; 56 to 70 dB is moderate/severe loss; 71 to 90 dB is severe loss; and 91 to 100 dB is profound loss. The above audiogram can be interpreted as hearing being measured in frequencies from 500 to 8,000 Hz in both left and right ears. The numbers below the frequencies are decibels (dB) indicating the level at which the sound was heard. Decibels range in numbers from 0 to 100, with 0 being the best one can hear and 100 being the worse. This audiogram reveals a normal left ear with a mild hearing loss in the right ear. (Note: Sample audiogram [hearing test] results measured at a range of sounds from low to high frequency indicating mild hearing loss in the right ear beginning at 4,000, 6,000, and 8,000 Hz with sound being presented in 30, 40, and 35 dB). (Source: National Institute for Occupational Safety and Health, 2008a.)

noise and design abatement strategies; a safety director to coordinate walk-throughs for noise hazard identification, enroll exposed workers in the HCP, and monitor hearing protection compliance (Bealer, n.d.); and management to provide resources and support. All workers and supervisors should be involved in the identification of high-noise areas. The team members may be employees of the company or hired on a contractual basis, part-time or full-time (Royster et al.). Audiometric tests must be performed by a licensed or certified audiologist, otolaryngologist, or other physician, or one (technician) who is certified by CAOHC (OSHA, 1983). A technician who performs audiometric tests must be responsible to an audiologist, otolaryngologist, or physician (CAOHC, n.d.), who is considered the professional supervisor of the audiometric monitoring program component of an occupational HCP (CAOHC). The advisory role of the professional supervisor is to ensure that audiometric testing is correctly performed, audiograms are reviewed, post-audiogram procedures are recommended, the audiometric database is managed, and work-relatedness of an employee's hearing loss is determined.

The occupational and environmental health nurse roles in hearing conservation include clinician, educator, and coordinator of the HCP and team. As a clinician and certified occupational hearing conservationist, the occupational and environmental health nurse performs audiometric testing. Prior to the testing, the nurse should conduct the clinical assessment and an occupational health history with emphasis on the hearing history for each employee in the HCP. This history should include questions about family hearing loss, childhood diseases and infections, hypertension, ear disease or injury, any injury to the head, and nonoccupational activities accompanied by loud noise (e.g., firearm use, military service, power tools, or machinery). An otoscopic examination should be performed to assess the ear canal for any signs of excessive wax buildup, irritation (possibly caused by earplugs), and eardrum abnormalities. If the examination of the ear is abnormal, the worker should be referred to the company physician or personal health care provider for evaluation and treatment prior to an audiogram. After performing the audiogram, it is compared to previous audiograms and the results discussed with the employee, explaining the changes in hearing over time, especially early signs of hearing deficit. However, if an audiologist is on the team, the test results can be reviewed by the audiologist. As previously indicated, when a confirmed 10 dB STS is present, the employee should be referred to the occupational physician or otolaryngologist to determine the cause of the shift and whether it is work-related. If the HCP team does not have an audiologist, the occupational and environmental health nurse is responsible for the referrals (Salazar, 2006). The occupational and environmental health nurse is also the custodian of the audiograms that are kept in each employee's record and retained for the duration of the affected worker's employment plus 30 years (OSHA, 2004).

Currently, the treatment of NIHL is limited to hearing amplification and counseling. Initially, employees may be reluctant to consider using hearing aids, associating them with the stigma of "old age." The occupational and environmental health nurse can work with employees and families to help them cope with a hearing disability. Hearing aids can amplify sounds but, despite technologic advances, often cannot fully correct problems of speech discrimination. A trained audiologist should carefully match a hearing aid to the individual's hearing deficit and lifestyle. Vocational rehabilitation may be necessary to ensure that employees can function safely and effectively with their hearing impairment (Rabinowitz, 2000). Resources for information about NIHL are provided in the Sidebar.

As an educator, the occupational and environmental health nurse teaches all employees, including management, about noise hazards; warning signs for hearing loss; use, fit, and maintenance of HPDs; and prevention strategies for NIHL, whether occupational or nonoccupational. Managers also must understand the importance of implementing all components of the HCP to protect employees from NIHL and comply with the OSHA noise standard, including recordkeeping, alternative HPDs from which employees can choose, and a compliance surveillance program (e.g., wearing the HPDs) (Royster & Royster, 1990).

Resources for Information About Noise-Induced Hearing Loss

The Council for Accreditation in Occupational Hearing Conservation conducts courses in audiometry and hearing conservation for audiologists, audiometric technicians, and health care professionals.

Council for Accreditation in Occupational Hearing Conservation
611 E. Wells St., Milwaukee, WI 53292
Telephone: 414-276-5338
Web address: www.caohc.org

The National Institute for Occupational Safety and Health (NIOSH) and the National Institute on Deafness and Other Communication Disorders (NIDCD) are conducting a public awareness campaign on the causes and prevention of noise-induced hearing loss.

NIOSH information: 800-35-NIOSH
Web address: www.cdc.gov/niosh

The National Hearing Conservation Association is a membership organization of professionals engaged in hearing conservation; the group also produces educational materials.

National Hearing Conservation Association
9101 E. Kenyon Ave., Ste. 3000, Denver, CO 80237
Telephone: 303-224-9022
Web address: www.hearingconservation.org

The League for the Hard of Hearing produces educational materials and programs about the noise hazards of toys and other common noise sources.

League for the Hard of Hearing
71 W. 23rd St., New York, NY 10010-4162
Telephone: 917-305-7700 (voice) or 917-305-7999 (TTY)
Web address: www.lhh.org/noise

The Sight and Hearing Association distributes "Know Noise," a curriculum for 3rd- to 6th-grade students on prevention of noise-induced hearing loss.

Sight and Hearing Association
674 Transfer Rd., St. Paul, MN 55114-1402
Telephone: 651-645-2546 or 800-992-0424
Web address: www.sightandhearing.org

The occupational and environmental health nurse is the coordinator of the HCP and team and may be the only health care provider in the company. By collaborating with other team members, the occupational and environmental health nurse maintains lines of communication and the program operates smoothly. Royster and Royster (1990) suggest six strategies for coordination of a successful HCP: empowering a key individual or coordinator, developing a checklist of duties, dividing duties among HCP team members, ensuring adequate knowledge of the team, ensuring accountability, and holding team meetings at least once every 6 months.

In every facility or company, regardless of size or location in the corporate structure, key individuals have the responsibility and authority for ensuring that the HCP functions successfully (Royster et al., 2000). These individuals are the most important members of the HCP team, at whose desks the "buck stops" (Royster et al.). According to Royster et al., the lack of a key individual at any size facility will almost certainly result in failure to achieve an effective HCP. As described previously, typically in companies with an occupational and environmental health nurse, this function is provided by the nurse; otherwise, another staff member must be designated.

Checklists for each component of the HCP, noise survey and monitoring, education and motivation, noise control, HPDs, audiometric testing, and recordkeeping, are essential to identify the specific duties or tasks that must be done (Royster & Royster, 1990). The coordinator should work with HCP team members to develop component-specific checklists, ensure documentation, and identify any problem areas. The coordinator meets with team members to discuss trends, problem areas and solutions, and newly identified high-noise areas to develop and institute HCPs in these areas.

The division of duties or tasks within the HCP team is dependent on the team's composition. The occupational and environmental health nurse coordinator must ensure that all HCP team members understand their roles and responsibilities. The HCP team may have two members or may include multiple disciplines that may be in-house personnel, contract personnel, or a combination of both types. In a small facility with two team members such as the occupational and environmental health nurse

and safety specialist, they will generally handle the duties covering all components of a HCP (i.e., performing safety inspections, conducting walk-throughs to ensure compliance with HPD use, monitoring noise levels, providing education and motivation, screening for hearing deficits [audiometric], documenting actions, and referring for further evaluation, if needed). In larger facilities, the duties may be assigned to other team members according to their specialty. For example, the industrial hygienist would perform noise surveys, the safety specialist would provide recommendations for noise controls, the occupational and environmental health nurse would provide clinical care, education, motivation, surveillance, and recordkeeping, and the audiologist would review audiometric results. The team must remain current because they are the trainers for the employees and supervisors and address multiple activities as part of the basic HCP plan (Royster et al., 2000). Each team member must be knowledgeable about all aspects of the HCP to provide a seamless and efficient approach to the overall management of the program.

Accountability is critical for an effective HCP, including not only HCP team members but also employees, production supervisors, and senior management (e.g., department managers, section chiefs, and executives of the company). Employees must be accountable for correctly wearing HPDs and complying with policies and procedures of the HCP in their respective worksites. Supervisors and managers must be appropriate role models for their employees, implementing and enforcing the hearing conservation standards set forth by OSHA. Health care professionals must be accountable for planning, implementing, and evaluating all aspects of the HCP. Team members' performance can be documented in their annual performance evaluations and reflected in salary adjustments (Royster et al., 2000).

Communication is essential to convey necessary information to team members. Royster and Royster (1990) suggest holding team meetings at least every 6 months to review the status of the HCP and identify areas in need of improvement. It is essential that team members communicate not only with each other, but also with workers and supervisors. Workers should be advised of their audiometric findings and the rationale for further evaluation if there is a threshold shift in their hearing. For example, Daniell et al. (2002) reviewed workers' compensation claims in Washington state and reported that more than half of the workers who had experienced a STS while employed at their present workplace did not recall being informed of that finding. Of the 10 companies reviewed, 3 never or irregularly provided annual employee training and audiometric testing, and training at the remaining 7 companies typically consisted of a non-interactive video presentation. The authors also found that these same audiometric findings were often underused in guiding efforts or evaluating the performance of their HCPs.

EVALUATION OF HCP EFFECTIVENESS

An effective and successful HCP is one that accomplishes its goals of prevention and compliance (Royster et al., 2000). According to Royster et al., prevention or at least limitation of permanent hearing loss associated with occupational noise exposure needs to be the primary goal of an occupational HCP. Environmental factors in the workplace such as ototoxic chemicals or vibration may interact with noise exposure levels and should be considered when developing an effective HCP for the workplace. Compliance with OSHA regulations must be enforced by management and observed by all exposed workers. Other goals may be formulated in addition to the goals of prevention and compliance, including reduction of worker stress and absenteeism, reduction of accidents due to workplace noise levels, and reduction of the facility's liability to workers' compensation claims for occupational hearing loss (Royster et al.).

Two evaluation approaches can be used to determined program effectiveness (Royster et al., 2000). The first approach is to determine if all the essential components of the HCP are in evidence, and if all the tasks that have been assigned have been completed. Although this approach adheres to the regulatory compliance of the standard, it complements and supports the prevention aspect of the HCP by ensuring all components are addressed. However, it does not ensure that the HCP is successful in preventing NIHL.

The second approach is to define a program as effective if it succeeds in preventing or limiting the occurrence of noise-induced positive threshold shift in a worker population (Royster et al., 2000). The easiest way to tell if the goal of prevention is being accomplished is to evaluate the annual audiometric evaluations of the workers enrolled in the HCP by analyzing the variability of the audiometric results to determine trends and problem areas early before a significant number of workers develop changes in their hearing (Royster et al.).

OSHA has provided the standard for an industrial HCP and each component should be thoroughly evaluated to determine whether the HCP is successful. NIOSH has developed a detailed component-specific evaluation checklist to provide evaluation assistance (NIOSH, 2008a). To begin, one of the most critical steps to effectively implementing a HCP is to determine whether management is committed to the program and how effective leaders are in motivating and supporting employees and enforcing HPD use. Data indicate that employees who refuse to wear hearing protection or who fail to participate in hearing tests frequently work for supervisors who are not totally committed to hearing loss prevention programs (NIOSH). Management and supervisors must make implementation of the HCP high priority. They should support affected employees participating in training classes and audiometric testing, develop procedures to identify potential noise exposures in the workplace (Stewart, 2000), and set an example by using the proper HPDs in areas where hearing protection is required. Management should take appropriate training and discipline employees who fail to adhere to the requirements of the HCP. Employees will recognize that it is in their best interest to fully participate in the HCP when the mechanics of the HCP are clearly explained, outlining the requirements, benefits, and adverse impacts.

Any deviation in the program may lead to failure. Identifying noise exposures in the workplace is critical because this will determine who is required to participate in the HCP, what areas need monitoring, how exposures are managed in terms of elimination or engineering controls, what policies and procedures need to be written, and what personal protective equipment must be provided. Conducting noise exposure monitoring provides essential data to validate the need for and effectiveness of the HCP. Companies should conduct noise exposure monitoring when there are changes or additions to processes and equipment, and when employees enter into work areas where noise exposures have been identified. Additional measurements should also be conducted as needed. Results of noise exposure monitoring should be shared with affected employees, transmitted to supervisors and other key individuals, and recorded in appropriate documents such as health and shop records (NIOSH, 2008a).

Adequate training and education must be provided to fully execute a successful HCP. Training should be supplemented with materials such as posters, handouts, and newsletters that can be easily understood by all employees, cover the requirements of the HCP, and are presented in terms that relate to employees' jobs and welfare. Training should be conducted and evaluated annually and the contents of the HCP should be reviewed periodically to reflect any changes in OSHA regulations or work environment. Inadequate training can be linked to trainer qualifications, irrelevant or poorly presented content, and frequency of training. If the trainer is not well versed in the HCP, it becomes difficult to convey the importance of the program and gain the respect of the listener. As a result, the employee may view HCP training as an imposition rather than understanding the true benefit. To ensure employees retain knowledge and interest in the HCP, annual review and updates must be offered.

When noise control measures are not feasible, or until such time as they are installed, HPDs may be the only way to prevent hazardous noise levels from damaging employees' inner ears. Making sure that these devices are worn effectively requires continuous supervisor, program staff, and worker attention. Hearing protection must be available to all employees whose 8-hour TWA noise exposure is 85 dBA or above. It is important to ensure that the right type of hearing devices are provided to employees and are fitted properly (Bessette, 2007). Employees should be given the opportunity to select from a variety of appropriate protectors and thoroughly trained at least annually.

Employees have many reasons to explain why they refuse to wear HPDs; however, workers' use relies heavily on device comfort and convenience. For example, NIOSH (2000) reported that the use of hearing protection among construction workers, including carpenters, nearly doubled when foam plugs were replaced with custom-molded ones because these were more comfortable. Employers must know the level of noise in their workplaces, otherwise workers could be inadvertently provided with too little or too much hearing protection. Although it is clear that too little protection can lead to hearing loss, too much hearing protection can impede important communication and block necessary sounds such as warning signals, alarms, and speech, leading workers to improperly wear HPDs or not use them at all (Murray-Johnson et al., 2004; The Quest for Hearing Health, 2001). Employees should be evaluated periodically regarding the care and use of HPDs and if any ear infection or irritations have developed associated with the use of these devices. They should be encouraged to take their HPDs home if they engage in noisy nonoccupational activities.

Administrative policies and procedures must also be evaluated. It should be determined if company policies and guidelines are available in hard copy and online and they are reviewed and updated periodically. The performance of key personnel responsible for the HCP should be evaluated to recognize acceptable performance and improve poor or marginal performance.

SUMMARY

A successful HCP is primarily aimed at preventing and reducing the incidence of work-related NIHL. The

IN SUMMARY

What Makes a Successful Hearing Conservation Program?

Rogers, B., Meyer, D., Summey, C., Scheessele, D., Atwell, T., Ostendorf, J., Randolph, S. A., & Buckheit, K.

AAOHN Journal 2009; 57(8), 321-335.

1. The National Institute for Occupational Safety and Health rates noise-induced hearing loss (NIHL) among the top 10 work-related health problems, affecting an estimated 30 million workers with an additional 9 million workers at risk of hearing loss from exposure to other agents such as solvents and metals. Exposure to high levels of noise, including work-related noise, power tools, motorcycles, and loud music, that exceed 85 dBA can place individuals at risk for NIHL.

2. A hearing conservation program (HCP) in which employees, the HCP team, and management work together to prevent or reduce workplace noise exposure is essential to decrease NIHL. The occupational and environmental health nurse functions as a clinician, educator, and coordinator of the HCP team and in some companies may be the only member of the HCP team on site.

3. Early screening for and education about NIHL in schools and communities can assist in educating the public about the importance of hearing protection.

HCP team collaborates with management to develop a successful HCP. In addition, several strategies (e.g., early identification of infant hearing loss, increased emphasis on education about hearing impairment in school hearing programs, expanded OSHA guidelines for workplace hearing testing and monitoring, enhanced nursing and medical school curricula emphasizing the inclusion of hearing screening as part of routine physical examinations for all age groups, and a broadened public health education program about the symptoms of hearing loss and the appropriate steps to treat hearing problems) are needed to develop a comprehensive approach to reducing the incidence of NIHL (Wallhagen et al., 1997).

REFERENCES

Alberti, P. (1591). Cited by C. C. Bunch, Traumatic deafness. In: E. P. Fowler Jr. (Ed.), *Medicine of the ear*, Chapter X (Reprinted, Translations of the Beltone Institute for Hearing Research, No. 23, 1970).

American Medical Association. (2008). *Portable listening devices and noise-induced hearing loss*. Retrieved November 20, 2008, from www.ama-assn.org/ama/pub/category/18645.html

American Speech-Language-Hearing Association. (2006). *Popular technology unpopular with ear's hair cells*. Retrieved November 19, 2007, from www.asha.org/about/news/2006/techdamage.html

Bealer, J. (n.d.). *HCP best practices, best practice guidelines for hearing conservation program management*. Retrieved October 15, 2007, from www.nehc.med.navy.mil/downloads/occmed/hctoolbox/Toolbox_files/HCP_Best_Practices

Berger, E. H. (2003). *The noise manual* (5th ed.). Fairfax, VA: American Industrial Hygiene Association.

Bessette, R. (2007). *Going beyond the minimum with hearing conservation*. Retrieved October 6, 2008, from www.ehstoday.com/ppe/hearing-protection/ehs_imp_46209/index.html

Bessette, R. S. (2008). *Developing and hearing*. Retrieved October 6, 2008, from www.occupationalhazards.com

Borchgrevink, H. M. (2003, January-March). Does health promotion work in relation to noise? *Noise and Health, 5*, 25-30.

Bull, G. (2006, September). *Sound advice on hearing conservation programs*. Retrieved September 23, 2008, from www.asse.org

Bureau of Labor Statistics. (2006, October). *Incidence rates of nonfatal occupational illnesses by industry*. Retrieved November 30, 2008, from www.bls.gov/opub/ted/2006/oct/wk4/art03.htm

Byrne, D. A. (2005). *A model hearing conservation program*. Retrieved April 21, 2009, from www.cdc.gov/niosh/mining/topics/hearingloss/hlprevworkshop/03-ByrneConservationPrograms.pdf

Centers for Disease Control and Prevention. (1986). Perspectives in disease prevention and health promotion: Leading work-related diseases and injuries—United States. *Morbidity and Mortality Weekly Report, 35*(12), 185-188.

Cooper, B. (2007). *Hearing loss prevention best practices and program evaluation*. Cleveland, OH: NASA Glenn Research Center.

Council for Accreditation in Occupational Hearing Conservation. (n.d.). *The professional supervisor*. Retrieved April 21, 2009, from www.caohc.org

Daniell, W., Swann, S., McDaniel, M., Stebbings, J., Seixas, N., & Morgan, M. (2002). Noise exposure and hearing conservation practices in an industry with high incidence of workers' compensation claims for hearing loss. *American Journal of Industrial Medicine, 42*, 257-262.

Hearing Industries Association. (2004). *A white paper addressing the societal costs of hearing loss and issues in third party reimbursement*. Retrieved September 5, 2008, from www.audiologyonline.com/articles/pf_arc_disp.asp?id=1204

House Ear Institute. (n.d.). *Noise induced hearing loss*. Retrieved November 30, 2008, from www.hei.org/news/facts/nihlfact.htm

Karmy, S. J., & Martin, A. M. (1982). Employee attitudes toward hearing protection as affected by serial audiometry. In P. W. Alberti (Ed.), *Personal hearing protection in industry* (pp. 491-509). New York: Raven Press.

Knowles, M. (1984). *The adult learner: A neglected species* (3rd ed.). Houston, TX: Gulf Publishing.

Lieb, S. (1991). *Adult learning principles*. Retrieved October 11, 2008, from http://honolulu.hawaii.edu/intranet/committees/FacDevCom/guidebk/teachtip/adults-2.htm

Lusk, S. (2002). Preventing noise-induced hearing loss. *Nursing Clinics of North America, 37*, 257-262.

Mango, K. N. (1991). *Hearing loss*. New York: Franklin Watts.

Murray-Johnson, L., Witte, K., Patel, D., Orrego, V., Zuckerman, C., Maxfield, A. M., et al. (2004). Using the extended parallel process model to prevent noise-induced hearing loss among coal miners in Appalachia. *Health Education and Behavior, 31*(6), 741-755.

National Institute for Occupational Safety and Health. (1998). *Criteria for a recommended standard: Occupational noise exposure*. Retrieved November 30, 2008, from www.cdc.gov/niosh/docs/98-126/chap3.html

National Institute for Occupational Safety and Health. (1999a). *A practical guide to preventing hearing loss*. Retrieved October 6, 2008, from www.cdc.gov/niosh96-1101.html

National Institute for Occupational Safety and Health. (1999b). *Fact sheet: Work related hearing loss*. Washington, DC: Author.

National Institute for Occupational Safety and Health. (2000). *Application of health communication theories*. Retrieved October 14, 2008, from www.cdc.gov/niosh/topics/noise/pubs/presentations/baltpres.pdf

National Institute for Occupational Safety and Health. (2001). *Work-related hearing loss*. Retrieved November 15, 2008, from www.cdc.gov/niosh/docs/2001-103

National Institute for Occupational Safety and Health. (2004). *Worker health chart book, 2004*. Cincinnati, OH: Author.

National Institute for Occupational Safety and Health. (2008a). *Hearing conservation program evaluation checklist*. Retrieved September 23, 2008, from http://cdc.gov/niosh/topics/noise/workplacesolutions/hearingchecklist.htm

National Institute for Occupational Safety and Health. (2008b). *Inquiring ears want to know: A fact sheet about your hearing test*. Retrieved October 31, 2008, from www.cdc.gov/niosh/mining/pubs/pubreference/outputid2573.htm

National Institute on Deafness and Other Communication Disorders. (2004). *Crank it down*. Retrieved January 26, 2009, from www.nidcd.nih.gov/health/hearing/10ways.asp

National Institute on Deafness and Other Communication Disorders. (2008a). *How loud is too loud?* Retrieved December 5, 2008, from www.nidcd.nih.gov/health/hearing/ruler.asp

National Institute on Deafness and Other Communication Disorders. (2008b). *Ten ways to recognize hearing loss*. Retrieved December 15, 2008, from www.nidcd.nih.gov/health/hearing/10ways.asp

National Research Council. (2006). *Hearing loss research at NIOSH: Reviews of research programs of the National Institute for Occupational Safety and Health*. Washington, DC: The National Academies Press.

Niskar, A., Kieszak, S., Holmes, A., Esteban, E., Rubin, C., & Brody, D. (2001). Estimated prevalence of noise-induced hearing threshold shifts among children 6-19 years of age: The Third National Health and Nutrition Examination Survey, 1988-1994. *Pediatrics, 108*, 40-43.

Occupational Safety and Health Administration. (1983). Occupational noise exposure: Hearing conservation amendment. Final rule. *Federal Register, 48*, 9738-9785.

Occupational Safety and Health Administration. (2004). *Supporting statement for information collection requirements for the occupational exposure to noise* (29 CFR 1910.95). Retrieved November 17, 2008, from http://osha.gov/reduction_act/1218-0048.html

Rabinowitz, P. M. (2000). Noise-induced hearing loss. *American Family Physician, 61*(9), 2749-2756, 2759-2760.

Rogers, B. (2003). Occupational and environmental health nursing: Concepts and practice. In L. Wilson & L. Thomas (Eds.), *Health promotion, health protection, and prevention* (2nd ed., pp. 375-430). Philadelphia: W. B. Saunders.

Rosen, E. J. (2001). *Noise induced hearing loss*. Retrieved November 25, 2008, from www.utmb.edu/otoref/grnds/Hear-Loss-Noise-000110/Hear-Loss-Noise.htm

Rosenman, K. D., & Reilly, M. J. (2002). *Analysis of reports on occupational noise-induced hearing loss, 1991-2000*. East Lansing, MI:

Michigan State University.
Royster, J. D., & Royster, L. H. (1990). *Hearing conservation programs: Practical guidelines for success*. Chelsea, MI: Lewis Publishers, Inc.
Royster, L., Royster, J., Driscoll, D., & Layne, M. (2000). *The noise manual*. Fairfax, VA: American Industrial Hygiene Association.
Salazar, M. K. (2006). *Core curriculum for occupational and environmental health nursing* (3rd ed.). St. Louis: W. B. Saunders.
Stapleton, L., & Royster, L. H. (1981). Education programs for hearing conservation. In L. H. Royster, N. D. Stewart, & F. D. Hart (Eds.), *Noise-con 81 proceedings* (pp. 153-156). New York: Noise Control Foundation.
Stapleton, L., & Royster, L. H. (1985). The education component of hearing conservation programs. *Sound and Vibration, 19*(2), 29-31.
Stewart, A. P. (2000). Program overview and administration. In E. H. Berger, L. H. Royster, J. D. Royster, D. P. Driscoll, & M. Layne (Eds.), *The noise manual* (5th ed., pp. 149-164). Fairfax, VA: American Industrial Hygiene Association.
The Quest for Hearing Health. (2001). *EHS today*. Retrieved October 6, 2008, from www.ehstoday.com/news/ehs_imp_34713/index.html
Tsukada, T., & Sakakibara, H. (2008). A trail of individual education for hearing protection with an instrument that measures the noise attenuation effect of wearing earplugs. *Industrial Health, 46*, 393-396.
U.S. Department of Labor. (1971). *Occupational noise exposure, standards–29 CFR 1910.95* Washington, DC: Occupational Safety and Health Administration.
U.S. Department of Labor. (2002a). *Audiometric test rooms: 1910.95 App D*. Retrieved January 8, 2009, from www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9739
U.S. Department of Labor. (2002b). *Recording criteria for cases involving occupational hearing loss–1904.10*. Retrieved January 8, 2009, from www.osha.gov/pls/oshaweb/owasdip.show_document?p_table=STANDARDS&p_id=964
U.S. Department of Labor. (2008). *OSHA technical manual: Noise and hearing conservation*. Retrieved November 18, 2008, from www.osha.gov/dts/osta/otm/noise/hcp/index.html
University of Rochester Medical Center. (2008). *Audiology: Hearing and noise protection*. Retrieved September 21, 2008, from www.stronghealth.com/services/audiology/hearing/hearingprotection.cfm
Wallhagen, M. I., Strawbridge, W. J., Cohen, R. D., & Kaplan, G. (1997, March). An increasing prevalence of hearing impairment and associated risk factors over three decades of the Alameda County study. *American Journal of Public Health, 87*, 440-444.
Witt, B. (2006, September 14). *Going beyond OSHA compliance to prevent hearing loss in the workplace*. Retrieved October 8, 2008, from www.ishn.com/Articles/Feature_Article/4afb481ff0cad010VgnVCM100000f932a8c

What Makes a Successful Hearing Conservation Program?

This issue of the AAOHN JOURNAL contains a Continuing Nursing Education Module on "What Makes a Successful Hearing Conservation Program?" 1.0 contact hour of continuing nursing education credit will be awarded by AAOHN upon successful completion of the posttest and evaluation.

A certificate will be awarded and the scored test will be returned when the following requirements are met by the participant: (1) The completed answer sheet is received at AAOHN on or before July 31, 2010; (2) A score of 70% (7 correct answers) is achieved by the participant; (3) The answer sheet is accompanied by a check or money order for $15.00 ($20.00 non-members), or purchase online for $10.00 ($15.00 non-members) at www.aaohn.org. Expect up to 4 weeks for delivery of the certificate.

Upon completion of this lesson, the occupational health nurse will be able to:

1. Describe the factors related to noise-induced hearing loss (NIHL) in the workplace.
2. Discuss the development and components of a successful hearing conservation program (HCP).
3. Identify the role of the occupational health nurse in workplace HCPs.

AAOHN is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation.

AAOHN is additionally approved as a provider by the California Board of Registered Nursing (#CEP9283) and the Louisiana State Board of Nursing (#LSBN3).

Contact hour credits received for successful completion of the posttest and evaluation may be used for relicensure, certification, or re-certification.

doi:10.3928/08910162-20090729-07

Directions: Circle the letter of the best answer on the answer sheet provided. (Note: You may submit a photocopy for processing.)

1. Which of the following commonly accompanies noise-induced hearing loss (NIHL)?
A. Vertigo.
B. Nystagmus.
C. Strabismus.
D. Tinnitus.

2. According to the National Institute on Deafness and Other Communication Disorders (2008a), regular noise exposure of 110 dBA for more than ___ minute(s) risks permanent hearing loss.
A. 0.5.
B. 1.
C. 1.5.
D. 2.

3. At which noise level must employees use hearing protection devices (HPDs)?
A. 80 dBA.
B. 85 dBA.
C. 90 dBA.
D. 95 dBA.

4. It is recommended that a group educational presentation not exceed:
A. 30 minutes.
B. 45 minutes.
C. 1 hour.
D. 1½ hours.

5. According to Tsukada and Sakakibara (2008), the use of HPDs among 68 male employees in a Japanese manufacturing plant increased from 46% to ___% after individual training was provided.
A. 53.
B. 57.
C. 61.
D. 66.

6. Determining what learners already know about a topic, what they need to know to improve job performance, and what they would like to know is indicative of this focus area for adult education (Knowles, 1984):
A. Problem-oriented learning.
B. Usefulness of past experiences.
C. Independent learning.
D. Readiness to learn.

7. Which of the following is an engineering control to eliminate or reduce hazardous workplace noise?
A. Redesigning or relocating noisy machinery.
B. Educating and training of workers about hearing conservation programs for NIHL.
C. Rotating workers to limit noise exposure.
D. Wearing HPDs.

8. An occupational health nurse is fitting earplugs for employees and has them use the _____ test to demonstrate a vacuum effect from the earplugs.
A. Vacuum.
B. Tug.
C. Roll.
D. Seal.

9. If there is a temporary threshold shift of 10 dB or more on the annual test, the test may be repeated within ___ days.
A. 16.
B. 23.
C. 30.
D. 37.

10. As custodian of audiograms, the occupational health nurse keeps each in an employee's record and retains them for the duration of employment plus ___ years.
A. 15.
B. 20.
C. 25.
D. 30.

What Makes a Successful Hearing Conservation Program?

August 2009

(Goal: To gain ideas and strategies to enhance personal and professional growth in occupational health nursing.)

Mark one answer only!
(You may submit a photocopy of the answer sheet for processing.)

1.	A	B	C	D	**6.**	A	B	C	D
2.	A	B	C	D	**7.**	A	B	C	D
3.	A	B	C	D	**8.**	A	B	C	D
4.	A	B	C	D	**9.**	A	B	C	D
5.	A	B	C	D	**10.**	A	B	C	D

EVALUATION (must be completed to obtain credit)

Please use the scale below to evaluate this continuing education module.

	4 - To a great extent	3 - To some extent	2 - To little extent	1 - To no extent
1. As a result of completing this module, I am able to:				
A. Describe the factors related to noise-induced hearing loss (NIHL) in the workplace.	4	3	2	1
B. Discuss the development and components of a successful hearing conservation program (HCP).	4	3	2	1
C. Identify the role of the occupational health nurse in workplace HCPs.	4	3	2	1
2. The objectives were relevant to the overall goal of this independent study module.	4	3	2	1
3. The teaching/learning resources were effective for the content.	4	3	2	1
4. How much time (in minutes) was required to read this module and take the test?	60	70	80	90

Please print or type: (this information will be used to prepare your certificate of completion for the module).
DEADLINE: JULY 31, 2010. Allow up to 4 weeks for processing.

NAME _____ *MEMBERSHIP NUMBER* _____

ADDRESS _____

CITY _____ *STATE* _____ *ZIP* _____

PHONE _____

LICENSE NUMBER _____

Processing Fees:
Check or money order $15.00 ($20.00 non-member) payable to AAOHN in U.S. Funds or bill my credit card: ☐ *M/C* ☐ *Visa* ☐ *AMEX. Or purchase online at www.aaohn.org $10.00 ($15.00 non-member).*
Mail to: Professional Affairs — CNE Module
AAOHN
7794 Grow Drive
Pensacola, FL 32514

Cardholder's Name _____

Cardholder's Signature _____

_____-_____-_____-_____ *Expiration Date* _____

AN AUTHORIZED SIGNATURE IS REQUIRED FOR ALL CREDIT CARD ORDERS.
CREDIT CARD ORDERS MAY BE FAXED TO (770) 455-7271.