

Medico-Legal Decision Making in NIHL-Related Tinnitus

P.H. Dejonckere

*Federal Institute of Occupational Diseases, Brussels,
Dept. of Neurosciences, Katholieke Universiteit Leuven,
Belgium*

1. Introduction

In clinical practice, tinnitus is a quite common symptom in patients with chronic acoustic trauma, and noise-induced hearing loss (NIHL). A review of the current state of knowledge on tinnitus in relation to noise exposure and hearing loss has been recently (Poole, 2010) published by the UK Health & Safety Executive. 252 publications were reviewed. The prevalence of tinnitus in populations exposed to noise at work is reported to be between 5,9% and 87,5%. Factors such as the type of subjects (e.g. health surveillance, compensation claimant), the characteristics of the noise exposure and the definition of tinnitus used apparently contribute to this variability. Several publications have shown that the prevalence of tinnitus in workers exposed to noise at work is significantly higher than in non-exposed workers. The majority of the published papers support the idea that there is an association between tinnitus and noise-induced hearing loss: the prevalence of tinnitus in workers with NIHL appears to be higher, and the workers with tinnitus have more severe NIHL.

In a medico-legal context, tinnitus is mostly a subsidiary item of claim, additional to that for noise-induced hearing loss. However, tinnitus may also be the principal or only complaint, e.g. in patients with a specific and selective noise-induced dip on 4 KHz but without obvious repercussion on their social hearing. Further, as in some cases tinnitus may cause devastating (and objectivable) effects on lifestyle and ability to work, it may attract higher levels of compensation than hearing loss (Coles, 2000).

In such a medico-legal situation, when e.g. the patient claims compensation for an occupational disease, potential financial advantage may be a strong motivation for feigning or exaggeration. The essentially subjective nature of tinnitus renders it very difficult to make – at least in some patients - equitable medico-legal decision about presence and severity of tinnitus. This implies that assessment needs to involve a large set of parameters, combining subjective with objective items (Nieschalk & Stoll, 2002).

The proposed method for medicolegally evaluating tinnitus in context of NIHL is based on a rational, echeloned progression in decision making: at each step, a quite large number of elementary (cellular) decisions, easy to make and reproducible among different experts, leads to the higher decision level. Four of such levels are worked out and formulated, with respectively 65, 12, 4 and 1 decisions. The final decision is then: accept or reject the tinnitus as a true component of the occupational disorder (noise-induced cochlear damage).

Directly related to this decision is the determination of the % of disability / impairment which may be attributed for this tinnitus component. The main purposes are to reach an optimal consistency among experts in these decisions, and to offer optimal transparency in case of litigation. The final aim is maximal equity.

However, the proposed system is not intended for being more than a methodological support. Adequate decision making, even at elementary level, requires from the expert / evaluator an exhaustive and encyclopedic knowledge of otoneurology.

2. The decision making system

(Dejonckere & Lebacqz, 2005)

The four decision levels are structured as follows (Fig. 1):

Level 4

- 4.1. Final decision: Accept or reject.
- 4.2. If tinnitus is accepted, how much % impairment / invalidity ?

Level 3 (4 decisions)

- 3.1. Is the patient reliable ?
- 3.2. Besides the tinnitus, does the patient also demonstrate an occupational hearing loss ?
- 3.3. Is there a link between tinnitus and occupational hearing loss ?
- 3.4. Is the tinnitus disabling, and if so, to what extent ?

A positive decision about all four of these essential aspects is requested for acknowledging the tinnitus as a part of the occupational disease, and providing compensation.

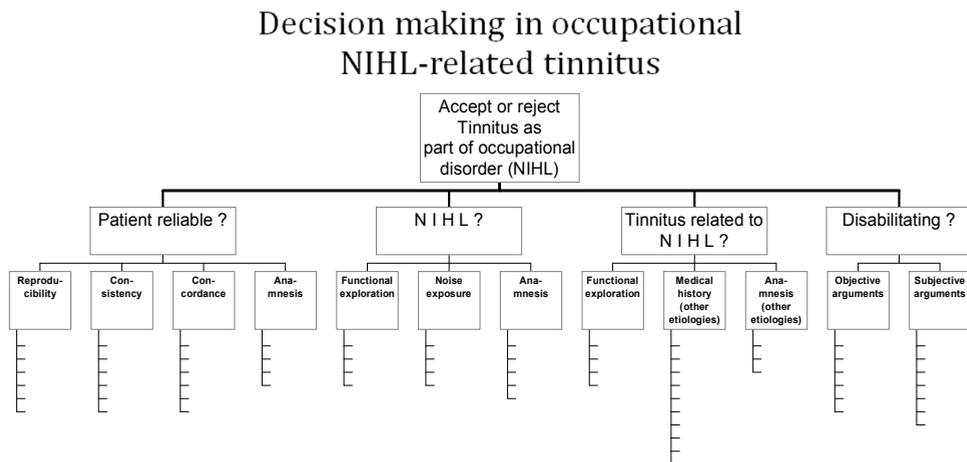


Fig. 1. Diagram showing the 4 levels of decision making, with respectively 65, 12, 4 and 1 decisions.

Level 2 (12 decisions)

As a general rule, possible answers are:

“Affirmative”: in agreement, evident, compatible, plausible, concordant.

“Neutral”: dubious, only partially in agreement, unclear, non evident, or non relevant item, or information lacking.

“Negative”: not in agreement, incompatible, discordant, unrealistic, unacceptable.

In case of one or more “non-affirmative” responses, the expert needs to make a weighing in order to come to a final positive or negative decision for each question of the level 3.

Decisions at level 2 pertaining to 3.1. Is the patient reliable ?

- 2.1. Are measurements based on patient’s responses reproducible ?
- 2.2. Are different approaches of a same physiological phenomenon consistent ?
- 2.3. Are subjective data concordant with objective data ?
- 2.4. Are the anamnestic data compatible with the (psycho-)physiological data ?

Decisions at level 2 pertaining to 3.2.: Besides the tinnitus, does the patient also demonstrate an occupational hearing loss ?

- 2.5. Does the hearing loss show the characteristics of NIHL at functional hearing assessment ?
- 2.6. Has the patient actually been exposed to harmful occupational noise ?
- 2.7. Is the anamnesis and is the history of complaints suggestive for progressive occupational hearing loss ?

Decisions at level 2 pertaining to 3.3.: Is there a link between tinnitus and occupational hearing loss ?

- 2.8. Does the functional assessment of tinnitus (tinnitometry) suggest the etiology of cochlear noise damage ?
- 2.9. Does the medical history demonstrate compatibility of tinnitus with the etiology of cochlear noise damage ?
- 2.10. Is the anamnesis and is the history of complaints suggestive for tinnitus related to progressive occupational hearing loss ?

Decisions at level 2 pertaining to 3.4.: Is the tinnitus disabling, and if so, to what extent ?

- 2.11. Are there convincing objective elements ?
- 2.12. Are there convincing subjective elements ?

Level 1 (65 decisions)

As a general rule, as for level 2, the possible answers are:

“Affirmative”: in agreement, evident, compatible, plausible, concordant.

“Neutral”: dubious, only partially in agreement, unclear, non evident, or non relevant item, or information lacking

“Negative”: not in agreement, incompatible, discordant, unrealistic, unacceptable.

Ad 2.1. Are measurements based on patient’s responses reproducible ?

Reproducibility of psycho-acoustic data

1.1.& 1.2. tone thresholds

- within one session
- over time

1.3 & 1.4. speech thresholds

- within one session
- over time

1.5 & 1.6. tinnitus identification (tinnitometry)

- within one session
- over time

Ad 2.2. Are different approaches of a same physiological phenomenon consistent ?

- 1.7. tone / speech audiometry
- 1.8. recruitment assessment
- 1.9. conventional thresholds / von Békésy thresholds
- 1.10. prosthetic tone thresholds
- 1.11. prosthetic speech intelligibility curves
- 1.12. masking tests

Ad 2.3. Are subjective data concordant with objective data ?

- 1.13. clinical examination
- 1.14. impedance measurements / stapedius reflexes
- 1.15. oto-acoustic emissions: SOAE (spontaneous otoacoustic emissions) - TEOAE (transient evoked oto-acoustic emissions)
- 1.16. otoacoustic emissions: DPOAE (distortion products otoacoustic emissions)
- 1.17. BERA (brainstem evoked response audiometry)
- 1.18. CERA (cortical evoked response audiometry)

Ad 2.4. Are the anamnestic data compatible with the (psycho-)physiological data ?

- 1.19. tinnitus mentioned already in medical documents prior to context of claim for compensation
- 1.20. tinnitus mentioned at medical exam for occupational health and safety
- 1.21. tinnitus mentioned from the 1st contact with the insurance organism
- 1.22. evidence for therapeutic seek / therapy trial(s)

Ad 2.5. Does the hearing loss show the characteristics of NIHL at functional hearing assessment ?

- 1.23. type of hearing loss
- 1.24. severity
- 1.25. symmetry
- 1.26. recruitment

Ad 2.6. Has the patient actually been exposed to dangerous occupational noise ?

- 1.27. type of exposure
- 1.28. duration of exposure
- 1.29. SPL levels
- 1.30. individual technical protection

Ad 2.7. Is the anamnesis and is the history of complaints suggestive for progressive occupational hearing loss ?

- 1.31. type of hearing complaints
- 1.32. time history of complaints
- 1.33. use of protection devices
- 1.34. use of hearing aids (at work ?, in private life ?)
- 1.35. use of masking devices for tinnitus

Ad 2.8. Does the functional assessment of tinnitus (tinnitometry) suggest the etiology of cochlear noise damage ?

- 1.36. pitch matching
- 1.37. masking possibility and minimal masking level
- 1.38. loudness matching
- 1.39. specific characteristics: pulsatile, bitonal...

Ad 2.9. Does the medical history demonstrate compatibility of tinnitus with the etiology of cochlear noise damage ?

- 1.40. middle ear pathology / surgery
- 1.41. trauma capitis
- 1.42. acute acoustic trauma
- 1.43. inner ear pathology, dizziness, vertigo, fluctuating hearing loss, Ménière, sudden deafness
- 1.44. eighth nerve pathology, schwannoma
- 1.45. pharmacology
- 1.46. poisoning , intoxication
- 1.47. vascular pathology, hypertension
- 1.48. neurologic pathology, polyneuropathy, central nervous system disease
- 1.49. psychiatric pathology

Ad 2.10. Is the anamnesis and is the history of complaints suggestive for tinnitus related to progressive occupational hearing loss ?

- 1.50. history of tinnitus (onset)
- 1.51. relation to working activities, private life activities...
- 1.52. relief conditions

Ad 2.11. Are there convincing objective elements for the nature and severity of impairment / disability / handicap ?

- 1.53. presence / absence of proven therapeutic seek / demand (medical advice of one / several medical specialties... ; non-medical treatments)
- 1.54. trial of pharmacological treatment(s)
- 1.55. personal purchase of physical devices (as e.g. tinnitus maskers)
- 1.56. consultation of a neuro-psychiatrist
- 1.57. psychiatric treatment
- 1.58. psychiatric hospital admission

Ad 2.12. Are there convincing subjective elements for the nature and severity of impairment / disability / handicap ?

- 1.59. changes in daily life (ceasing specific activities, hobbies)
- 1.60. sleeping troubles, use of hypnotic drugs
- 1.61. avoiding specific eliciting or aggravating circumstances
- 1.62. behavioral changes: irritableness
- 1.63. neurovegetative symptoms, headache
- 1.64. influence on mood
- 1.65. depression, tendency to suicide
(all these to be confronted with objective elements)

3. Interrater reliability

In order to check for agreement between different experts of first level decisions, as well as for concordance in higher level decisions, ten exemplary files were selected within the patient material of the Institute of Occupational Disorders. All were examined by four different medical specialists (oto-rhino-laryngologists) all interested in legal and forensic medicine. They had to make their decision according to the pathway proposed in the protocol. A variant of Cohen's Kappa (Fleiss, 1981) was applied, as this statistical test takes in account the possible agreement between raters by chance (there are no more than 3 choices). It fits the Kappa to the situation of more than two raters. The test reveals a Kappa value of 0,74, demonstrating a high inter-rater consistency at the first level. In all ten cases, the decisions at levels 3 and 4 were identical.

4. Implementation in medicolegal practice

The material consists of 113 consecutive patients with a history of occupational exposure to noise and claiming for compensation for tinnitus and NIHL within the framework of the Belgian insurance system for occupational diseases (Dejonckere & al., 2009). All requests were introduced in the period 2004 - 2009.

In each individual case, a detailed technical inquiry on working conditions and environment was performed by an engineer of the Federal Institute of Occupational Diseases. All patients were also requested to provide a copy of all medical documents in their possession, and - when available - medical files were collected from the Occupational Health and Safety Service (including annual audiometric data).

All patients had an exhaustive otological and audiological investigation within the ENT-department of the Federal Institute of Occupational Diseases, including tone and speech audiometry (prosthetic audiometry when relevant), automatic audiometry (von Békésy), impedance audiometry, evoked response audiometry (including frequency-specific cortical responses to stimuli of 1, 2 and 3 KHz), recording of spontaneous and evoked otoacoustic emissions, and tinnitometry. Combined with the information from the medical history and the medical correspondence and documents, the data of the clinical and instrumental investigations were used to check the 65 items of the level 1 of our decision making system.

According to this decision making system, 35 out of the 113 claimants were recognized as having a tinnitus directly related to their NIHL, and specifically compensated for this tinnitus. Normally the compensation for tinnitus is additional to that for NIHL, but in 23 cases, compensation concerned the sole tinnitus, as the severity of the NIHL was insufficient. Acceptance as an occupational disease automatically implies a proposal for withdrawal from the noisy workplace (with possible occupational recycling and compensation), or a technical adaptation.

As controls, 35 files of patients were selected with also a history of occupational exposure to noise, and also claiming for compensation for NIHL in the same period, but without complaints of tinnitus. The control group was matched for the criterion of a similar (on average) hearing loss at 3 and 4 KHz, accounting for a comparable cochlear damage due to noise. The average thresholds on 3 and 4 KHz for the tinnitus group are 54,83 and 61,17 dB, and for the control group 54,57 and 61,30 dB.

5. Results

5.1 Outcomes of the decision making system

Arguments for a negative decision at level 4, implicating a rejection of the tinnitus component of the claim in 78 claimants, were as follows:

At least one out of the four decisions at level 3 needed to be negative, but it frequently occurred that two or even three of these decisions came out unfavorably.

1. **Reliability:** 38 times negative. This negative decision never occurred as the sole one.
2. **Concomitant occupational NIHL:** 25 times negative, and 2 times as sole negative decision.
3. **Relation Tinnitus-NIHL:** 57 times negative, and 5 times as sole negative decision.
4. **Degree of impairment:** 24 times negative, and 2 times as sole negative decision.

Distribution of allowed impairment percentages are given in the histogram of Fig. 2

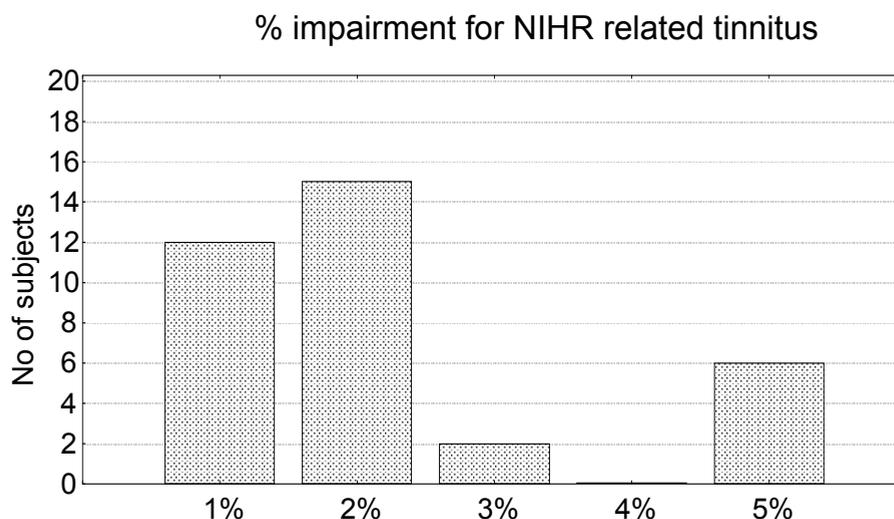


Fig. 2. Distribution of allowed percentages for tinnitus (35 patients). These percentages are in addition to those allowed for hearing loss.

5.2 Characteristics of the tinnitus in the cases considered as related to NIHL and recognized as occupational disease

The tinnitus was bilateral in 31 of the "accepted" cases, and unilateral in 4 cases (3 left, 1 right).

The histogram of Fig. 3 shows the distribution of perceived tinnitus frequency in the 66 investigated ears (tinnitotopy). In most cases tinnitus is located at 4 KHz.

The histogram of Fig. 4 shows the distribution of perceived tinnitus intensities above the pure tone hearing threshold. In average, the tinnitus is perceived 7,20 +/- 3,4 dB above the threshold.

On average, the tinnitus has been lasting for 7,3 years, with a large spreading.

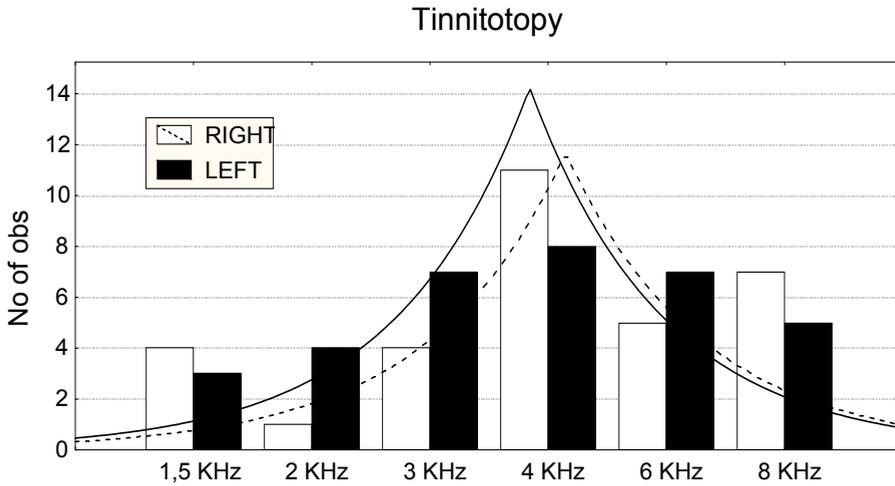


Fig. 3. Distribution of perceived tinnitus frequency in the 66 investigated ears (tinnitoty) (Lagrange fitting curve).

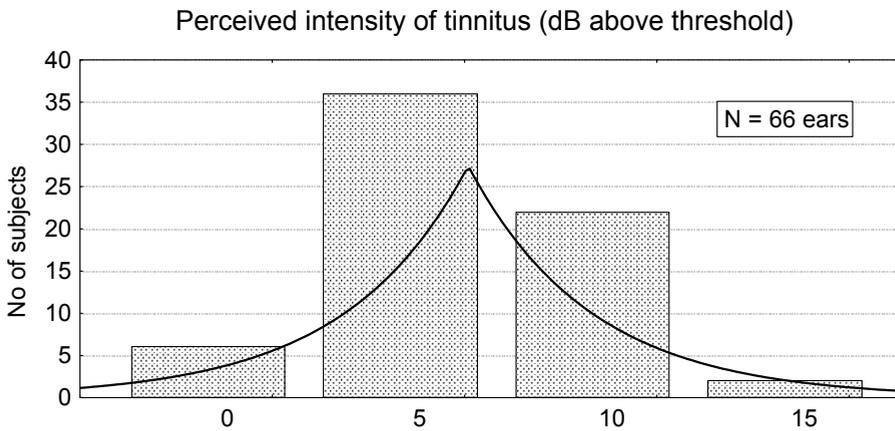


Fig. 4. Distribution of perceived tinnitus intensities above the pure tone hearing threshold (Lagrange fitting curve).

5.3 Comparison with the matched control group

Age

Subjects with NIHL-related tinnitus are slightly younger than control subjects: 48,9 vs. 53,5 years on average (Fig. 5). The difference is significant ($p < ,01$; Mann-Whitney test).

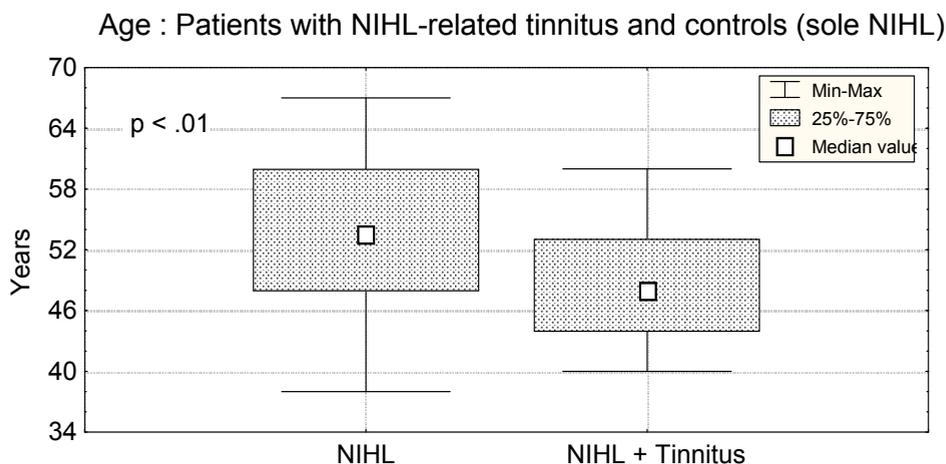


Fig. 5. Age of subjects with NIHL-related tinnitus and control subjects with NIHL but free from tinnitus.

Duration of noise exposure

Duration of noise exposure is slightly less in the tinnitus group than in the control group: 25,7 vs. 28,7 years on average (Fig. 6). However the difference does not reach the ,05 significance level (Mann-Whitney test).

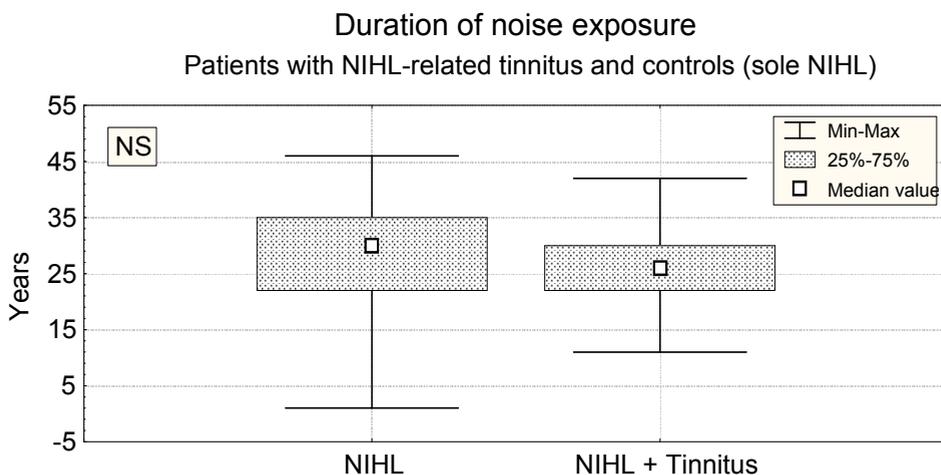


Fig. 6. Duration of noise exposure in the tinnitus group and in the control group.

Pattern of hearing loss

Fig. 7 shows the average hearing levels (+/- 1 S.D.) for 1,2,3,4 and 6 KHz for the subjects with (66 ears) and without (70 ears) tinnitus respectively. Hearing levels on 3 and 4 KHz were used to match the two groups. However, variances differ highly significantly ($p < ,001$) between

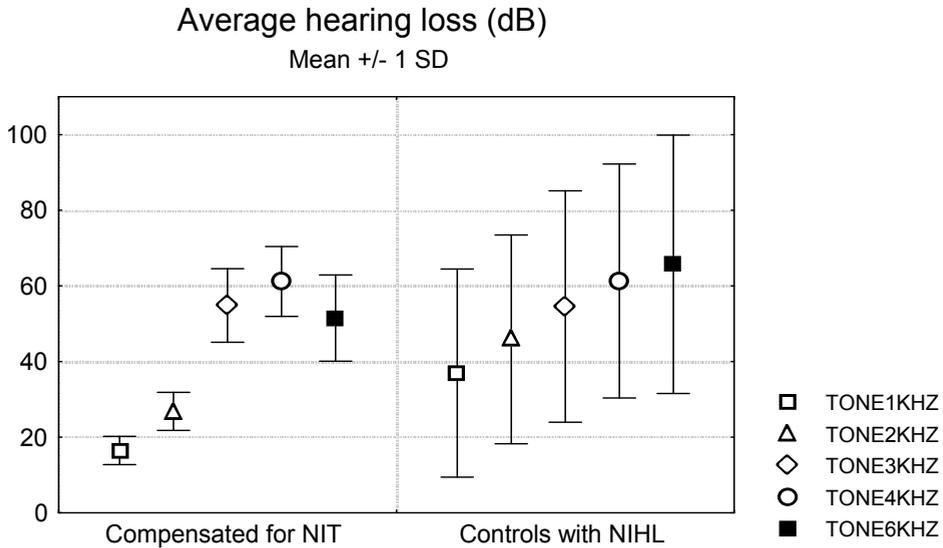


Fig. 7. Average hearing levels (\pm 1 S.D.) for 1,2,3,4 and 6 KHz for the subjects with (66 ears) and without (70 ears) tinnitus respectively. Hearing levels on 3 and 4 KHz were used to match the two groups.

the two groups for all frequencies: spreading is smaller in the tinnitus group. Further a Mann-Whitney test indicates that - except for 3 and 4 KHz - the hearing loss is more pronounced in the group without tinnitus: p is always $< .001$. Furthermore, the pattern of the two averaged audiometric curves is different: the typical 4 KHz notch is lacking in the control group. A sign-test reveals that the difference in hearing level between 4 and 6 KHz highly significantly differs between the two groups ($p < .001$): in the tinnitus group, the hearing level improves on 6 KHz compared with 4 KHz, while in the control group the 6 KHz value is worse.

DPOAEs

DPOAEs were recorded according to the usual DP-Gram procedure. The distortion product elicited by the non-linear intermodulation between two sinusoids of frequencies f_1 and f_2 along the basilar membrane was measured at $2f_1 - f_2$. A fixed ratio of $f_2/f_1 = 1,22$ is set for all the measurements and the level of the two pure tones is 70 dB HL. The equipment is able to test frequencies from 1000 to 8000 Hz. According to Attias & al. [7], DPOAEs are considered to be present only if values (in dB SPL) are larger than at least 2 SD above the upper noise floor at the corresponding frequency. A notch (3-4 KHz) in the DPOAEs was observed in 39 out of the 66 ears with tinnitus, but only in 6 out of the 70 control ears ($p < .001$: Chi-square test).

6. Discussion

Reliability of the subject

Medico-legal decision making needs to rely upon maximal objectivity. A few basic points are helpful in assisting medical criticism and experience:

1. Reproducibility requires an internal reference. Inconsistent responses are suspicious.
2. When, within an exhaustive assessment, those topics for which the patient's assertion can be objectively controlled systematically demonstrate reliability, it may reasonably be assumed that those for which such an objective control is impossible, are also credible. This is particularly true when the patient ignores which of the items can be objectively controlled.
3. Reports or indications about existence of tinnitus prior to any compensation claim (e.g. in the file of the occupational medicine physician) support reliability.
4. Similarly, documents proving seek for relief of tinnitus before any claim for compensation are highly relevant in this context (repeated medical consulting, acupuncture, purchase of tinnitus maskers, etc.)
5. Verifiable changes in the daily life or behavior of a tinnitus patient may comfort plausibility (e.g. terminating an activity within a choir) and reflect severity as experienced by the patient.

Concomitant occupational NIHL

25 claims were rejected because of lack of concomitant occupational NIHL. A detail to be mentioned is that in order to be considered meaningful, the hearing threshold shift (air conduction) on 4 KHz in the best ear needs to be at least 25 dB above normal value (Ref.: ISO-norm 7029 2nd ed. 2000-05-01). Attias & al. (2001) define NIHL as a hearing threshold more than 25 dB HL at the high frequency range.

Relation Tinnitus-NIHL

Reasons to consider the relation tinnitus-NIHL as improbable referred to medical history and anamnestic data (e.g. onset of tinnitus), clinical and audiological findings, subjective characteristics of tinnitus (e.g. pulsating), tinnitometry (e.g. 125 Hz) together with data obviously pointing to another etiology than NIHL: e.g. sudden deafness, Menière's disease, otosclerosis, trauma capitis, commotio labyrinthi, blast, middle ear disease, hypertension, cerebral MRI-(vascular)lesion, side-effect of drugs.

Degree of severity and allowed impairment/disability %

For reasons of maximal objectivity in determining an impairment percentage, the estimation of the degree of severity needs – particularly in a medicolegal context - to rely as far as possible on factual and verifiable data. Such data are e.g. provided by the extent and intensity of the medical/paramedical help seeking specifically related to the tinnitus, particularly before the claim for compensation was introduced. Also purchase of devices for relieving tinnitus and personal expenses for alternative treatments may be relevant information.

The following rating scale is indicative (all items specifically concern the tinnitus):

Level 0: neither medical nor alternative seeking for help.

Level 1: consulting the home physician, looking for alternative medicine. Treatment with sedatives, hypnotics.

Level 2: consulting an ENT-specialist or a neurologist. Treatment with Betahistine and vasoactive drugs...; physical treatments; tinnitus maskers; psychological treatments...

Level 3: referral to a psychiatrist. Treatment with antidepressive and psychotropic drugs, psychotherapy.

Level 4: psychiatric hospitalization for major behavioral troubles. Treatment with major psychiatric drugs.

In our series, there was only one level 4-case, but – according to the patient himself and to his home physician – the tinnitus was a secondary problem. Three patients were referred to a psychiatrist, but required no more than a short treatment. In the case of a serious psychiatric problem, the medical expertise of a psychiatrist would obviously be requested. The reason of a negative decision 4 in level 3 (“Is the tinnitus debilitating, and if so, to what extent ?”) was mostly that, when patients were examined, the tinnitus had disappeared or was disappearing. In other cases, patients reported about the tinnitus (besides the hearing loss), but did not consider it as actually debilitating.

Perceived frequency of tinnitus (tinnitotopy)

Our observation – the correspondence in frequency between audiometric notch and tinnitus – is in agreement with the literature: Okumura & al. (2006) also noticed a strong correlation between tinnitus frequency and hearing loss. The presence of whistling tinnitus was found significantly correlated with high frequency hearing loss (Nicolas-Puel & al., 2006).

Perceived intensity of tinnitus

The observed tinnitus sensation levels are also in agreement with values reported in the literature: those obtained by Andersson (2003) were not higher than 16 dB supraliminal.

Pattern of hearing loss

Our tinnitus and control groups were matched for similar average thresholds at 3 and 4 KHz. This may be interpreted as a similar cochlear damage specifically due to noise, which fits with a comparable duration of noise exposure. Average ages are slightly different (48,9 and 53,5). In normal subjects, this age difference would account for a shift of up to 5 or 6 dB on 6 KHz (ISO-norm 7029 2nd ed. 2000-05-01) but it has been shown that in subjects with NIHL, the superimposed effect of presbycusis in the notch zone (3-4-6 Hz) is considerably reduced (Gates & al., 2000): hair cells lost from one cause cannot be ‘re-lost again’ from another cause. Nevertheless, it seems that the tinnitus group was exposed at a younger age than the control group.

The main audiometric differences between our two groups are:

- i. a significantly higher hearing loss at the non-matched frequencies in the control group;
- ii. a steeper slope of the curve between 2 and 3 KHz in the tinnitus group (0,028 dB/Hz vs. 0,009 dB/Hz);
- iii. a lack of notch effect in the control group.

These findings seem to point out that there is a relationship between the occurrence of tinnitus and a marked imbalance between hearing levels at the different frequencies, particularly 2 and 3 KHz. König & al. (2006) compared 30 patients having noise-induced hearing loss without tinnitus and 41 (non-matched) patients having noise-induced hearing loss with tinnitus. They found that tinnitus patients had less overall hearing loss than patients without tinnitus. Moreover, the maximum steepness of the audiogram was higher in patients with tinnitus (-52,9 +/-1,9 dB/octave) compared to patients without tinnitus (-43,1 +/-2,4 dB/octave).

This abrupt discontinuity in the activity along the tonotopic axis of the auditory system could be a factor facilitating perceptual auditory misinterpretation (tinnitus), as there appears to be a correspondence between audiometric notch and tinnitus frequency.

Differences in the audiometric patterns of the two groups are partially to be explained by concomitance of other hearing pathologies in the control group (nosocusis). A scotopic hearing loss on 3-4 KHz is known to be highly specific of NIHL.

DPOAEs

Hitherto, there have been only a few reports on tinnitus, NIHL and DPOAEs, and they are to some extent controversial (Ozimek & Wicher, 2006). DPOAEs were found to correlate moderately and negatively with the audiometric thresholds (Attias & al. 1998), but Shupak & al. (2007) conclude that, in subjects with beginning NIHL, the DP-gram is not significantly correlated with pure tone audiometry. Attias & al. (2001) as well as Ozimek & Wicher (2006) found in subjects with NIHL and tinnitus a notch shape of the DPOAEs reflecting quite well the hearing loss notch. Our data of the tinnitus group support these last observations. The difference with the control group is probably due to the more severe hearing damage on 1, 2 and 6 KHz.

7. Conclusion

Tinnitus is frequently associated with occupational hearing loss, and can be an additional item of claim in countries applying a specific insurance system for occupational disorders.

As it is not objectivable, tinnitus remains a difficult item for medicolegal assessment and compensation within an insurance context. A decision making system based upon an exhaustive investigation and a 4-level decision structure, proves to be helpful. An aggregate of multiple choice decisions (yes / no / partially) on elementary questions leads to a decision of the next level, which in turn determines – together with the other decisions of the same level - the conclusion at a still higher level. The 4 main decisions at level 3 each pertain to a specific independent aspect, and appear to be in comparable proportions the limiting factor for acceptance of the tinnitus as an occupational disease. A variant of Cohen's Kappa for multiple raters demonstrates high inter-rater consistency at the first level (ten cases, four raters). In all cases, the decisions at higher levels 3 and 4 appear to be identical.

Furthermore, cases with one single negative decision at level 3 are a minority. The analysis of the files where NIHL-related tinnitus was recognized and compensated as an occupational disease show tinnitus characteristics that are in full agreement with what is known from the clinical and epidemiological literature (thus out of medicolegal context). Comparison with a matched group of patients claiming compensation for NIHL without tinnitus reveals that NIHL-related tinnitus is associated with a more specific audiometric profile of cochlear damage due to noise. This specificity mainly concerns the notch on 4 KHz and the steep slope of the audiometric curve between 2 and 3 KHz. Patients with NIHL – related tinnitus have also been exposed on average at a younger age than patients with sole NIHL.

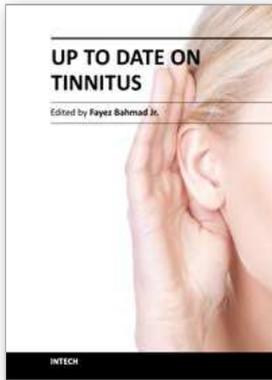
A major advantage with the use of the decision making system is that the final medico-legal decision relies on standardized criteria and becomes perfectly transparent in case of litigation.

The final aim is maximal equity in compensation.

8. References

- Andersson G: Tinnitus loudness matching in relation to annoyance and grading of severity. *Auris Nasus Larynx* 30: 129-133, 2003.
- Attias J, Bressloff I, Reshef I, Horowitz G, Furman V: Evaluating noise induced hearing loss with distortion product otoacoustic emissions. *Br J Audiology* 32: 39-46, 1998.

- Attias J, Horovitz G, El-Hatib N, Nageris B. Detection of noise-induced hearing loss by Otoacoustic Emissions. *Noise & Health* 3, 12: 19 – 31, 2001.
- Coles R. Medicolegal issues. In R Tyler (ed), *Tinnitus Handbook*. San Diego: Singular Thomson Learning, 2000: pp. 399 – 417.
- Dejonckere PH, Lebacqz J: Medicolegal decision making in noise-induced hearing loss – related tinnitus. *Int Tinnitus J* 11: 92-96, 2005.
- Dejonckere PH, Coryn C, Lebacqz J: Experience with a Medicolegal decision-making system for occupational hearing loss-related tinnitus. *Int Tinnitus J* 15: 185-192, 2009.
- Fleiss JL: *Statistical methods for rates and proportions*. 2nd Ed. Wiley New York, 1981.
- Gates GA, Schmid P, Kujawa SG, Nam B, D'Agostino R: Longitudinal threshold changes in older men with audiometric notches. *Hearing Research* 141: 220-228, 2000.
- König O, Schaette R, Kempter R, Gross M: Course of hearing loss and occurrence of tinnitus. *Hearing Research* 221: 59-64, 2006.
- Nicolas-Puel C, Akbaraly T, Lloyd R, Berr C, Uziel A, Rebillard G, Puel JL: Characteristics of tinnitus in a population of 555 patients: specificities of tinnitus induced by noise trauma. *Int Tinnitus J* 12: 64-70, 2006.
- Nieschalk M, Stoll W. Die Begutachtung von Tinnitus. In *Das neurootologische Gutachten*. Wolfgang Stoll (ed.) Thieme Verlag, Stuttgart NewYork, 2002, pp. 94 – 98.
- Okumura H, Satoshi S, Sato H, Takahashi S. Location of tinnitus frequency examined from the pure tone audiometric pattern. *Pract Oto Rhino Laryngol* 99(7): 523-530, 2006.
- Ozimek E, Wicher A: Distortion product otoacoustic emission (DPOAE) in tinnitus patients. *J Acoust Soc Am* 119: 527-538, 2006.
- Poole K. A review of the current state of knowledge on tinnitus in relation to noise exposure and hearing loss. Research Report HSE 2010 www.hse.gov.uk.
- Shupak A, Tal D, Sharoni Z, Oren M, Ravid A, Pratt H. Otoacoustic emissions in early noise-induced hearing loss. *Otology & neurootology* 28: 745-752, 2007



Up to Date on Tinnitus

Edited by Prof. Faye Bahmad

ISBN 978-953-307-655-3

Hard cover, 186 pages

Publisher InTech

Published online 22, December, 2011

Published in print edition December, 2011

Up to Date on Tinnitus encompasses both theoretical background on the different forms of tinnitus and a detailed knowledge on state-of-the-art treatment for tinnitus, written for clinicians by clinicians and researchers. Realizing the complexity of tinnitus has highlighted the importance of interdisciplinary research. Therefore, all the authors contributing to the this book were chosen from many specialties of medicine including surgery, psychology, and neuroscience, and came from diverse areas of expertise, such as Neurology, Otolaryngology, Psychiatry, Clinical and Experimental Psychology and Dentistry.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

P.H. Dejonckere (2011). Medico-Legal Decision Making in NIHL-Related Tinnitus, Up to Date on Tinnitus, Prof. Faye Bahmad (Ed.), ISBN: 978-953-307-655-3, InTech, Available from: <http://www.intechopen.com/books/up-to-date-on-tinnitus/medico-legal-decision-making-in-nihl-related-tinnitus>

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University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
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InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

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