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NIOSH TOOLS FOR HEARING LOSS PREVENTION PROGRAMS

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ABSTRACT

The mining workforce experiences high rates of hazardous noise exposure and hearing loss. However, previous studies have identified specific behavioral and attitudinal barriers that keep miners from effectively acting to prevent their own hearing loss. NIOSH has developed several new hearing loss prevention tools and interventions that specifically target these barriers to prevention. The NIOSH Hearing Loss Simulator addresses motivation to take action and knowledge about the consequences of noise exposure. The QuickFit earplug test device and QuickFitWeb online hearing protection tester address barriers to effective earplug and earmuff use by verifying at least 15 decibels of protection. The NIOSH Roll-Pull-Hold technique helps miners obtain better protection through an easy-to-remember set of steps that improves attenuation by 9 decibels. The "Inquiring Ears Want to Know" fact sheet helps miners to understand audiograms and to use them to maintain their hearing health. Each of these interventions can be used within the context of a comprehensive hearing loss prevention program.

INTRODUCTION

The mining workforce experiences high levels of noise exposure and in turn suffers from high rates of noise-induced hearing loss (NIHL). The mining sector has the highest prevalence of hazardous workplace noise exposures (76%) among all industrial sectors (Tak, Davis, and Calvert, 2009). Although most miners use hearing protection, and diligent effort is put forth both by manufacturers and researchers to quiet mining machinery, miners continue to exhibit a high prevalence (24%) of hearing difficulty (Tak and Calvert, 2008). Most U.S. miners are exposed to noise levels that mandate their enrollment in a Hearing Conservation Program (HCP) through their employers. MSHA's 1999 Health Standards for Occupational Noise Exposure codified in 30 CFR 62 (commonly called the "Noise Rule") requires a Hearing Conservation Program (HCP) for most miners. The mandatory HCP includes exposure monitoring, annual audiometry, access to hearing protectors, training, and recordkeeping. NIOSH recommends additional components beyond those mandated for HCPs to provide procedural audits, worker motivation, program evaluation, and integration of engineering and administrative controls as part of the program. These programs that go beyond the regulatory requirements are referred to as Hearing Loss Prevention Programs (HLPP) to reflect the more comprehensive and proactive approach (NIOSH, 1996). To enable mines to implement an effective HCP or HLPP the NIOSH mining hearing loss research program has developed a variety of tools and resources. In particular, several tools have been developed to address the need for worker education and motivation to play a critical role in preserving their own hearing.

Previous studies have identified attitudinal and behavioral barriers that prevent miners from acting to effectively protect their own hearing. Virtually all of these studies examine the use or non-use of hearing protection, although noise controls are the preferred method of hearing loss prevention. A positive association has been identified between attitudes regarding hearing protection and behavioral intentions to wear hearing protection (Quick et al., 2008). Also, workers who believe that hearing protectors are effective at preventing NIHL are more likely to use HPDs in noisy situations, while those who do not believe that HPDs are effective do not use them consistently. Other factors that reduce hearing protector use include workers' perceptions that they already have poor hearing, that the devices are uncomfortable, and that HPDs can interfere with communications, job performance, and audibility of warning signals (Morata, 2002). Additional barriers such as lack of motivation, lack of hearing protector fitting skills and lack of knowledge can undermine even the most employee-centered hearing loss prevention programs. NIOSH has developed several hearing loss intervention tools targeting specific barriers to effective hearing loss prevention which can be implemented into a comprehensive hearing loss prevention program.

MOTIVATION

Workers may not take action to protect their hearing because they lack the motivation to do so. Without understanding the consequences of noise exposure on hearing, a worker has no reason to take any actions for protection against noise exposure. The NIOSH Hearing Loss Simulator was developed to motivate miners to protect their ears from noise-induced hearing loss. It is a software training and communication tool that allows for self-experience of the impact of NIHL. Self-experiences of symptoms have been found to be positively associated with anti-noise attitudes and behaviors (Widen et al., 2009). The purpose of this tool is to motivate workers to protect their own hearing by allowing them to experience the potential hearing loss they may incur with conditions very similar to their "real life" work environment. The main screen of the Hearing Loss Simulator is shown in Figure 1.

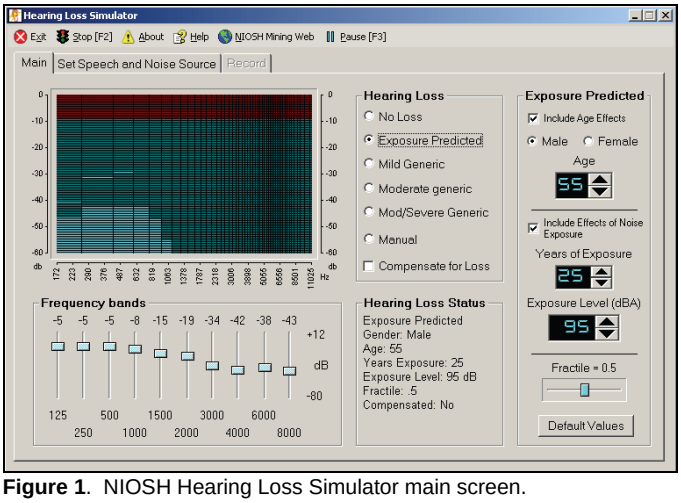

Figure 1. NIOSH Hearing Loss Simulator main screen.

A user of the Hearing Loss Simulator can adjust various parameters to estimate the hearing loss one would experience given a specific level of noise exposure over a specific number of years. The effects are shown visually on a frequency band control panel while the user listens to audio playback. Additionally, frequency band sliders are available that allow users to manually input hearing thresholds, from an audiogram, for example, so that a specific hearing loss can be demonstrated. Because hearing in background noise is a more difficult

task than hearing in quiet, the Hearing Loss Simulator also offers a variety of background noise conditions for demonstration. Users can select from several recorded mining worksite sounds (continuous mining machine, bulldozers, processing machines) as well as standard generic background noises such as multi-talker babble. Customized sounds may be recorded using a high-quality microphone for further individualization of workplace noise conditions. Through manipulation of these various conditions, a user can experience a range of estimated hearing impairments in a variety of background noise conditions. This variety allows for demonstration of noise conditions that are very similar to a user's own noise exposures, and therefore an increased understanding of how their own working conditions may negatively impact their hearing ability.

The Simulator gains realism by basing its approximation of the NIHL experience on models derived from hearing impaired populations. The software performs calculations based on the ANSI standard S3.44, "Determination of Occupational Noise Exposure and Estimation of Noise-Induced Hearing Impairment" (ANSI, 2006). This standard provides algorithms for predicting hearing loss based on age and noise exposure. These algorithms were derived from studies of large populations, including some groups with no exposure to hazardous noise and other groups that experienced various levels and durations of noise exposure. The Simulator can demonstrate the individual variability in susceptibility to NIHL by using its population quartile adjustment. For instance, it can show how much additional NIHL is experienced by individuals in the most susceptible quartiles versus those at the population median. Although no individual user can predict their own susceptibility, the program can show the range of possible expected NIHL. By doing so, the Simulator provides realistic examples of the negative impact of repeated or prolonged noise exposure with data from a large subject pool.

The NIOSH Hearing Loss Simulator functions on systems with Windows 98 or higher and standard Windows sound support and speakers. Projectors and/or headphones may be used for certain training applications. The NIOSH Hearing Loss Simulator and the Hearing Loss Simulator Instruction and Training guide are available for download from the internet at:

www.cdc.gov/niosh/mining/products/product47.htm

Additionally, these tools can be ordered by calling 1–800–CDC–INFO (1–800–232–4636).

HEARING PROTECTOR FITTING SKILLS

Lack of hearing protector fit skills is another barrier that impedes workers' attempts to prevent noise-induced hearing loss. Hearing protection devices (HPDs) marketed in the U.S. are tested in laboratories to determine their Noise Reduction Rating (NRR). This rating is intended to represent the amount of noise protection that the protector can provide. However, the attenuation values obtained at work sites are often much less than those achieved in the laboratory (Berger, Franks and Lindgren, 1996). With incorrect HPD fit, as often occurs with untrained users, little or no protection from noise may be obtained. NIOSH has developed two tools to aid users of HPDs in achieving adequate fit. The Roll-Pull-Hold method and QuickFit earplug fit tester are NIOSH products aimed to alleviate two specific issues with fitting earplugs.

Roll-Pull-Hold

It can be difficult to understand and remember the instructional wording and small print that is often found on the packaging of soft foam earplugs. Additionally, the directions for earplug insertion can be inconsistent between manufacturers or the packaging may be discarded before the directions are read and comprehended. NIOSH has developed and published the Roll-Pull-Hold method to simplify the insertion of soft foam earplugs by standardizing the instructions to focus on three words essential to the insertion task. By breaking the instructions into 3 simple steps, each linked to a single word, users of foam earplugs are able to remember the insertion procedure without referring the packaging, and in turn achieve a better plug fit. The most critical departure from standard instructions is the use of the term "pull" to remind users that they need to pull the pinna of the ear outward and upward to facilitate insertion. Prior to this, most earplug instructions used the word "insert" or other non-specific terms to describe this crucial step. Figure 2 is a visual representation of the NIOSH Roll-Pull-Hold method.

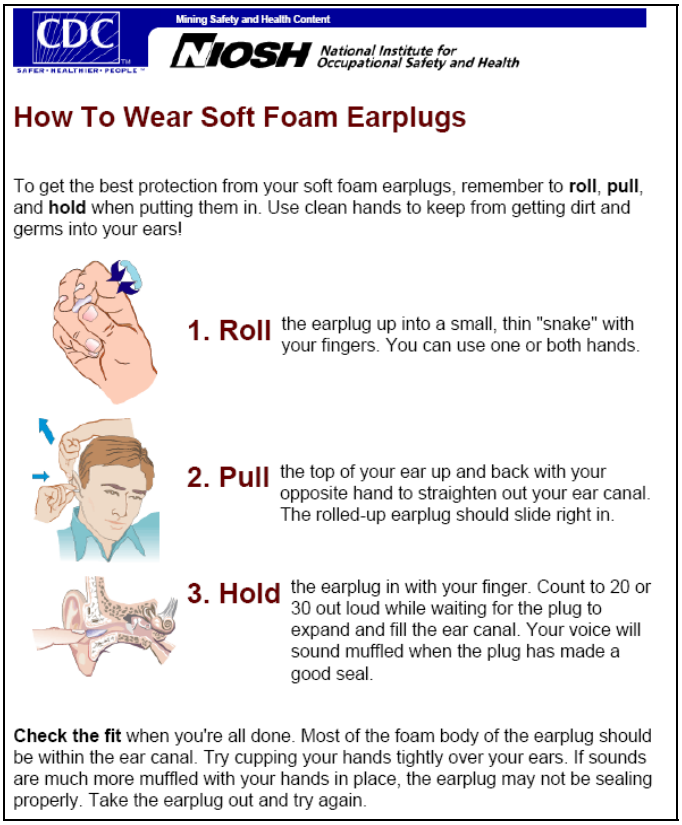

Figure 2. NIOSH Roll-Pull-Hold method for insertion of foam earplugs.

An unpublished pilot study of 308 coal miners was conducted to determine the benefits of the Roll-Pull-Hold technique. Subjects who were observed to complete none of the three steps attained an average of only 15 dB of attenuation at 1000 Hz. Subjects who completed all three steps attained an average of 24 dB of attenuation, a 9 dB improvement.

QuickFit

Personal fit testing is an effective and proven way to determine the amount of protection a worker is receiving from their hearing protection, however fit-test systems can be expensive and impractical to implement at worksites. NIOSH has developed the QuickFit as an affordable, simpler fit-testing device for use in classroom training and at the worksite.

The NIOSH QuickFit is a highly simplified variation of laboratory fit evaluations such as the procedure specified in ANSI S12.6 (ANSI/ASA 2008). The simplicity and low cost of the device result from its design. The electrical components are derived by using off-the-shelf MP3 player components, with a few other parts, housed in the shell of a standard earmuff style hearing protector. In contrast to most other fit-test systems only one critical test frequency is used with the QuickFit, which saves time and allows for a simple three-step procedure that can be done at the worksite.

The QuickFit does not replace more complex systems that provide users with a personal attenuation rating (PAR). Instead, the QuickFit tests only one frequency 1/3 octave band in a "go" or "no-go" paradigm designed to determine whether a user has achieved at least 15 dB of attenuation with earplugs. This simplified method of fit testing proves more time-effective for use at busy worksites, and is simple enough for workers to use without much training. A three-step process is followed which can be completed for both ears in less than 5 minutes. Figure 3 shows a miner using the QuickFit to assure that his

earplugs are properly inserted. The user first holds the QuickFit to their ear and adjusts the output to their hearing threshold (where they can just barely detect the output). The user then inserts an earplug following the NIOSH Roll-Pull-Hold method or other method suited to the type of earplug being used. After insertion, the user will again hold the QuickFit over the protected ear and press the "boost" button, which raises the level of the test tone by 15 dB. If the user cannot hear the boosted signal, they have successfully achieved at least 15 dB of hearing protection. However, if the signal is still audible, they have not achieved enough attenuation from the earplug and should re-insert or try another style of earplug.

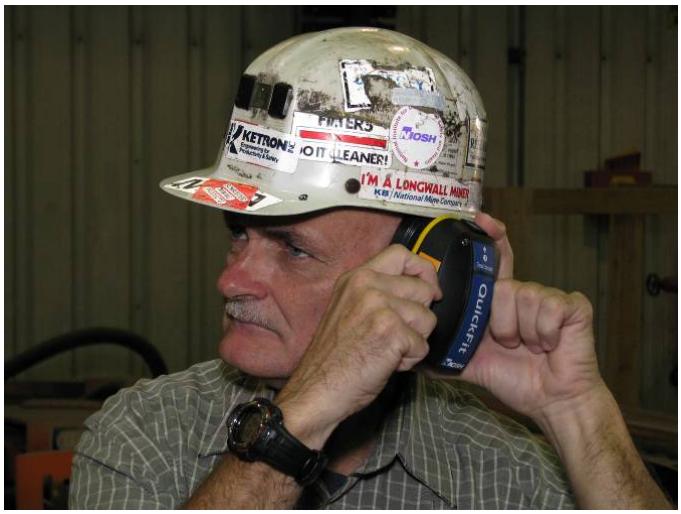

Figure 3. Worker adjusting the volume control on the QuickFit device to set his hearing threshold prior to inserting an earplug.

QuickFitWeb is an online application that uses the same test tones as the handheld device, except that the sounds are played through computer speakers. This application, available to those with access to a computer and the internet, allows for testing of earmuff style protectors as well as plugs. The web version eliminates the need for the handheld device, but does not allow for testing earplug fit separately for left and right ears. The QuickFitWeb is available through the NIOSH website:

www.cdc.gov/niosh/mining/topics/hearingloss/quickfitweb.htm

HEARING TEST KNOWLEDGE

Audiometric testing is the standard monitoring method in hearing conservation programs. Yet, audiograms remain misunderstood by most workers, leading to confusion and indifference regarding their hearing status and necessary steps for hearing protection. NIOSH developed the "Inquiring Ears Want to Know" fact sheet to increase worker knowledge about their own hearing status. This one-page (front and back) flyer is designed to augment the verbal information provided to workers after an audiometric test with written information and visual images for a greater retention of the most salient points. An explanation of test results is provided, along with tips for preventing future hearing loss, a list of non-noise related causes of hearing loss, as well as a reminder of the Roll-Pull-Hold method for earplug insertion. The document is appropriate for all noise-exposed workers through simple wording and vivid images intended to convey complex messages. A Spanish translation is also available to accommodate the growing Spanish-speaking segment of the workforce. Figure 4 shows the front page of the English and Spanish versions of the fact sheet. The purpose of the document is not only to increase worker knowledge about their hearing, but to motivate proactive behaviors towards hearing loss prevention efforts.

The "Inquiring Ears Want to Know" fact sheet has been field evaluated with public health professionals as well as miners to assure the clarity and simplicity of the intended messages. Suggestions from the public health professionals regarding content and images were implemented to make the fact sheet as useful yet simple as possible. The document was also pilot tested with a group of mining trainees to confirm that the text and images were communicated in a way that could be understood by the target audience. "The Inquiring Ears Want to Know" fact sheet is available online for download at:

www.cdc.gov/niosh/mining/pubs/pdfs/2008-102.pdf

or by calling 1–800–CDC–INFO (1–800–232–4636).

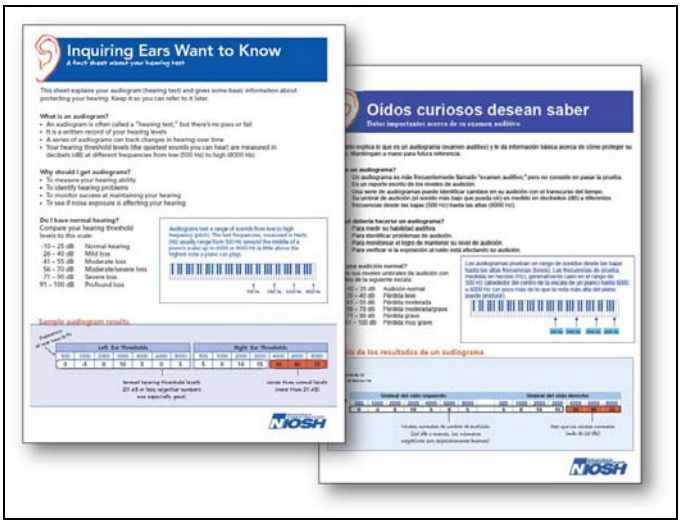

Figure 4. Front pages of English and Spanish versions of the "Inquiring Ears Want to Know" fact sheet.

CONCLUSION

The Hearing Loss Simulator, QuickFit, Roll-Pull-Hold method, and "Inquiring Ears Want to Know" fact sheet can be implemented into hearing loss prevention programs individually or as a suite of interventions. Worker motivation can be addressed through specific examples with the Hearing Loss Simulator. Hearing protector fit skills can be improved through hands on training using the Roll-Pull-Hold method and the QuickFit. For improved comprehension of hearing test results and basic hearing knowledge, the "Inquiring Ears Want to Know" fact sheet provides practical, easily understood information. Workers can carry the sheet away from the test and retain it with their test results for future reference. By targeting specific behavioral barriers, hearing loss prevention programs are likely to yield greater success in reducing NIHL and improve worker acceptance through understanding of the purpose of the program.

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