Occupational Hearing Loss

Evaluation of Noise Induced Hearing Loss and Presbycusis Using Internet-Based Software

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Lecture Sections

- Noise Induced Hearing Loss
- Presbycusis: Definitions and Measurement
- Hearing Handicap
 Determination & Medical Legal
 Concerns
- Client Evaluation



Noise Induced Hearing Loss - Characteristics

- Sensory hearing loss with loss of discrimination commensurate with the loss in hearing.
- Maximum in the high frequencies sometimes with a 4000 Hz Notch.
- ◆ 23% will have tinnitus (Phoon WH, 1983)
- Vertigo is not present



Noise Induced Hearing Loss - Characteristics

 After 10 years of exposure, the damage caused by noise remains constant, but presbycusis progresses as predicted.

Passchier-Vermeer, W *Hearing Loss due to Exposure to Steady-State Broadband Noise*. IG-TNO report no. 35. Delft, The Netherlands: Research Institute for Public Health Engineering, Sound and Light Division (1968)

McCrae JH, Noise-induced hearing loss and presbyacusis. Audiology 10:323-333,1971.



Noise Induced Hearing Loss - Noise Levels

 Individuals have different susceptibilities to noise. (Kyong-Myong Chon, 1996)

- Noise levels are measured in dB SPL on the A Scale.
- Impulse Noise is more damaging than a constant noise.



Two Different Recommended Maximum Exposure Levels

♦ OSHA

- 25% chance of developing NIHL with a 40-year lifetime exposure

♦ NIOSH

- 8% chance of developing NIHL with a 40-year lifetime exposure



Two Different Recommended Maximum Exposure Levels

• OSHA Maximum Exposure = $16 / ((dB - 85) / 5)^2$

• NIOSH Maximum Exposure = $16 / ((dB - 82) / 3)^2$



Noise Levels

Duration of	Sound Level dB(A)						
Exposure (hrs/day)	ACGIH	NIOSH	OSHA				
16	82	82	85				
8	85	85	90				
4	88	88	95				
2	91	91	100				
1.4	94	94	105				
1/2	97	97	110				
1/4	100	100	115*				
1/8	103	103					
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Noise Induced Hearing Loss - Levels of Environmental Sounds

SourceDangerous Level	dBA SPL
Produces Pain	140-150
Jet Aircraft During Takeoff (at 20 meters)	130
Discomfort Level Snowmobile Tractor Without Cab	120
Rock Concert	110
Die Forging Hammer Gas Weed-Wacker Chain Saw Pneumatic Drill	100-105
Home Lawn Mowers	95 to 100 dB
Semi-trailers (at 20 meters)	90



Noise Induced Hearing Loss - Levels of Environmental Sounds

Source—Safe Levels	dBA SPL
Heavy Traffic	80
Automobile (at 20 meters)	70
Vacuum Cleaner	65
Conversational Speech (at 1 meter)	60
Quiet Business Office	50
Residential Area at Night	40
Whisper, Rustle of Leaves	20
Rustle of Leaves	10
Threshold of Audibility	-0-



Presbycusis

- Pure Presbycusis refers to the hearing loss which occurs with physiological aging. Schuknecht divided "Pure Presbycusis" into sensory, neural, strial (metabolic) and cochlear conductive
- Nosocusis refers to hearing loss caused by other factors than noise and pure presbycusis (aging).
- Sociocusis non-work related noise induced hearing loss.



Presbycusis

- Accounting for presbycusis is not mandatory but it is often done in the legal setting. What is actually sought is to account for non-occupational hearing loss. Seven states allow deductions for presbycusis.
- Or to answer the question: Is the progression of hearing loss in the worker more than which can be expected from non-occupational hearing loss?



Presbycusis

- NIOSH does NOT recommend accounting for presbycusis when looking for Medical Causation of a progressive hearing loss. If a worker has a progressive hearing loss it is assumed to be due to noise trauma and corrective measures should be taken.
- However, estimation of presbycusis is used for compensation purposes. The test for compensation is whether the hearing loss is medically more likely than not caused by noise exposure.



Presbycusis --Sex Difference

- Several researchers have studied primitive cultures to determine the influence of aging on hearing acuity in the absence of occupational noise. These studies found aging effects on hearing, but observed no sex difference in the hearing loss. Goycoolea MV, 1986; Rosen S, 1962
- Animal studies have also found no sex difference. Hunter KP, 1987
- It has been proposed that the difference between male and female thresholds as a function of age, is due to environmental factors. The most important of which is noise exposure. Kryter KD, 1983



Presbycusis --Sex Difference

 However, Spoor's Equations (1967) and Robinson Sutton's (1979) Data in ISO-1999 Annex A were derived from populations screened for noise induced hearing loss and there is still a marked difference between the sexes. Rosenhall (1990) also found a gender difference when noise exposure was compensated for.



Presbycusis --Measurement

- Robinson Sutton's Equations: These equations were derived by combining a number of studies and are adopted for the values in ISO-1999 Annex A
- Spoor's Equations: Combined data from 8 different studies. Spoor accounted and controlled for noise in the derivations of his equations.
- OSHA (Occupational Safety and Health Administration) has published correction values for aging. These values will correct threshold frequencies of 1000 Hz to 6000 Hz. Since no values are given for 500 Hz, this method can only be used with the NIOSH and Wisconsin equations.

Handicap Equations

Determination of a hearing impairment from an audiogram is performed by one of the predefined equations.

The equation selected is often dictated by statue, not by medical opinion.

Handicap Equations

Formula	Frequencies (Hz)	Low Fence (dB)	High Fence (dB)	Better Ear Ratio
AAO 1979	500, 1000, 2000, 3000	25	92	5:1
AAOO 1959	500, 1000, 2000	25	92	5:1
NIOSH-FECA 1972	1000, 2000, 3000	25	92	5:1
NIOSH-1997	1000, 2000, 3000, 4000	25	92	5:1
British Society of Audiology	500, 1000, 2000, 4000	25	92	5:1
Wisconsin (CHABA)	1000, 2000, 3000	35	92	4:1
Oregon	500, 1000, 2000, 4000, 6000	25	92	5:1
Ireland	500, 1000, 2000, 4000	20	100	4:1

Handicap Equations - NIOSH 1997

- Uses 1000, 2000, 3000, and 4000 Hz.
- The equation was first proposed for detecting the early effects of noise on inner ear function.
- It is now used by the Federal Government for compensation purposes.
- Dobie, fells that this is not the best equation to use, since the mean frequency of speech recognition is 1600 Hz. The best representative frequencies are 500, 1000, 2000, & 4000 Hz (Dobie RA, 1998)

Handicap Equations

- Employers will argue for the use of the AAOO-1959 Equation.
- Plaintiffs will argue for the use of the NIOSH-1997 Equation.
- A good compromise is the AAO-1972 Equation.

Handicap Equations Widely Different Results

Audiogram from a 60 yr old white male.

Frequency	250	500	1000	2000	3000	4000	6000	8000
Right Ear (dB)	10	15	20	25	45	65	50	70
Left Ear (dB)	10	20	20	25	35	60	45	50

Now go to the master calculator and compare the handicap results calculated from different equations.

http://www.occupationalhearingloss.com/master_calculator.htm

Handicap Equations Presbycusis used to Mitigate Damages

The percentage of handicap due to presbycusis is often determined by ISO-1999 Annex A (Robinson Sutton's Data). It is assumed that presbycusis and noise trauma are additive but one can argue in severe hearing losses that this is not true. However, legally this is a mute point. Since, either the two are additive and the percentage of presbycusis is predicted by Robinson Sutton's Equations or if they are not additive then some of the noise trauma prevented some presbycusis from taking place, or visa versa. Thus, this percentage of noise trauma caused no harm and therefore would still not be compensatible.

Handicap Equations Presbycusis used to Project Hearing Loss

- It is assumed with all of the calculators that hearing loss due to noise and presbycusis are additive.
- ISO 1999 compression factor is applied when projecting audiometric data.
 - Hearing Loss = ARL + NIL (ARL * NIL)/120

ARL: Age Related Loss, NIL: Noise Induced Loss

Handicap Equations Presbycusis used to Project Hearing Loss

- Answer the Question: Is the hearing loss in the patient's employment exit audiogram greater than that expected from the effects of aging on the pre-employment audiogram?
- Remember the test is "medically more likely than not." In other words: Your opinion has a greater than 50% chance of being correct.

Total Body Handicap

Finally, the client's hearing handicap is used to determine the "Total Body Handicap."

AMA Guide to Permanent Impairment, 4th ed.

A 100% hearing handicap will have a total body handicap of 35%.



Plaintiff Evaluation -History is very important

- \checkmark Other ear diseases can cause a hearing loss.
- ✓ Other associated systemic diseases which can cause a hearing loss.
- ✓ Other exposure to noise trauma. This is very important because noise exposure's effects on the inner ear are finite and will cause no further damage after approximately 10 years. Thus, it could be argued that the plaintiff's occupational exposure to noise caused no harm because of his home/recreational exposure.



- Other ear diseases can cause a hearing loss

Vertigo

- Endolymphatic Hydrops
- Perilymph Fistula
- ✓ Dizziness
- ✓ Eustachian Tube Dysfunction
- ✓ Tympanic Membrane Perforation
- ✓ Ossicular Fixation or Discontinuity



- Other systemic diseases which are associated with hearing loss (nosocusis)

Vascular Disease ✓ Diabetes ✓ Heart Disease ✓ Smoking ✓ Hyperlipidemia

 ✓ Ototoxic Drug Use
 ✓ Otologic Ear Infections
 ✓ Meningitis

- ✓ Head Trauma
- ✓ Alcohol Usage

Rosenhall U, Penderson KE Presbycusis and Occupational Hearing Loss Occup Med 10(3):593-607,1995



- Other exposure to noise trauma (Sociocusis)

 Hunting. Kryter KD, 1991 found that 69% of 9800 railroad workers used guns. Most have an asymmetrical hearing loss. (Job A, Grateau P, Picard J, 1998)

✓ Home machinery – Lawn mowers, weed trimmers, etc.

✓ Chain saws

Loud Music, Rock Concerts
 (Yassi A et al Canadian Family Physician, 1993)



- Physical Examination

✓ Examination of the ear
✓ Tuning fork and whispered voices
✓ Full ENT examination



Plaintiff Evaluation - Audiological Examination

No exposure to noise for 24 hrs.
Air & Bone Conduction
Speech Reception Thresholds
Speech Discrimination
If unilateral – Stenger Testing
Tympanometry



Calculation of Hearing Handicap and Presbycusis

Compare the post-employment audiogram with the pre-employment audiogram. Is the sensorineural loss in excess of what would be normally predicted by presbycusis?

Pre-employment: 30 yr old white male

Frequency	250	500	1000	2000	3000	4000	6000	8000
Right Ear (dB)	10	15	20	25	45	65	50	70
Left Ear (dB)	10	20	20	25	35	60	45	50

Post-employment: 65 yr old white male

Frequency	250	500	1000	2000	3000	4000	6000	8000
Right Ear (dB)	15	20	25	35	60	80	70	90
Left Ear (dB)	15	25	25	35	50	75	70	80

http://www.occupationalhearingloss.com/master_calculator.htm