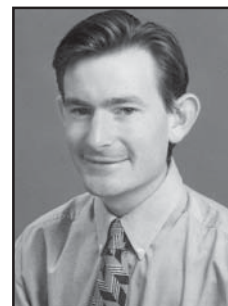


The management of tinnitus

Grant D Searchfield BSc MAud(Hons) MNZAS is a lecturer in Audiology and Director of the University of Auckland's Hearing and Tinnitus Clinic. His research interests include tinnitus mechanisms, assessment and management.



Seventy-nine per cent of people with tinnitus obtain their first information about it from their family doctor.¹ The information they receive at this consultation can be a contributing factor to whether their tinnitus becomes a significant problem or a minor annoyance. Positive, evidence-based information may prevent undue attention being paid to tinnitus. The alleviation of fears and concerns can facilitate a natural process of habituation. There is now no reason for the statement *'nothing can be done for your tinnitus, you just need to live with it.'*

The phantom perception of sound is believed to be experienced in a mild occasional form by the majority of the population.² Between six and 17% of the population have problematic tinnitus, with 0.5–2% having tinnitus that produces sufficient annoyance to interfere with normal daily life.^{3–5} Severe tinnitus is often associated with depression, loss of concentration, and difficulty sleeping^{4,6,7} but rarely suicide.^{8,9}

Definition

Tinnitus is the perception of a sound in the absence of a physical sound stimulus. Tinnitus is most often categorised into two types: objective and subjective tinnitus. **Objective tinnitus** can be made audible to an outside observer and may arise from auditory and non-auditory structures such as the palate, eustachian tube and vasculature.¹⁰ **Subjective tinnitus** is the most common manifestation of tinnitus and is only audible to the

patient, often being reported as *'a ringing, buzzing or hissing sound in the head or ears'*.

Mechanisms of generation

Subjective tinnitus is most likely generated by the peripheral auditory system with central auditory processing contributing to its perceived loudness and annoyance. Many injuries to the ear which result in hearing loss are associated with tinnitus, in particular noise induced damage, ototoxic medication, vestibular schwannomas, endolymphatic hydrops, idiopathic sudden hearing loss, and otitis media. It is generally accepted that the cause of hearing loss is also the likely cause of any accompanying tinnitus.¹¹ While

tinnitus can occur in individuals with normal hearing and no detectable disease^{12,13} models of tinnitus usually consider changes in cochlear function as the source of the tinnitus signal within the auditory pathways.¹⁴ The incidence of tinnitus increases with hearing loss¹¹ and the pitch of tinnitus is often related to the frequency region of hearing loss.¹⁵ The development of equipment able to test with high frequency resolution suggests that tinnitus may be associated in slight irregularities of hearing sensitivity, even in the 'normally hearing'.^{16,17}

Tinnitus severity is not fully explained by the degree of pathology of the ear as there is poor correlation between hearing threshold and self-reported tinnitus distress.^{18,19} It is thought that much of the severity of tinnitus relates to enhancement by central auditory processing and the individuals' psychological response to the abnormal perception.¹⁴

Most bothersome tinnitus appears to be the consequence of the auditory system's interpretation of altered activity from the inner ear. Unevenness in the spontaneous output of the cochlea may be exaggerated by lateral inhibition networks and lead to cortical reorganisation.

In the normal tonotopic map of the auditory cortex each frequency

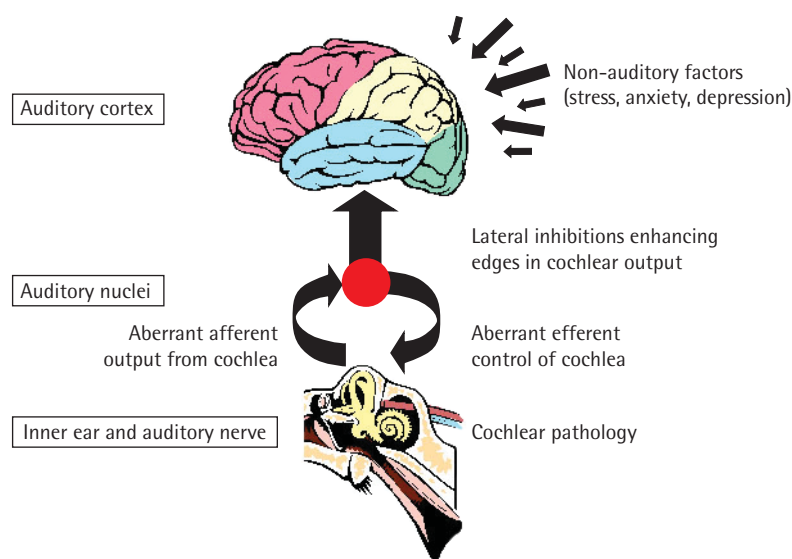
Tinnitus severity is not fully explained by the degree of pathology of the ear as there is poor correlation between hearing threshold and self-reported tinnitus distress

of sound is represented by a narrow strip of cells. Cells of the inner ear project to cells in the cortex in a pattern set at birth or soon after. When damage occurs to a specific region of the ear there is reduced

input to the corresponding region of the brain.

Accumulating evidence from brain imaging and auditory evoked potentials suggests that cells in the brain deprived of this input begin to respond to tones adjacent in pitch to the damaged areas and the frequency regions neighbouring damage expand.²⁰ The expanded region has been

Figure 1. A schematic diagram showing mechanisms potentially responsible for the generation and/or maintenance of tinnitus.



Music for tinnitus

Music can be used to either mask tinnitus or as a stimulus for habituation.

Recommendations:³⁰

- Only music that induces positive feelings should be used.
- Music without vocals or pronounced base beat.
- Music should be pleasant but not too interesting.
- For short-term relief, when tinnitus is severe, attention capturing music can be beneficial.
- For long-term tinnitus habituation music which induces relaxation while reducing tinnitus audibility should be used.
- Music should be played at a low level, ideally where the music begins to blend with the tinnitus.

What about a cure?

Tinnitus appears to be due to aberrant information being sent to the brain from the lower parts of the hearing system, which is interpreted as sound. New treatments will develop from our understanding of how such aberrant messages are generated and how they are perceived by the brain. With such an understanding, drug or behavioural treatments can be developed to reduce the tinnitus. A 'cure', however, may be many years away.

found to be related to the pitch of tinnitus and some preliminary evidence suggests that there may be an association between the extent of reorganisation and perceived tinnitus magnitude.²¹

Assessment of tinnitus

The first step in the evaluation of tinnitus and then its management is a comprehensive case history including questions of onset, description, location, possible cause (noise, medications, stress) and severity. If the tinnitus is objective, pulsatile, unilateral or associated with a temporomandibular joint complaint referral to an otolaryngologist is recommended.¹⁰ The underlying cause in these cases may be medically treatable. If ear wax and otitis media are excluded as possibilities for subjective tinnitus a referral for audiological evaluation should be made.

There is currently no objective measure of tinnitus. Psychoacoustical assessments of tinnitus qualities (pitch and loudness)²² and psychometric evaluations of tinnitus severity²³ are often used by audiologists to characterise tinnitus. Such assessment can be used in medico-legal proceedings surrounding a workplace injury or stress.

Questionnaires are used in the tinnitus evaluation as they provide insight into specific problems faced by patients, help to quantify subjective attributes and are useful in monitoring change in perception of tinnitus and treatment efficacy. There is at least one questionnaire (the Short Index of Tinnitus, SIT, available on request from audiology@auckland.ac.nz) designed specifically for use in general practice. Questions address the degree to which tinnitus affects the individual (e.g. 'I cannot concentrate because of noises in my head/ears – never, sometimes, always').

Management of tinnitus

Current treatments of tinnitus are not cures, they are a means to reduce tinnitus perception or awareness. Well controlled trials of management strat-

egies are few and published success rates of most treatments remain controversial.²⁴ Despite this there is sufficient evidence to advocate existing strategies to reduce tinnitus annoyance and improve quality of life.

Counselling

Tinnitus counselling undertaken by an audiologist, otologist or hearing therapist is intended to provide reassurance and correction of false beliefs. The intention is demystification of the tinnitus and typically teaches the tinnitus patient to understand their condition by providing information on:

- Cochlear anatomy and pathology;
- Hearing loss;
- Central auditory processing of sound;
- Tinnitus mechanisms;
- Tinnitus management options;
- Stress and its management.

Cognitive behavioural therapy

Cognitive behavioural therapy is undertaken by psychologists. The patient is taught techniques to enable them to cope with their tinnitus. This therapy attempts to change the way the tinnitus sufferer thinks about their tinnitus. By minimising negative thoughts about tinnitus its annoyance can be reduced.

Masking

Masking is the process of covering, or partially covering, the tinnitus with an external sound. The sound used is not crucial, but should be less bothersome than the tinnitus. Masking often allows the sufferer to gain control over their tinnitus by determining when they do not wish to hear it. Masking can be difficult in some cases as the tinnitus can become more audible the longer the masker is used, or simply may not be able to be masked. Masking has been replaced by habituation therapy as the mainstay of audiological tinnitus management but is still a very effective management option, especially when combined with appropriate counselling.

Habituation therapy

If a person with tinnitus has no reason to attend to their tinnitus they should habituate to it. Even loud sounds can be habituated to if they are non-threatening, for example rabbits living near airport runways do not startle to jet take-offs.

*'For the rabbits, the number of take-offs observed and the noise of jet engines are less important than the fact that aircraft never eat, or mate with, rabbits.'*²⁵

The difference between a person who experiences tinnitus and one who 'suffers' from it may be the person's ability to habituate to the tinnitus. Habituation therapies usually combine sound therapy with counselling. Hearing aids, broadband noise generators and devices combining both amplification and generation of sound (combination aids) are used to reduce tinnitus audibility to facilitate the habituation of tinnitus. Initially benefit from the devices occurs only when they are worn, the sound reduces the contrast between tinnitus-related and normal auditory activity. In six to 18 months, if a programme of use for over eight hours per day is followed, the tinnitus may be reduced sufficiently to discontinue the use of the device.²⁶

Hearing aids

Hearing aids are used both in masking and habituation therapies. There are at least five ways the fitting of hearing aids can benefit tinnitus sufferers:²⁷

- By understanding that hearing loss not tinnitus causes communication problems;
- Psychological benefit from assisting hearing;
- By less attention being paid to hearing and consequently tinnitus;
- Amplified ambient sound and internal hearing aid circuit noise make the tinnitus less audible;
- The counselling accompanying hearing aid fitting can provide an understanding of tinnitus.

Key Points

- Tinnitus is a common symptom of auditory dysfunction.
- Most people who experience tinnitus find it a minor annoyance.
- Hearing loss, anxiety and stress can result in bothersome tinnitus.
- While no cure exists many different management methods are available.
- An understanding of the cause and nature of tinnitus can reduce the attention paid to the tinnitus, leading to habituation.
- A multidiscipline treatment approach is more likely to succeed than strict adherence to one treatment paradigm.
- The general practitioner has a key role as the point of first contact to educate and facilitate habituation by addressing patient fears and misconceptions.

Stress management

Stress is a common aggravator of tinnitus and most methods that reduce stress (e.g. biofeedback, breathing exercises, meditation) can reduce the annoyance of a person's tinnitus.

Medications

While no medication exists for tinnitus per se, medications which alleviate co-symptoms such as anxiety or depression have been used successfully to improve the individual's reaction to tinnitus. There is some emerging evidence that serotonin uptake inhibitors may be successful in this role.²⁸

Diet and medications

For the tinnitus sufferer excessive use of alcohol, caffeine, or central nervous system stimulants should be avoided. However the tinnitus en-

hancing properties of these substances may be overstated, and a repeated process of withdrawal of use and reintroduction should be trialled to ascertain their effect.²⁹ Many common medications, most notably aspirin, can result in tinnitus, patients need to be counselled by the prescribing doctor as to whether alternatives are available.

Alternative therapies

Tinnitus has been a fruitful area for practitioners of 'non-western' medicines. As well as acupuncture, herbal remedies (ginkgo biloba), ear candling, low power lasers and electromagnetic stimulation have all

been advocated as tinnitus reducing treatments with little evidence of benefit.²⁹

Self-help and support groups

Such groups are useful as a source of information, they provide support at times of distress, and occasionally host

talks from professionals working in the area of tinnitus. Some people benefit from hearing others' experiences, but only if these are positive and do not reinforce the person's negative thoughts. The New Zealand Tinnitus Association is staffed on a volunteer basis (NZTA, 09-525 9847).

Internet resources

Hearing and tinnitus clinic, **The University of Auckland**

<http://www.health.auckland.ac.nz/audiology>

Tinnitus clinic, **Oregon Health Sciences University**

<http://www.ohsu.edu/ohrc/tinnitusclinic>

American Tinnitus Association

<http://www.ata.org>

References

1. Thomas M, Willoughby A, Veitch G. Information given to patients before attending tinnitus clinics: patient and doctor responses. VIIth International Tinnitus Seminar 2002, Fremantle: 235–237.
2. McFadden D. Tinnitus: Facts, theories and treatments. Washington: National Research Council National Academy Press, 1982.
3. Coles R. Epidemiology of tinnitus (2). Demographic and clinical features. *J. Laryngol. Otol.* 1984; Suppl 2:195–202.
4. Axelsson A, Ringdahl A. Tinnitus: A study of its prevalence and characteristics. *Bri. J. Audiol.* 1989(23):53–62.
5. Cooper JC. Health and Nutrition Examination Survey of 1971–75: Part II. Tinnitus, subjective hearing loss, and well being. *J. Am. Acad. of Audiol.* 1994(5):37–43.
6. Folmer R, Griest S, Martin W. Co-symptoms that contribute to the severity of tinnitus or pain. VIIth International Tinnitus Seminar 2002, Fremantle: 208–213.
7. George R, Kemp S. A survey of New Zealanders with tinnitus. *Bri. J. Audiol.* 1991(25):331–336.
8. Lewis J, Stephens S, McKenna L. Tinnitus and suicide. *Clin. Otolaryngol. Allied Sci.* 1994; 19(1):50–4.
9. Jacobson G, McCaslin D. A search for evidence of a direct relationship between tinnitus and suicide. *J. Am. Acad. of Audiol.* 2002; 12(10):493–496.
10. Goodey R. Tinnitus: When the patient complains of noises in the ear. *Patient Management* 1988:75–89.
11. Coles R. Classification of causes, mechanisms of patient disturbance, and associated counseling. In: Vernon JA, Moller AR, eds. *Mechanisms of tinnitus*. Needham Heights: Allyn and Bacon, 1995: 11–20.
12. Pulec L, Hodell S, Anthony P. Tinnitus: diagnosis and treatment. *Ann. Otol. Rhinol. and Laryngol.* 1978; 87:821–833.
13. Chung D, Gannon R, Mason K. Factors affecting the prevalence of tinnitus. *Audiology* 1984; 23:426–440.
14. Jastreboff PJ. Phantom auditory perception (tinnitus): Mechanisms of generation and perception. *Neurosci. Res.* 1990; 8:221–254.
15. Meikle MB. The interaction of central and peripheral mechanisms in tinnitus. In: Vernon J, Moller AR, eds. *Mechanisms of tinnitus*. Needham Heights: Allyn and Bacon, 1995.
16. Robertson DJ. The role of threshold equalising noise (TEN) test for IHC dead regions in the assessment of tinnitus. Master of Audiology Dissertation: The University of Auckland, 2003.
17. Zhao F, Stephens D, Meyer-Bisch C. The audioscan: a high frequency resolution audiometric technique and its clinical applications. *Clin. Otolaryngol.* 2002; 27:4–10.
18. Baskill JL, Coles RRA. Relationship between tinnitus loudness and severity. VIth International Tinnitus Seminar 1999, Cambridge: 424–428.
19. Raymond SM. Hearing loss and tinnitus severity. Master of Health Science Dissertation: The University of Auckland, 2002.
20. Harrison RV. Representing the acoustic world within the brain: Normal and abnormal development of frequency maps in the auditory system. A sound foundation through early amplification. *Proceedings of the second international conference 2001*, Chicago: 3–24.
21. Muhlneckel W, Elbert T, Taub E, Flor H. Reorganization of auditory cortex in tinnitus. *Proc. Nat. Acad. Sci. USA.* 1998; 95(17):10340–10343.
22. Henry JA, Meikle MB. Psychoacoustic measures of tinnitus. *J. Am. Acad. of Audiol.* 2000; 11:138–155.
23. Nobel W. Tinnitus self-assessment scales: Domains of coverage and psychometric properties. *The Hear. J.* 2001; 54(11):20–25.
24. Dobie RA. A review of randomized clinical trials in tinnitus. *Laryngoscope* 1999; 109:1202–1211.
25. Worden FG. Auditory habituation. In: Tighe TJ, Leaton RN, eds. *Habituation*. New York: Erlbaum Associates, 1976: 109–137.
26. Jastreboff PJ, Jastreboff MM. Tinnitus retraining therapy (TRT) as a method for treatment of tinnitus and hyperacusis patients. *J. Am. Acad. of Audiol.* 2000; 11:162–177.
27. Coles R. Tinnitus and its management. In: Kerr A, Groves J, Stephens D, eds. *Scott-Brown's Otolaryngology*. London: Butterworth & Co. Ltd., 1985:368–414.
28. Folmer RL, Griest SE, Bonaduce A, Edelfsen L. Use of selective serotonin reuptake inhibitors (SSRI) by patients with chronic tinnitus. VIIth International Tinnitus Seminar 2002, Fremantle: 81–85.
29. Coles R. Therapeutic blind alleys. In: Vernon JA, ed. *Tinnitus treatment and relief*. Needham Heights: Allyn and Bacon, 1998: 8–19.
30. Hann D. The elements of music which aid in the management of tinnitus. Master of Audiology Dissertation: The University of Auckland, 2003.