ACTA SCIENTIFIC OTOLARYNGOLOGY (ISSN: 2582-5550)

Volume 2 Issue 10 October 2020

Research Article

The Medicolegal Assessment of Noise Induced Hearing Loss Avoiding an ENT Face to Face Exam in the COVID 19 Climate

Sylvester Fernandes[1]* and Ryelen Fernandes[2]

[1]*Department of Health Sciences, Newcastle University, Newcastle, Australia*

[2]*Newcastle University, Newcastle, Australia*

***Corresponding Author:** Sylvester Fernandes, Department of Health Sciences, Newcastle University, Newcastle, Australia.

Received: June 23, 2020

Published: September 24, 2020

Abstract

Background: In the current COVID-19 climate, a face to face (F2F) ear nose and throat examination is not possible. ENTs are among the highest risk specialties for the infection. The majority of physicians involved in medicolegal examinations lie in the vulnerable status. Some claimants may need early access to funds in the current situation. Methodology is provided to invoke the available epidemiological data to inform insurance payment decisions.

Methods: Predictions of ISO (2013) for noise-induced threshold shifts can be used in calculating the noise-induced threshold shifts. The 90 percentile figures are used. Methodology for Australia is detailed. Other jurisdictions can modify the methodology as appropriate.

Results: The possibility of a mathematical model is highlighted.

Conclusions: Given a worker's occupational noise exposure history, the methodology can estimate the expected contributions of noise and can replace the audio-clinical examination entirely.

Keywords: Noise-Induced Hearing Loss (NIHL); COVID-19

Introduction

The COVID-19 crisis has thrown the ENT face to face (F2F) examination in confusion and an end is not in sight. However, the medicolegal assessment of noise induced hearing loss (NIHL) may be amenable to be pursued under such circumstances by the method suggested herein.

Substantial noise exposure is the sine qua non in the diagnosis of noise induced hearing loss (NIHL). It is worth noting that most noise in industries [1] lies in the range of 85 - 95 dB(A), with some industries having noise exposures up to 100 dB(A) and very few occupations being exposed in excess of this level.. Exposures above 140 dB Lpeak is, however, very rare in industry. It is, however, very common in the military and in sports shooters. In this methodology, the role of impact/impulse noise is ignored. Exposure to organic solvents (toluene, xylene, styrene) may have a synergistic effect. It is not necessary or possible to differentiate between noise and the chemical contributions, as the employer's scope of liability extends to include both in regard to the hearing loss.

As a result of this current need, any available data at exposures of 85, 90, 95 and 100 dB(A) is convenient.

If such noise exposure can be historically documented even by exploiting the trends in teletechnology, a path may be available to calculate the NIHL.

The medicolegal assessment of noise induced hearing loss has evolved over several decades. Several dictums both medical and legal are now in place. In usual circumstances clinical examination particularly to rule out competing diagnoses and complications is mandatory. Further, the type of hearing impairment (sensorineural), shape of the audiogram to note the presence of a dip or "bulge" around 4 kHz, the range of frequencies affected by the hearing loss etc. have all to be considered in a F2F exam. This is not available under the present circumstances.

Unless statute imposed, it appears that negligence law does not allow the application of “a whole to an individual” strategy [2]. However, the occurrence of hearing loss at a definite rate in relation to exposure (immission) levels is a well established trans-global causation fact. The fact of its occurrence is not related to any racial or cultural or subgroup factors. Variations in degree of loss will be accounted for in the method suggested herein. In other words, the epidemiological data provided by ISO 1999 tables [3] are definitive and universal.

Incidentally, logic and common sense reasoning allows a “whole to an individual” strategy and this is actually the entire basis of our deductive reasoning.

In negligence law, in this matter, the claimant must establish that, not just persons in general can be affected to the degree contended for, but that his own degree of NIHL was, more probably than not, affected to the degree that the data suggest. If it is more (than the 90th percentiles), than he has to bear the burden of proof. If the respondent contends it is less, than the respondent has to bear the burden. With the inclusion of the 90th percentiles as suggested herein, in the present circumstances the epidemiological data may overcome this hurdle and hence may be acceptable to all the stake holders. After all when we make deductions for presbycusis (age related hearing loss) we use exactly this same methodology (epidemiological data) but then it is statute imposed in presbycusis.

Again, if it is acceptable to all the stake holders then effectively there is no dispute and the matter can be settled. Hence it is most important to ensure this agreement amongst all stake holders.

It is proposed here that the ISO 1999: 2013 Means for Noise Induced Permanent Threshold Shifts, 85, 90, 95, 100dB(A) and NAL (Australia) Tables [4] may be considered for Australia. The two NAL tables (1974 and 1988) for Australia show roughly parallel changes. Other nations can employ local similar documents to substitute for the latter document, as appropriate.

The development of a mathematical model for use in calculating %NIHL was prompted by visual inspection of the ISO 1999: 2013 Means and NAL (Australia) Tables [4] plots indicating the possibility of a relatively uncomplicated trend. This is discussed below.

Methods

ISO 1999, as published in 1990 and revised in 2013, includes a model for predicting hearing thresholds for populations of workers from the 10th to the 90th percentiles. Since most noise-exposed workers are men, only men are considered in this initial study. In the current methodology, the 90th percentiles are also preferable particularly if one wants to err on the side of a noise contribution that is high, rather than one that is low. Thus, understanding that the purpose of this intervention is essentially not to disadvantage the worker, the 90th percentiles is chosen here. Also thus, the variation in degree of loss related to racial variation is catered for. However, if there is a very good reason to believe that a worker is much less susceptible to NIHL then it may be reasonable to resort to the lesser percentiles.

Also certain legal precedents allow for the situation to be in favour of the employee i.e. the apportionment of impairment rule, which states that damages for hearing impairment should be apportioned or attributed to only that part of the hearing loss which is occupationally related, and since this is often a difficult if not impossible task, many commissions and agencies tend to assign a major portion or all of the damage claim to the employer. In other words, the 90th percentiles is again more acceptable.

And finally in accepting the 90th percentiles, “a fair and equitable” result is assured.

The database suggested in the recommended ISO 1999: 2013 Means for Noise Induced Permanent Threshold Shifts does not consider age related loss.

It is also advisable to ignore the age factor as this factor is already ingrained in the document as pointed out in the observations made by Dobie [5] on a similar technique with statements such as, “For each exposure level, more than 60% of the 40- year NIPTS is present after only 10 years”, “NIHL progresses with a decelerating trajectory”. Dobie also suggests that the work-relatedness analysis should be based on the actual threshold shifts, without age correction.

No use of hearing protection devices (HPDs) is assumed for simplicity. This may not matter as even on a practical level, for behavioural and other reasons, HPDs are often much less effective than the ideal figures suggested by the laboratory tests of manufacturers, often reducing the noise exposure by much less than the 20-30 dB values often quoted and sometimes in the region of 2 - 3 dB(A).

As mentioned above the ISO 1999:2013 tables provide a mean noise induced permanent threshold shift in dB at each frequency for workers exposed to various noise levels of 85, 90, 95 and 100 dB(A) at percentiles of 10, 50 and 90. We will utilise the 90th percentiles for reasons provided above.

The NAL 1988 tables are then applied to the threshold shifts on the ISO 1999:2013 tables to provide a percentage Binaural Hearing Loss (BHI%) at each frequency and utilising 18dB as 0% BHI at each frequency to give a resultant binaural hearing loss in dB at each frequency. By adding together, the separate BHI% at each frequency the total BHI% is obtained. Graphs can then be drawn by plotting y = the total BHI% against x = the years of exposure for noise of various loudness. Knowing a claimants duration of exposure and the exposure noise level, a percentage Binaural Hearing Loss (BHI%) is polated from the graph.

Such a calculation for 100 dB(A) over 40 years yields a WPI of 22% according to the NSW Workcover Guides [6].

Incidentally, the Position Statement on Noise induced Hearing Loss. American College of Occupational and Environmental Medicine (ACOEM) 2002; states, "Noise exposure alone usually does not produce a loss greater than 75 decibels (dB) in high frequencies, and 40 dB in lower frequencies. However, individuals with superimposed age-related losses may have hearing threshold levels in excess of these values". Although individual variation due to factors such as diabetes, hypertension, cigarette smoking etc. can be contributory, such is already ingrained in the above samples. Therefore, assuming that any individual has been exposed to chronic noise greater than 85dB the maximum loss that this ACOEM calculation yields is WPI 21%.

Thus, from both these separate documents employed in the calculations above, it appears that the maximum WPI obtainable from nonimpulse/impact noise in industry lies under WPI 25%!

Results

By employing the 90th percentiles for a 100dB noise exposure values obtained from the ISO 1999 - 2013 Means 1988 NAL Tables for binaural hearing loss and squaring the values, it was possible to obtain a perfectly ($R^2 = 0.9998$) matched polynomial regression equation.

The regression equation obtained for 100dB exposure is expressed as:

% Hearing loss = $\sqrt{(-0.104x^2 + 21.004x)}$ where x = years of exposure.

Encouraged by this result we proceeded further utilising polynomial and exponential regression equations, applied to both the original data, and squared and exponential functions of the original data. All regressions with R^2 values over 0.90 were plotted alongside the NIHL data points provided to examine longer term behaviour. Attempted regressions at 90 and 95 dB levels were less straightforward and did not yield a satisfactorily fitting equation, suggesting further investigation.

The best-fit curves for 100dB can be seen in figure 1 below as the black line fitting the green data points precisely.

Figure 1: The best-fit curves for 100dB.

Discussion

A "more likely than not" presumption of work-relatedness is initially obtained by perusing the work history and the materiality of other possible contributory causative factors. In the presence of other complicating factors, its exact temporal occurrence must be deciphered in relation to the NIHL, as the "egg shell" rule may be applicable. If the contributory loss post-dated the NIHL loss then it cannot be ignored and must be considered as the NIHL component does not deteriorate after cessation of noise exposure at work (See 2002 American College of Occupational and Environmental Medicine).

If there is a definite co-existing complicating factor and the moiety of the complicating factor is assessable, then it may be deducted after ascribing adequate reasons. If the moiety of the complicating factor is not assessable then it should be ignored with such mention in the report.

These data statistics go only up to 40 years. It appears that subsequent noise exposure (if extrapolated) will show a plateauing tendency in the losses toward exposures beyond 40 years and although data for beyond 40 years is not available, it may be possible to extrapolate such mathematically with a very high degree of certainty. Considering that noise damage is cumulative and the increments in the magnitude of hearing loss grow at an increasingly slow rate with further exposures, this will eventually reach a limiting value of near zero for such increases. Still further exposures will eventually exhibit zero increases. In other words this means there nothing further to lose. As Dobie [5] states, "The basic concept is that when most of a person's hearing has already been lost, there is less to lose".

Other benefits provided by this method include the exclusion of the problem of dealing with excessively high thresholds as in hyperacusis/malingering, asymmetric hearing loss in confirming unilateral correctness, calculating earlier losses sequentially and the presence of tinnitus interfering with accurate hearing thresholds.

Other material benefits to the insurer may include savings in the costs of travel and accommodation of claimants, the costs incurred in providing relevant experts and/or other reports.

As may be evident, the accuracy of the method is not full proof in every single case, but then in any dispute resolution, which method is?

As a further application, often when a claimant has worked in separate jurisdictions a calculation of earlier losses is requested and relevant interim audiograms are not available. Under these circumstances, it is often argued (incorrectly) that hearing loss tends to linearity (in BHI terms) as the lesion expands through time. This, it is mentioned, is because there is a tendency to linearity (in BHI terms) as the lesion expands through time which is related to the cochlear noise lesion spreading temporally to progressively lower frequencies to which the NAL Table assigns higher values. As a result a linear result is provided in spite of the tendency to lose more hearing early.

This so called tendency to linearity in the long term exposure is a myth. Even so, the application of a linear solution to calculating an earlier exposure is a very gross fallacy (See below). Usually the required query demands a calculation for earlier and shorter periods of exposure when only the higher frequencies of 2, 3 and 4 KHz may be affected (towards which the NAL tables are also not weighted). Hence ascribing linearity for these intervals is ill informed. Only the ISO calculations as above can provide the requisite (scientific) methodology in these circumstances in our current state of knowledge.

Consider a 400m athlete who runs the first 100m in record time to gain a lead and then decelerates for the next 300. If it is requested that his speed in the first 100m be calculated, surely, his eventual time at 400m divided by 4 will not provide an answer! Weighting the latter 300m will provide a very false result!

The question of hearing aids: In Australia, in employing this methodology hearing aids may be recommended when the WPI lies at or above 6%. Hearing aids are not reasonably necessary when the WPI is less than or equal to 4%. Between 4 and 6% a recommendation for a 30 day trial of hearing aids may be valid [7].

Conclusion

Thus, a method of dealing with NIHL medicolegally under the current COVID-19 crisis is outlined. With this approach if a dispute still prevails, the burden of solutions would eventually be placed upon the courts, which would develop a series of legal precedents over a period of time if the virus persists. Also, any errors in compensation payments may be available for correction when and if a reapplication is made in the future under more stable conditions.

From this initial enquiry, it is possible to obtain a rudimentary mathematical model to determine %NIHL at 100dB from squared noise exposure information using a quadratic regression from the ISO 1999 - 2013 Means 1988 NAL values for binaural hearing loss. While this may support the non F2F medico-legal assessment to proceed, it is recommended a more comprehensive model be developed using a combination of terms obtained from multiple regression equations, or from surface fitting mathematical tools.

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