



UPDATE

Hearing Aids + Earmuffs: Counter-Intuitive Hearing Conservation



By Babette Verbsky

Introduction

At first glance, the thought of wearing hearing aids underneath earmuffs may seem counter-intuitive, crazy or contrary to OSHA or MSHA regulations. After all, the reason for wearing hearing protection devices (HPDs) is to reduce the sound level in the ear sufficiently so that the worker will not sustain a noise-induced hearing loss (NIHL). What justification could there be for increasing the sound level under the HPD? Furthermore, even if such a justification did exist, would not the increased sound level put the worker at increased risk for NIHL?

The Problem

Many workers do not wear HPDs or do not wear them consistently. One of the primary reasons given by workers for not consistently wearing HPDs is that they interfere with speech communication (Morata et al., 2001). Other barriers to HPD use include beliefs that HPDs reduce job safety and the ability to hear warning signals (Verbsky, 2004).

Workers who have hearing loss continue to be employed in the same hazardous noise conditions in which they acquired their NIHLs. For listeners with hearing loss, HPDs could reduce the audibility of speech to such low sensation levels that speech intelligibility is reduced, or worse, speech is rendered completely inaudible (Verbsky, 2002). Since HPDs may impede communication for workers with hearing loss, these workers may be less likely to wear HPDs than their normal-hearing coworkers thus potentially putting them at increased risk for additional NIHL.

All Things Considered

It would seem that the simplest solution to the problem would be to penalize employees for non-compliance with policies requiring HPD use. An employer has the right to enforce safety regulations. The problem with this solution is that the hearing-impaired employee is left with a communication problem. Unfortunately, there is no law that says workers in general must be able to communicate in noise.

If the worker has a communication problem when wearing his or her HPD, what are the typical strategies for accommodation? Off the job, a person who has a hearing loss will either attempt to increase the level or speech-to-noise ratio (SNR) of the speech through various strategies (hearing

aids, getting closer to the speaker, etc.) or pretend to understand what was said.

In a high noise environment, increasing the level of the speech often is accomplished by removing the HPD (Morata, 2002). At first consideration, this may seem like a fairly safe method of accommodation. However, it is easy for minutes of unprotected noise exposure to add up over the course of an eight-hour work shift. For example if one is working in relatively continuous noise, it only takes a total of 30 minutes of unprotected exposure to reduce the effective HPD attenuation by more than 50 percent. Thus, an HPD which might have provided 30 decibels of protection when worn 100% of the time would provide only 12 decibels of "effective protection" when worn for 7 1/2 hours out of an 8-hour day.

The second method of accommodation, pretending to understand, better protects the hearing. However, miscommunication may result in costly mistakes or workplace injuries to others. Additionally, while the link between miscommunication and physical injury or death has not been substantiated in the epidemiological literature to date, there have been case reports of death due to impaired communication by fire fighters and railroad workers. Neither method of accommodation is without its potentially unfavorable consequences. In light of this evidence, perhaps it would be better not to ignore the communication component in attempting to prevent NIHL in hearing-impaired workers.

The technology to solve the communication-in-noise problem exists in the form of an FM transmitter and receiver incorporated in the HPD. However, in the real world cost is an important factor. Therefore, state-of-the-art communication headsets are not always available for noise-exposed workers.

The Solution for Some

Some hearing-impaired workers wear hearing aids off the job to enable them to communicate better with their family and friends. Audiologists counsel their patients to avoid wearing their hearing aids in high noise environments and to use HPDs instead. This advice promotes good hearing conservation, but not good communication. Is it possible to provide better audibility for speech without putting the worker at risk for increased NIHL?

continued on page 6

Content

	PAGE
Hearing Aids + Earmuffs: Counter-Intuitive . . .	1
Chair's Message	2
OHC Corner - External Otitis and Hearing Protector Hygiene	3
Time-Weighted Averages and Fire Fighter Hearing-Loss	4
Ototoxicity: An Issue in Hearing Loss Prevention	7
OHC Courses	10
Manual Order Form	11

Hearing Aids – continued from page 1

A quantitative model for the prediction of “safe” amounts of hearing aid gain based on the levels of noise exposure and amount of HPD attenuation was recently developed and tested on an acoustic test fixture (Verbsky, 2002). The “safe” or maximum acceptable exposure (MAE) is defined with reference to octave-band sound pressure levels measured in the unoccluded earcanal as it is exposed to a noise of 85 dBA. When hearing protectors are worn in concert with hearing aids in a given noise environment, the hearing-aid gain must then be limited so the levels (again measured in the earcanal) do not exceed the MAE specified above. Eighty-five dBA was chosen because it is the maximum noise level that does not require the use of HPDs in the workplace according to NIOSH recommendations (NIOSH 1998). It is possible that the reason persons have already acquired NIHL is that they may be more susceptible to the damaging effects of noise than their coworkers. Therefore, if this method of accommodation is implemented, the audiologist should closely monitor the client for evidence of temporary or permanent threshold shift especially during the first few days of combined hearing aid and earmuff use.

Does going to all this trouble really improve speech intelligibility in noise? Yes. Figure 1 shows the results of a study with adult subjects who were tested with their own hearing aids set below the MAE and worn in combination with each of two sets of passive earmuffs in 90 dBA of talker babble (Verbsky, 2002). The dependent variable (shown on the vertical axis in the figure), average speech-to-noise ratio at 50% correct (SNR50), is an indicator of how well a listener can understand speech in noise. A score of 10 dB means that the speech must be 10 dB higher than the noise for 50% of the speech to be understood. Therefore, a numerically lower score indicates better hearing for speech in noise than a higher score.

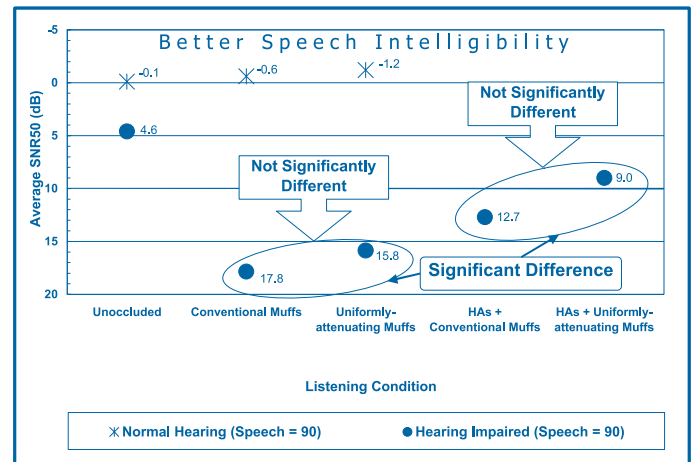
These results support two main conclusions. First, hearing aids worn in combination with earmuffs at “safe” levels significantly improved speech intelligibility over the earmuff-only listening conditions. Second, hearing-impaired listeners were shown to be handicapped in terms of speech understanding ability in the conditions tested while the normal hearing listeners were not.

Is this method of accommodation “safe” for all noise environments and earmuffs? No! Unless the values for all three of the quantitative model’s variables (hearing aid gain, HPD attenuation, and octave band noise levels) are known, no worker should be permitted to wear his or her hearing aids in combination with HPDs.

The Future

The solution proposed in this paper must not be the final answer to the problem. There are too many adverse noise environments in which this accommodation is inappropriate. As audiologists and occupational hearing conservationists continue to advocate for access to advanced technology for the enhancement of communication in the workplace, newer procedures may be developed for determining how best to accommodate the hearing-impaired worker who must continue to work in noise.

Figure 1— Normal-hearing listeners were able to understand 50% of what was being said when the speech was the same level as the noise. The use of conventional or uniformly-attenuating passive earmuffs did not change their performance. Hearing-impaired listeners needed the speech to be nearly 5-dB louder than the noise even without earmuffs, and the use of earmuffs greatly reduced their speech intelligibility. Hearing aids worn under earmuffs significantly improved speech intelligibility, but did not restore the unoccluded performance. Although some improvement was measured with the uniformly attenuating earmuffs compared to the conventional earmuffs, the differences were not statistically significant.



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