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CLINICAL ASSESSMENT IN THE WORKPLACE

Occupational noise-induced hearing loss

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Occupational noise-induced hearing loss is, at least in theory, preventable. One way to assess the problem and whether preventative measures are effective is to assess employees' hearing. In order to minimize cost and time off work this can be carried out effectively in the workplace as long as certain conditions are met.

Key words: Assessment; occupational noise-induced hearing loss; work.

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INTRODUCTION

Occupational noise-induced hearing loss causes problems not only for the individuals concerned[1] but also for their families[2] and co-workers.[3,4] The OPCS disability survey (1985–88) suggested that 52,500 individuals in England and Wales are affected by occupational noise-induced hearing loss (see Jons, 1996[5]). Jons also quotes the 1990 labour force survey which claims that 103,000 workers have deafness, tinnitus or other ear conditions directly attributable to their employment and that a further 18,300 have a condition made worse by their work. A total of 13,000 workers received benefit for occupational noise-induced hearing loss in 1993.[5] This is the third most common assessed claim behind hand-arm vibration and tenosynovitis. This problem is not confined to Britain and a Europe-wide research project is just starting.[6]

ASSESSMENT

Clinical assessment of deafness should start with the taking of a history to try and define all possible causes of hearing loss. The history should include: medication; family history of hearing loss; general medical conditions; previous head injury; previous ear disease; exposure to leisure noise; and previous exposure to work-related noise (including the armed services). The expected extent of any hearing loss related to previous noise exposure can be calculated[7] and compared to the obtained results.

The history can be taken in a personal interview or by questionnaire. There is a case for taking a history only in those with abnormal hearing tests although some would argue that this should be done in every test. The immediate pre-test noise exposure should however be known in all cases.

Clinical assessment of hearing loss by questionnaires has been used in Scandinavia.[3,4] Using whispered voice tests and tuning forks is inaccurate and not easily quantifiable therefore the most usual work place assessment of hearing impairment is by audiometry. This is not new; Volvo have been performing pre-employment audiometry since at least 1955.[8]

The ears should be checked by otoscopy before testing. This is to look for wax, foreign bodies (including cotton wool and ear plugs), discharge and perforation of the tympanic membrane. The test should probably be postponed until any discharge is cleared to prevent cross infection and to allow any consequent hearing loss to improve. Wax and other foreign bodies need to be removed only if the meatus is obviously fully occluded or if there is any conductive element to the hearing loss. The test should be repeated after removal of the obstruction. Perforation of the tympanic membrane should be noted as a possible cause of any conductive loss.

There are three main types of audiometry available for use in the workplace: manual (either operator or computer controlled) and self-recording. The latter is also known as Bekesey Audiometry. Otoacoustic emission testing has been tried as a screening test in the workplace but has been found to be too inaccurate.[9] Perhaps in the future this will become more widespread. Testing is not without potential sources of error but most of these can be controlled by careful attention to calibration and technique. Calibration should be performed at least annually to ensure that the reading on the dial corresponds to the output at the earphone and vibrator. The equipment should also be checked on each day of use by an experienced tester to ensure

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accuracy. This checklist should include: cleaning of the earphones; checking thresholds against the tester's known thresholds to all frequencies in each ear; checking the subjective loudness of a 60dB tone in each ear; checking that both channels are equally loud at a given output setting; listening for distortion and feedback; ensuring that the tone switch or pen deflection is silent in operation; checking that the response signal is working.

Correct technique is also important for accuracy in operator controlled manual audiometry. The standard method is to increase the test tone in 5dB steps and to reduce it in 10dB steps.[10]

Masking of the non-test ear, where appropriate, is essential in all types of audiometry. In order to test the ears independently by bone conduction, masking is always required. When using air conduction masking is necessary if there is a difference between the ears of 40dB or more at the test frequency. Masking is also required if there is a difference 40dB or more between the air conduction threshold in the test ear and the bone conduction threshold in the non-test air at the frequency being tested. It is equally important that whoever is interpreting the results is aware of the need for masking and that the tester clearly notes whether masking has been used or not.

Once the above have been allowed for the main sources of potential error in the test are inaccurate headphone placement, the subject's own threshold uncertainty and the instructions given by the tester.[10–12] The instructions given probably affect the result more in self-recording and computer controlled tests but can have a significant effect in manual audiometry.[11] Subject uncertainty can be improved by use of trials before the test proper begins, and repeating one or two frequencies at the end of the procedure in the ear first tested will check accuracy.

The place and time of test can also affect results. Background noise can worsen low frequency thresholds and pre-test noise exposure can cause temporary threshold shift in the high frequencies. Because of this, workers should be tested at the beginning of a shift or within two hours of defended noise exposure, although a 48 h noise-free period is recommended by the DHSS on their assessment form for pension claims.

Despite the limitations discussed above, audiometry is largely reliable and repeatable[12] as long as correct techniques are used.[10,11] Robinson[12] studied test–retest variation over a two year period and found that 90% of tests were within 10dB except at 500Hz and 6kHz and that 50% were within 5dB. Repeatability was especially good at 1kHz and 2kHz. The average of thresholds at 1, 2 and 3kHz was within 10dB in 97% of cases and within 15dB in 'almost all'. He found that only one in 200 self recorded audiograms gave anomalous results and even then these were usually restricted to one frequency.

Having obtained an audiogram what happens next? Clinically the audiogram can be classified into one of five categories. Three of these require referral to a doctor, one suggests that the worker be warned about the need to protect hearing and one is a normal test[13] (see Appendix). Normality of the audiogram can also be assessed by comparison with published tables of normal thresholds related to age.[14–17]

Audiograms are also used to assess hearing handicap in claims assessment. The British Association of Otolaryngologists use the average threshold at 1, 2, and 3kHz. This average is compared to published tables to obtain a percentage handicap score.[13] Using this method the DHSS threshold for payment of a pension for occupational noise-induced hearing loss is 20% which equates to an average of 50dB in the best ear. For other medico-legal work more complex assessments are used[7, 18,19] but these are beyond the scope of this article.

Finally whenever audiometry is performed the tester (and the person interpreting the results if different) must always be aware of the possibility of a spurious result. This can be due to testing inaccuracies as discussed above but may be due to exaggeration of the extent of any hearing loss. This may or may not be deliberate but it is most common in those seeking compensation for occupational noise-induced hearing impairment. The main way to detect this is to be suspicious that it might be a factor in all tests. Objective testing by evoked response audiometry is obviously not possible in the workplace but it may be possible to confirm that the test is inaccurate at the initial testing and to recommend further testing elsewhere.

Retesting the first frequency at the end of the test should produce identical results. When using manual audiometry, by watching the way in which the subject responds, it is sometimes possible to see that a sound has been heard but no response given. Another easy test is to compare ascending and descending thresholds. The result obtained by starting at -5dB and rising in 5dB steps should be within 5dB of the result obtained by starting at 90dB and reducing by 10dB steps. When performing self-recording audiometry it is possible to compare the threshold obtained by using continuous rather than pulsed tones. If the pulsed is less sensitive by 10dB or more the thresholds were inaccurate. The tester can use the 10 or 20dB step button or manually override the system to return the signal to 0dB. In both situations the trace should quickly return to its previous level.

CONCLUSION

Clinical assessment of deafness in the workplace by audiometry is feasible. There are a variety of methods available and as long as meticulous attention to detail is observed, accurate results are possible. The tester and any other person involved in interpreting results should be aware of the need for masking and the possibility of spurious results.

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APPENDIX

Categorization of audiograms

Category 1 Deterioration in hearing level since last test. REFER TO DOCTOR.
2 Significant difference between hearing levels in right and left ears. REFER TO DOCTOR.
3 Hearing level considerably worse than is to be expected, taking into account the worker's age. REFER TO DOCTOR.
4 Hearing level slightly worse than is to be expected, taking into account the worker's age. WARN WORKER of the need to protect hearing.
5 Not falling into categories 1–4 *i.e.*, normal. NO ACTION

To categorize an audiogram you need to calculate the sum of the low frequencies (0.5, 1 and 2kHz) and the high frequencies (3, 4, and 6kHz) for each ear.
This gives four totals.

Category 1 If any total has increased by 30dB or more (45dB if the test was more than 3 years ago).
2 If the difference between the low frequency total for each ear is more than 45dB, OR if the high frequency difference is more than 60dB.

Categories 3 and 4:

	Warning Cat 4		*Refer Cat 5*	
Age	*Low frequency*	*High frequency*	*Low frequency*	*High frequency*
20–24	45	45	60	75
25–29	45	45	66	87
30–34	45	45	72	99
35–39	48	54	78	111
40–44	51	60	84	123
45–49	54	66	90	135
50–54	57	75	90	144
55–59	60	87	90	144
60–64	65	100	90	144
> 64	70	115	90	144

Note that an audiogram might fit more than one category