

The Role of the Professional Supervisor in the Audiometric Testing Component of Hearing Conservation Programs

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ACOEM believes that the functions of a professional supervisor in hearing conservation programs are part of the “core practice” of occupational medicine. This guidance emphasizes the role occupational medicine clinicians play in the supervision of audiometric surveillance conducted under the auspices of hearing conservation programs and reviews the regulatory and scientific basis and pertinent practices involved in this supervisory role.

BACKGROUND

Noise is one of the most ubiquitous workplace exposures, and noise-induced hearing loss (NIHL) is one of the most prevalent occupational medical conditions.^{1,2} About 24% of the hearing loss suffered by US workers involve occupational exposures, and an estimated 22 million workers are exposed to hazardous noise annually.³ Prevention and early detection of NIHL should therefore be a priority for occupational medicine. The American College of Occupational and Environmental Medicine’s (ACOEM) statement on noise-induced hearing loss (NIHL)⁴ emphasizes the role which occupational medicine clinicians play in the supervision of audiometric surveillance conducted under the auspices of hearing conservation programs. This document reviews the regulatory and scientific basis, and pertinent practices for this supervisory role.

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HEARING CONSERVATION PROGRAMS AND THE BASIS OF THE PROFESSIONAL SUPERVISOR ROLE

The 1983 Occupational Safety and Health Administration’s (OSHA’s) Hearing Conservation Amendment⁵ mandated that workplaces where workers are exposed to noise levels at or exceeding 85 dBA for an 8-hour time-weighted average (TWA) put in place hearing conservation programs. Such programs must include noise assessment and engineering controls, training, administrative controls, and hearing surveillance of noise exposed workers. In its requirements for audiometric testing, the OSHA standard makes specific reference to the role of health care professionals in the hearing conservation program:

1910.95(g)(3) Audiometric Testing Program

“Audiometric tests shall be performed by a licensed or certified audiologist, otolaryngologist, or other physician, or by a technician who is certified by the Council for Accreditation of Occupational Hearing Conservation. . . A technician who performs audiometric tests must be responsible to an audiologist, otolaryngologist, or physician.”

1910.95(g)(7) (iii) Evaluation of audiogram

“The audiologist, otolaryngologist, or physician shall review problem audiograms and shall determine whether there is need for further evaluation.”

1910.95(g)(8) Follow-Up Procedures

“1910.95(g)(8)(i) If a comparison of the annual audiogram to the baseline audiogram indicates a standard threshold shift as defined in paragraph (g)(10) of this section has occurred, the employee shall be informed of this fact in writing, within 21 days of the determination.

1910.95(g)(8)(ii)

Unless a physician determines that the standard threshold shift is not

work related or aggravated by occupational noise exposure, the employer shall ensure that the following steps are taken when a standard threshold shift occurs:

1910.95(g)(8)(ii)(A)

Employees not using hearing protectors shall be fitted with hearing protectors, trained in their use and care, and required to use them.

1910.95(g)(8)(ii)(B)

Employees already using hearing protectors shall be refitted and retrained in the use of hearing protectors and provided with hearing protectors offering greater attenuation if necessary.

1910.95(g)(8)(ii)(C)

The employee shall be referred for a clinical audiological evaluation or an otological examination, as appropriate, if additional testing is necessary or if the employer suspects that a medical pathology of the ear is caused or aggravated by the use of hearing protectors.

1910.95(g)(9)

Revised baseline. An annual audiogram may be substituted for the baseline audiogram when, in the judgment of the audiologist, otolaryngologist, or physician who is evaluating the audiogram:

1910.95(g)(9)(i)

The standard threshold shift revealed by the audiogram is persistent; or

1910.95(g)(9)(ii)

The hearing threshold shown in the annual audiogram indicates significant improvement over the baseline audiogram.”

Similarly, the MSHA Noise Regulation (30 CFR Part 62) states that an audiometric technician must be under the supervision of a physician or an audiologist (62.170)[3].⁶ These regulatory stipulations, therefore, outline responsibilities

for physicians and audiologists working in hearing conservation programs related to audiometric testing and follow-up of employees who have experienced a standard threshold shift in hearing (including determination of work-relatedness and medical referral of hearing loss cases). Guidelines for best practice in these areas of responsibility are outlined in this document.

ROLES OF THE PROFESSIONAL SUPERVISOR

Supervision of Audiometric Testing

As demonstrated above, OSHA mandates that audiometric testing of noise-exposed workers must be accomplished either by the physician or audiologist providing professional services to the hearing conservation program, or by a technician under the supervision of this professional. Therefore, the professional supervisor has responsibility for ensuring the adequacy of the audiometric testing environment, procedures, and recordkeeping; the training of audiometric technicians; as well as the coordination of audiometric services delivered by a third-party health care provider. Further, it is necessary that in order to maintain a quality hearing protection program, any supplemental contracted or fee-for-service clinical auditory services, such as mobile hearing units, are assessed to ensure that they implement standards consistent with federal, state and local statutes, best practices, and clinical guidance established for hearing conservation programs.

The Council for Accreditation in Occupational Hearing Conservation (CAOHC) is the national certifying body for occupational hearing conservationists (OHCs) serving as audiometric technicians in industrial hearing conservation settings. Having CAOHC-certified audiometric technicians is an important component of a hearing conservation program, but the professional supervisor must still be vigilant for problems with testing reliability. This can include sudden shifts in hearing thresholds and inconsistent testing responses. It may also be useful to review the variability of all audiometric tests conducted in a given time period, looking for sudden changes that could signal problems with audiometric calibration or testing environment. While there are no standardized methods for assessing audiometric variability, the audiometric database analysis methods outlined in the American National Standards Institute (ANSI) standard S12.13-1991 allow for calculation of test-test variability resulting from either testing problems or noise-induced threshold shifts.⁷

Follow-Up of Employees With Hearing Loss

OSHA defines a standard threshold shift (STS) as a worsening of hearing from baseline of 10 dB in the average of 2, 3, and 4 kHz in either ear. Such shifts are potentially recordable on the OSHA log if the average of hearing thresholds at these same frequencies is at least 25 dB, and no other cause can be found to completely explain the loss. OSHA requires that unless a physician or audiologist determines an STS to be not work-related, the worker must be notified, counseled, and refitted with a hearing protection device. Audiometric technicians are not allowed to interpret audiograms, diagnose ear disorders, or refer to specialized care. The follow-up of employees with hearing loss involves several judgments by the professional supervisor: (1) what baseline should be used; (2) should age correction be employed; (3) is the loss work-related; and (4) what additional follow-up is necessary.

Baseline Audiogram Decisions

According to OSHA guidelines, an employee's initial hearing test is conducted following a noise-free period of at least 14 hours, and serves as the baseline audiogram against which subsequent audiometric tests are compared. If, however, later audiograms show significant improvement, due either to improved testing ability of the employee (the learning effect⁸ or a resolving medical condition), it is more valid to use the improved audiogram as a "revised" baseline. Similarly, if an STS occurs, OSHA guidelines indicate that the baseline should be revised in the ear where the STS has occurred. The decision about whether to revise a baseline must be made by the professional supervisor. The National Hearing Conservation Association has published recommended guidelines for baseline revision.⁹

Use of Age Correction

Whether or not to use age correction routinely in the calculation of STSs is an important decision for Professional Supervisors of audiometric testing programs. Under the 1983 OSHA Hearing Conservation standard, the use of age correction is optional. The recent OSHA record-keeping rule also considers age correction of audiometric shifts to be optional, stating that it "may be applied." OSHA does not, however, allow age correction of the threshold values used to calculate whether the pure tone average of thresholds at 2, 3, and 4 kHz is at least 25 dB.

Age correction reduces the magnitude of a calculated threshold shift by the amount of hearing loss expected due to

aging, based on age-specific median population values. As a result, some 10 dB STS cases among a group of noise-exposed workers would, after age correction, no longer meet the STS definition or require any OSHA-mandated action. Therefore, programs that routinely apply age correction would be expected to have lower rates of STS than programs that do not.

The National Institute for Occupational Safety and Health (NIOSH) has recommended that age correction not be used in STS determinations, citing concerns that its routine use could delay diagnosis of noise-induced hearing loss and that it is "technically inappropriate to apply population statistics to an individual."¹⁰ An analysis of a large industrial audiometric database found that the occurrence of age-corrected STS, meeting the OSHA recordability criteria, was assessed after the development of potentially compensable hearing impairment by American Medical Association (AMA) criteria.^{11,12} In some states, age correction for the purpose of calculating STSs is not allowed under law. Nationally, there are no data on the prevalence of the practice of age correction in hearing surveillance.

There are several potential advantages to the use of age correction, however. Just as a worker's pulmonary function test results can be compared with age-corrected "predicted" values, age correction can suggest whether expected loss due to aging could explain a worker's case of hearing loss. In this way, it can help prevent "false positive" diagnoses of NIHL. The clearest indication for the use of age correction would be for the comparison of STS rates between worker populations with differing age structures.

In summary, while age-correction has a role in the standardized reporting of hearing loss cases, the age-corrected STS meeting OSHA recordability criteria is not an early indicator for hearing loss in an individual. For the early detection of NIHL, other more sensitive indicators should be employed. A number of such "early flags" have been proposed, including the NIOSH "15 dB twice" criteria, and the use of the non-age corrected 10 dB STS. Significant differences in sensitivity have been found between the various measures.¹³ Concerns have been raised that the more sensitive measures could create an unacceptable number of "false positives" due to audiometric variability alone.¹⁴ At present, there is insufficient outcomes based research to support the use of any one particular measure. Consequently, in selecting a metric to use for "early warning," the professional supervisor should consider the optimal balance between false positives and false negatives given available program resources and degree of hearing loss risk.

Determining Work-Relatedness

The OSHA recordkeeping rule has criteria for recordable hearing loss cases,¹⁵ and has therefore given increased importance to the role of the professional supervisor in determining work-relatedness of hearing loss. Studies have found that the revised OSHA recordkeeping rule increased the potential numbers of recordable hearing loss cases by as much as eightfold.¹¹

According to the OSHA standard, the occurrence of an STS triggers notification and corrective action, regardless of whether criteria for recordability are met, unless the professional supervisor determines that the hearing loss is not work-related. There are four basic steps to making such a determination: (1) Is the audiometric test valid? (2) Was the occupational noise exposure sufficient to cause or contribute to hearing loss? (3) Is there a medical condition that completely explains the loss? and (4) On a “more likely than not” basis, did occupational noise exposure cause the loss?

First, the professional supervisor must determine whether the audiometric test is valid, or whether there is evidence of testing irregularity. Reasons for invalid testing include excessive noise in testing environment, inadequate instruction in testing, audiometer malfunction, errors in test recording, recent illness, and malingering.

Second, there is a need to determine the degree of noise exposure that an individual has experienced. Ideally this is based on records of noise surveys and dosimetry in the individual’s work area. A work history can be assembled of years worked at each job and the noise levels at each job. ANSI standard 3.44 gives a formula to calculate an equivalent noise exposure level based on this work history.¹⁶

In assessing noise exposure, the professional supervisor should keep in mind that time-weighted averages may not adequately capture the occurrence of peak noise exposures and short-duration impulse noise that has been shown to be damaging to hearing.¹⁷ OSHA propounds that the action level for noise exposure is 85 dBA, yet, data exist to support the conclusion that exposures between 80 and 85 dBA are capable of causing hearing loss, especially in susceptible individuals.¹⁸ Further, emerging evidence suggests that delayed effects to the cochlear nerve resulting from noise exposure could be seen in the future.¹⁹ Ergo, the probability exists that hearing loss due to noise may progress once the noise exposure is discontinued.

Records of hearing protection use should also be reviewed; however, it should be kept in mind that field performance of

hearing protectors has been found to be highly variable and not well correlated with manufacturer noise reduction ratings (NRR).²⁰ Although “OSHA does allow the worker’s use of hearing protection to be considered by an employer when making determinations of work relatedness, it should not be the sole criterion in such determinations, nor should the determination be reduced to an equation.”²¹ Therefore, documentation that a worker has been wearing hearing protection at work may not by itself provide sufficient proof that they received adequate protection from noise effects. As part of the exposure history, the clinician should document any significant exposure to ototoxic drugs such as aminoglycosides or cisplatin. Likewise, past occupational exposures to potentially ototoxic chemicals such as organic solvents, heavy metals and asphyxiants, should be assessed,²² especially if there is a history of acute or chronic neurotoxicity due to such exposures.

Non-occupational noise exposure should also be part of a comprehensive exposure assessment, including frequency and intensity of exposures to recreational noise sources including firearms, vehicles, machinery, and amplified music. At the same time, documentation of significant non-occupational noise exposure is not sufficient evidence to consider a case of hearing loss to be non-work related. The professional supervisor should determine a clinical risk assessment based on exposure information and reach a clinical assessment as to whether or not the worker has been sufficiently exposed to noise and/or ototoxic chemicals in the workplace resulting in hearing loss. Hence, the professional supervisor must consider many factors while assessing for hearing loss and when determining work-relatedness, and such determinations must be made on a case-by-case basis.²¹

Third, the professional supervisor must also determine whether the hearing loss is consistent with NIHL, or whether another etiology can explain the loss. The differential diagnosis of NIHL includes ruling out other sensorineural processes including presbycusis (age-related hearing loss), 8th nerve neoplasm, sudden sensorineural hearing loss and head trauma, as well as conductive hearing loss due to infection, otosclerosis, or cerumen impaction. Since the surveillance audiogram is usually limited to measurement of air conduction pure tone hearing thresholds, an important decision for the professional supervisor is whether more complete audiological testing including bone conduction, speech discrimination or other testing modalities could assist in the differential diagnosis of the hearing loss case. ACOEM’s

statement on noise-induced hearing loss lists clinical characteristics of NIHL that can be used to differentiate it from other conditions.²³ One feature is the “notching” of the audiogram in the higher frequencies around 4000 Hz. This feature of the audiometric configuration has been used successfully in medical legal determinations of hearing loss.²⁴ A recent study found good agreement between objective criteria for audiometric notching and the judgments of an expert panel.²⁵

The final step in a work-relatedness determination is for the professional supervisor to consider all the evidence accumulated during steps 1 to 3, and then to decide, on a “more likely than not” basis, whether the hearing loss was related in any way to work exposures.²⁶ The OSHA recordkeeping standard for hearing loss refers to general OSHA guidance of presumption of work-relatedness unless a specific exception can be found.²⁷ OSHA allows for such a determination of exception to the work-relatedness presumption, on a case-by-case basis. In cases of hearing loss, this would mean demonstrating that the hearing loss is due solely to non-occupational noise exposure or a medical cause (including aging), and that occupational noise was not a contributing factor. Ideally, this issue should have been addressed during the evaluation process outlined above.

Additional Follow-Up of the Worker With Hearing Loss

In every hearing loss evaluation, the professional supervisor should consider whether further referral for possibly treatable hearing loss is medically indicated. Some conditions such as cerumen impaction or otitis media or externa may be appropriately treated in a primary care setting, while others including retrocochlear tumors or sudden hearing loss require specialist care. The American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) has published recommended criteria for referring individuals in hearing conservation programs to an otolaryngologist.²⁸ Employees for whom a hearing impairment is assessed should be notified verbally and in writing of the professional supervisor’s decision to refer including specific details about the clinical indication for referral, medical follow-up expectations, and the employee’s personal responsibilities. The employer should be notified in writing about the referral of an employee for diagnostic assessment or medical management while respecting the worker’s confidentiality, and include an overview of the employer’s responsibilities, and expectations about employee medical follow-up evaluations.

The referral should compile all documentation of all screening audiograms

including baselines and any baseline revisions, noise exposure data, employee job tasks and processes, and documented use of hearing protection devices. Further, the referral should include a request for a written report including recommendations about medical management including follow-up, and specific occupational restrictions, etc. The referral source should have some familiarity with the workplace and occupational-related regulations and policies. There are three main referral routes: (1) audiology for diagnostic audiologic evaluation, retest due to STS (air conduction only), hearing protection device effectiveness measures, cerumen debridement, etc.; (2) medical diagnosis and treatment of ear pathology from otolaryngology, neurology, occupational medicine, family practice, internal medicine, etc.; and (3) referral to other specialists such as speech pathology, psychology, physical therapy, hearing aid dispensary. Examples of referral criteria to an audiologist or otolaryngologist include when the hearing threshold levels average greater than 25 dB at 500, 1000, 2000, and 3000 Hz or 45 dB at 4000 and 6000 Hz, in either ear, and have not been previously evaluated; new onset unilateral hearing loss; for example, greater than 20 dB at 500, 1000, or 2000 Hz, or 40 dB at 3000, 4000, or 6000 Hz, that has not been previously evaluated; when hearing thresholds at any test frequency differ by 40 dB or more between ears; or when workers are refractory to treatment for ear canal occlusion, persistent ear pain, drainage, severe unilateral tinnitus, sudden onset of hearing loss, among others.

Workers with hearing loss may also require accommodation in the workplace. The impact of the hearing status on safety sensitive jobs must be considered, as well as the possible need for hearing protection that is appropriate for individuals with preexisting hearing loss and that avoids over attenuation. OSHA has published recommendations for workplace accommodation of the hearing impaired worker.²⁹

Finally, the professional supervisor should ensure that each evaluation of a worker with hearing loss becomes an opportunity for prevention, health promotion and education, and hazard-related education. For example, a majority of women of child-bearing age are occupationally active which correlates to pregnancies potentially exposed to workplace noise hazards. Studies demonstrate that the developing fetus can be clinically susceptible to maternal noise exposure,^{30,31} with a greater risk of resulting in childhood hearing impairments including conductive mixed with sensorineural hearing loss, sensorineural hearing loss, tinnitus, and other hearing injuries.³² Hence, it is prudent that

expectant mothers and women of childbearing age are informed not only about the potential health effects from noise exposure to self, but to the developing fetus as well. Such cases, among others, can be important indications that noise controls and personal protective measures in the workplace are ineffective, require corrective action including changes in administrative and engineering controls. The counseling, training, and refitting of individuals can potentially help prevent incident or further hearing loss, although studies of the efficacy of such measures are lacking.

Fitness-for-Duty or Qualification Examinations

The professional supervisor may be asked to review audiograms to determine whether an individual possesses adequate hearing in order to function in a safe and effective manner. Certain tasks performed by an individual may be deemed “hearing-critical,” in that job performance or safety may suffer if the auditory messages are not correctly interpreted. Hearing-critical tasks not only require the ability to detect sounds, but may also include recognizing and localizing sounds plus understanding speech.³³

The military and many public safety jobs have protocols defining acceptable audiometric thresholds primarily for the speech frequencies (500 Hz through 4000 Hz). These testing protocols have been developed for rapid screening, and may require subsequent testing assessing functional capacity for real world background noise conditions. If the professional supervisor is asked by the client to determine the auditory fitness for duty of a worker, it is important that this determination must take into account whether the expected job performance in a real-world setting relates to the clinical functional testing.

Two examples of functional examinations include the Speech Recognition in Noise Test (SPRINT) and the Hearing in Noise Test (HINT). The Department of Defense uses the SPRINT which consists of 100 monosyllabic words (Form C of the Northwestern University Test No. 6) pre-recorded in a background of multi-talker babble noise (speech to babble ratio 9 dB). The examinee is scored based on how many words he or she is able to repeat correctly. The score is then extrapolated to a percentile ranking among similar groups and then used with other factors to determine fitness for duty.³⁴ The HINT test is an adaptive measurement, in quiet or in noise, used to determine a signal to noise threshold.³⁵ Like SPRINT, the examinee is administered HINT binaurally. HINT is composed of 250 sentences, categorized into 25 lists. The recorded sentences are administered through an adaptive up-down strategy

based on what the examinee is able to hear and understand.³⁴ The signal-to-noise ratio is computed by how loud, above the noise floor, the sentences need to be to ensure that the examinee approaches a 50% correct response rate.

Although these specialized audiometric tests provide information to guide auditory fitness for duty, SPRINT, HINT, and other similar speech in noise tests are insufficient alone, to arrive at auditory fitness for duty determinations. Clinical testing cannot test non-speech signals or the ability to localize sound and integrate information across both ears. Many employees have the ability to compensate for their hearing loss through visual cues or loud warning signals. Since functional testing cannot assess these factors, real-world simulations may be required to assess a worker’s auditory fitness to meet job performance expectations.³⁶

Workers’ Compensation

Besides determining hearing loss work-relatedness for legal reporting, such as to determine OSHA recordability, this procedure is presumed to occur in determination of workers’ compensation. The professional supervisor should be aware of the hearing loss workers’ compensation guides which are prescribed by either state, provincial, or federal statutes.³⁷

There is no common agreement on the degree of hearing loss which creates a handicap. Most states use either a method recommended by the American Academy of Ophthalmology and Otolaryngology (1959) and later adopted by AMA (1961) or the more recent and more widely used version by the American Academy of Otolaryngology (1979), also adopted by AMA.³⁸ In general, hearing loss above 25 dB in the speech frequencies (500, 1000, 2000, and 3000 Hz) is categorized as both material impairment and handicap. Speech frequency pure-tone thresholds are calculated for each ear and then combined by a formula to create a binaural handicap value, or what AMA has now termed binaural hearing impairment. Compensation is based on pure-tone threshold determinations, but could be adjusted for accompanying tinnitus, pre-existing hearing loss, or effective hearing aid use.³⁸

PROFESSIONAL SUPERVISOR TRAINING AND QUALIFICATIONS

The professional supervisor carrying out the activities listed above must be either a physician or audiologist. Whereas, the term *physician*, as described by OSHA and when not elsewhere qualified within a standard, is an allopathic or osteopathic physician and may include a graduate from

a medical school or university listed in the World Directory of Medical Schools, who has achieved credential(s) granted by a Board of Medicine of the US Federation of State Medical Boards, and harbors the requisite training or competency to practice medicine.³⁹ While OSHA does not mandate specific professional supervisor training, it is evident that the required competencies involve both familiarity with supervision of audiometric testing, diagnosis of hearing disorders, exposure assessment, and work-relatedness determinations.

ACOEM believes that the functions of a professional supervisor in hearing conservation programs are part of the “core practice” of occupational medicine. ACOEM, therefore, recommends that occupational medicine training programs ensure that current trainees achieve competency in these areas, and that occupational medicine professionals in practice utilize continuing medical education programs as necessary to address these competencies. CAOHC has created a scope of practice document for professional supervisors⁴⁰ and a training course for physicians and audiologists leading to CAOHC certification as a Professional Supervisor of the Audiometric Component of Hearing Conservation Program (CPS/A). ACOEM has been a joint sponsor of this training at the annual American Occupational Health Conference.

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