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Evidence-Based Management of Troublesome Tinnitus: Practical Guidelines for the Practicing Professional

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Evidence-Based Management of Troublesome Tinnitus: Practical Guidelines for the Practicing Professional

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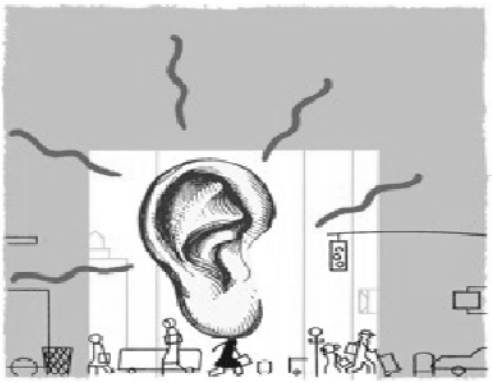


Evidence-Based Management of Troublesome Tinnitus: Practical Guidelines for the Practicing Professional

- **Definition of tinnitus?**
- **Audiologic assessment of tinnitus**
- **General management strategies**
- **Specific treatment options**
- **Summary, questions, & answers**

Definition of Tinnitus

- **Tinnitus is a phantom auditory perception,i.e., the perception of a sound in the absence of an external sound signal.**
- **Tinnitus is real, not imagined or "just in your head".**
- **Tinnitus is a *symptom* … not a disease.**
- **Bothersome tinnitus is "subjective tinnitus"**
- **"Somatosounds" require medical assessment and management**

Definition of Tinnitus: The type of sound has no diagnostic or prognostic significance

Description of types of tinnitus for 119 patients presenting for consultation

ringing = 47	clicking = 2
crickets = 21	frying sound = 2
high-pitch tone = 17	mid-pitch tone = 1
hissing = 13	screeching = 1
humming =13	whizzing = 1
roaring = 6	fizzing = 1
static noise = 5	siren = 1
buzzing = 4	crackling = 1
pulsing = 4	running water = 1

Definition of Tinnitus: Demographics

- **Almost everyone experiences transient spontaneous tinnitus**
- **About one-third of all adults in U.S.A. experience actual tinnitus at least once**
- **Tinnitus is experienced regularly by about 40 million Americans (1/5 persons)**
- **Tinnitus is a serious problem for 13-15% Americans who seek medical attention for their tinnitus.**
- **Tinnitus is debilitating for an estimated 2 million Americans.**

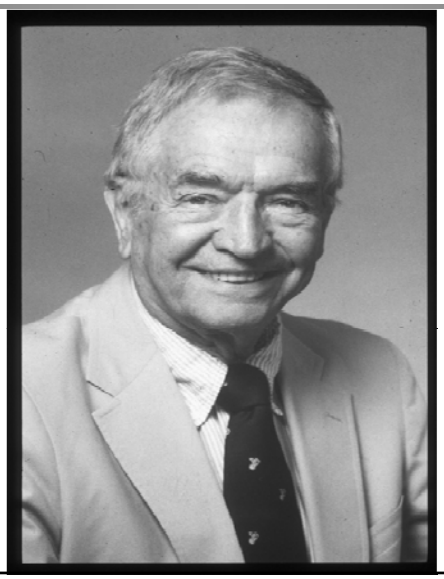
Definition of Tinnitus: Non-Helpful Advice from Physicians

- **Poor medical advice and information (summarized from hundreds of patient reports)**
  - **There's nothing wrong with you**
  - **You have normal hearing**
  - **There's nothing we can do for you**
  - **Avoid being around noises**
  - **"You'll just have to live with it"**

Definition of Tinnitus:
Common patient complaints and characteristics

- **Very tired, slowed down, fatigue**
- **Persistently sad mood**
- **Patient doesn't enjoy things the way he/she used to**
- **Restless or irritable**
- **Difficulty concentrating**
- **Sleeping and/or eating less than usual**
- **Persistent headaches, stomach aches, or chronic pain**
- **Nervousness**
- **Excessive crying**
- **Hopelessness, e.g., life is not worth living**
- **Absence of pleasures or joys**

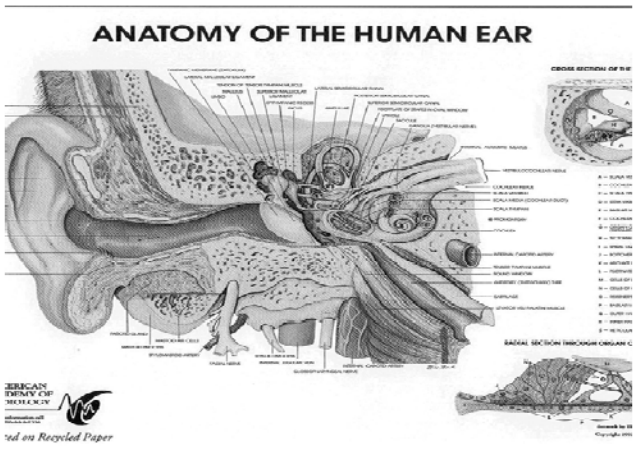
Jack Vernon
(1922-2010)
"American Father of Tinnitus"



Causes and Mechanisms of Tinnitus: Anatomy & Physiology (1)

- **Origin in cochlea**
  - **Hair cell damage**
  - **Imbalance between outer hair cells (OHC) and inner hair cell (IHC) function**
  - **Peripheral deafferentation**
  - **Loss of input to tonic inhibitory systems**
  - **Release of excessive amounts of excitatory neurotransmitter glutamate**
  - **Over-expression of synaptic receptors type NMDA (N-Methyl D-Aspartate)**
- ***Eighth cranial nerve***
  - **Increased or changed resting potential**
  - **Changes causes by dysfunction of nerve**
- **Influence of middle ear disorder … increases tinnitus loudness because external everyday sounds do not "mask" tinnitus as much**

Tinnitus Anatomy & Physiology: Middle Ear, Inner Ear and Auditory Nerve



Causes and Mechanisms of Tinnitus: Anatomy & Physiology (2)

- **Auditory brainstem, thalamus and cortex in the CNS**
  - **Perception of sound**
  - **Reorganization of neuronal activity**
  - **Release of excessive amounts of excitatory neurotransmitter glutamate**
  - **Over-expression of synaptic receptors type NMDA (N-Methyl D-Aspartate)**
- **Non-traditional auditory regions**
  - **Limbic system**
  - **Autonomic nervous system**
- **Efferent auditory system in the brain**
  - **Reduced activity**

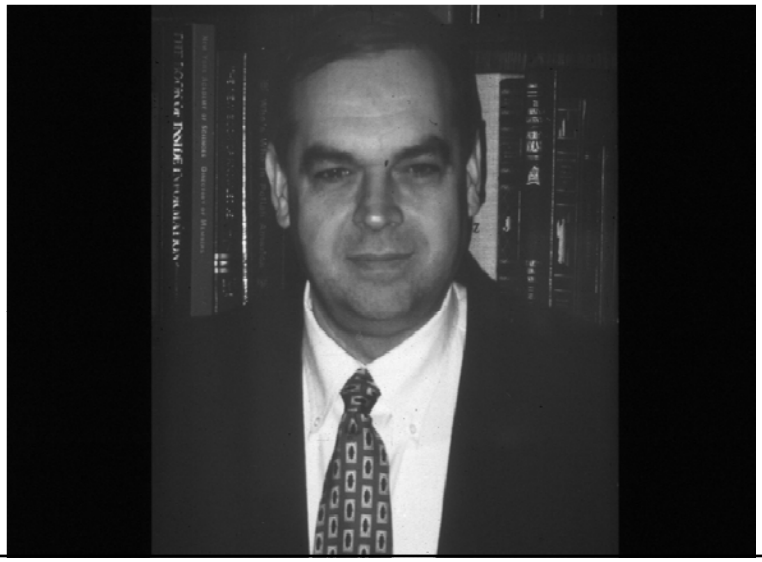
Current Theories and Publications on the Mechanisms and Management of Tinnitus

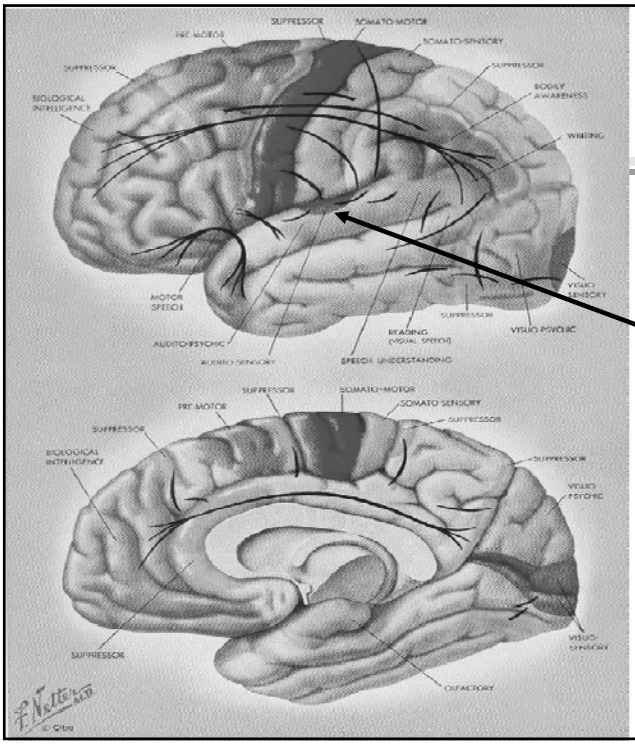
- **Baguley DM. Mechanisms of tinnitus. *British Medical Bulletin 63*: 195-212, 2002.**
- **Eggermont JJ & Roberts LE. The neuroscience of tinnitus. TRENDS in Neuroscience 27: 2004.**
- **Eggermont JJ. Tinnitus: neurobiological substrates. *Drug Discovery Today 10*: 2005.**
- **Shore, Zhou & Koehler. Neural mechanisms underlying somatic tinnitus. In Langguth, Hajak, Kleinjung, Cacace, Møller. *Progress in Brain Research, 166*: 2007**
  - ***Somatosensory stimulation via trigeminal and dorsal root ganglia affect physiology in DCN***
- ***Possible Mechanism:* imbalance in activity of excitatory (GABA) and inhibitory (glutamate) auditory neurotransmitters in CNS (e.g., brainstem, midbrain, cortex)**

Current Theories and Publications on the Mechanisms and Management of Tinnitus (2)

- **Kaltenbach JA. The dorsal cochlear nucleus as a contributor to tinnitus: mechanisms underlying the induction of hyperactivity. In Langguth, Hajak, Kleinjung, Cacace, Møller. *Progress in Brain Research, 166*: 2007**
  - **Hyperactivity in CN with tinnitus documented in animal models and in humans (imaging studies)**
  - **Direct electrical stimulation of DNC changes tinnitus loudness**
  - **Center of integration of different sensory modalities (e.g., pain)**
- **Moller AR. The role of neural plasticity in tinnitus. In Langguth, Hajak, Kleinjung, Cacace, Møller. *Progress in Brain Research, 166*: 2007**
  - **Deprivation of input can lead to neural plasticity**
  - ***Neural plasticity can play a role in***
    - ***Balance between excitation and inhibition***
    - ***Hyperactivity***
    - ***Reorganization of CNS and redirection of information to non-classical auditory areas, e.g., limbic system, pain centers***
- ***Possible Mechanism:* imbalance in activity of excitatory (GABA) and inhibitory (glutamate) auditory neurotransmitters in CNS (e.g., brainstem, midbrain, cortex)**

Pawel Jastreboff "Neurophysiological Model of Tinnitus"

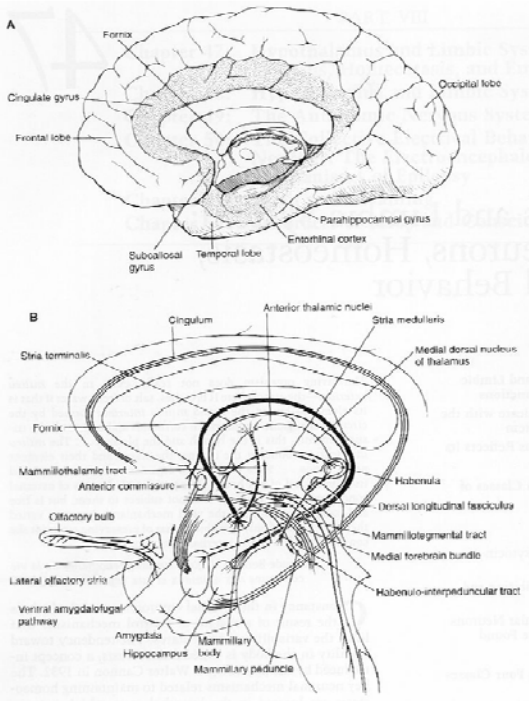




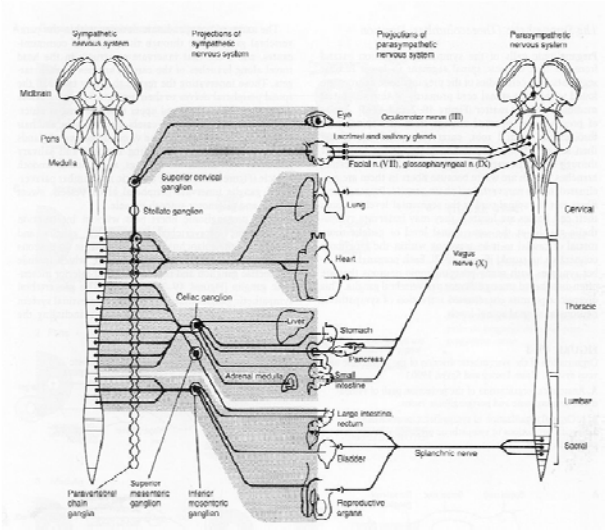
Tinnitus Anatomy & Physiology

Auditory region of the brain (Heschl's gyrus) in the temporal lobe of auditory cortex … responsible for the perception of tinnitus

Limbic System (emotional center of the brain)



Autonomic Nervous System



Controlling the brain's response to "danger sounds"

Tinnitus … Current Research and Treatment Options: fMRI Documentation of CNS Representation of Tinnitus

Lockwood AH, Salvi RJ, Coad BA, Towsley ML, Wack DS, Murphy BW.

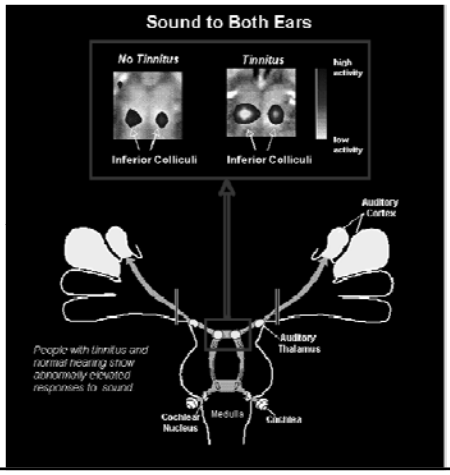
(Buffalo NY V.A. Medical Center and Univ. of Buffalo)

The functional neuroanatomy of tinnitus: Evidence for limbic system links and neural plasticity

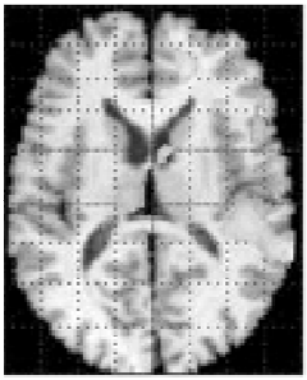
Neurology 50: 114-120, 1998.

Tinnitus … Current Research and Treatment Options: fMRI Documentation of CNS Representation of Tinnitus

Brainstem



Cortex



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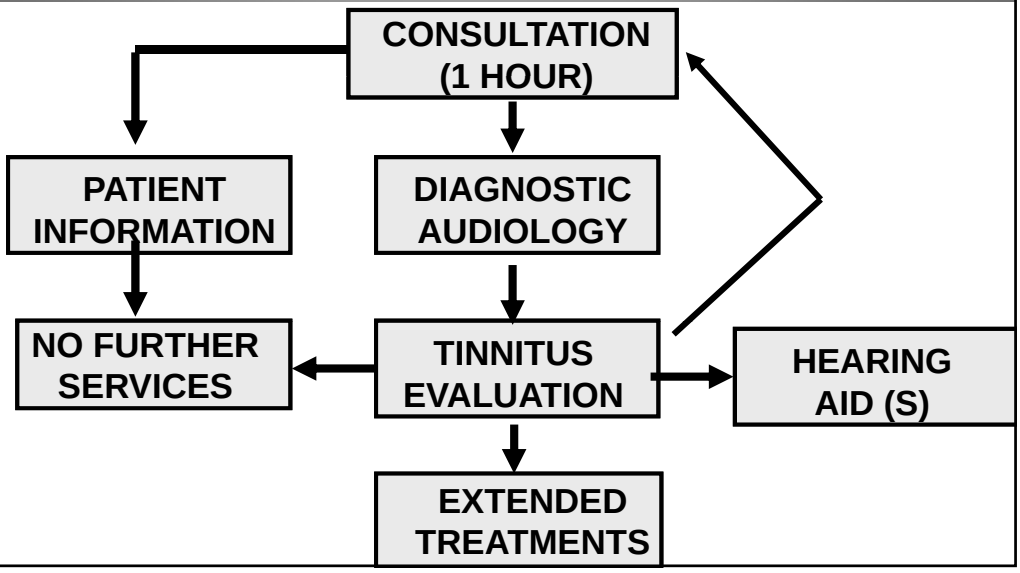
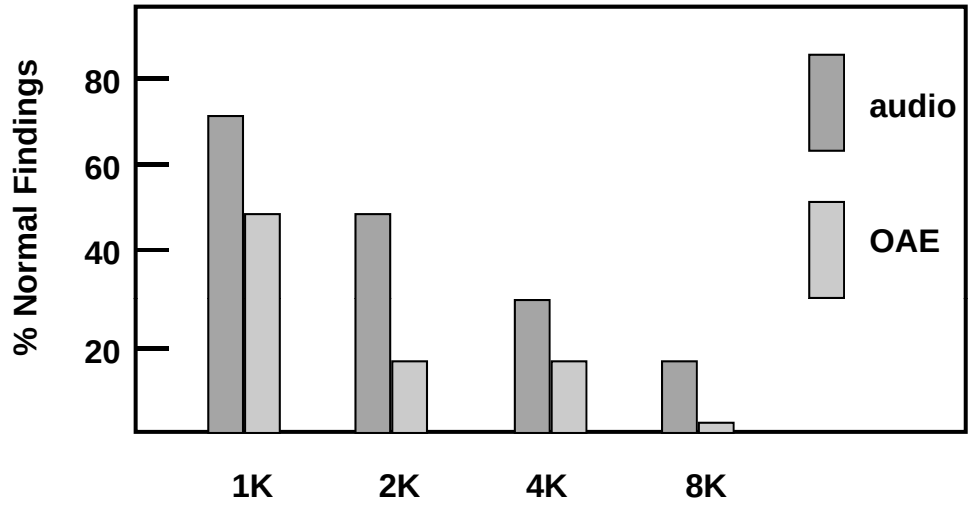
Tinnitus Assessment and Management: Role of the Audiologist



Audiological Assessment of Tinnitus

- Diagnostic Hearing Assessment
  - Immittance measurement
    - Do not record acoustic reflexes
    - Approximately 50% of tinnitus patients complain of intolerance to loud sounds
  - Pure tone audiometry
    - Conventional octave frequencies
    - Inter-octaves of 3000 Hz and 6000 Hz
    - High-frequency audiometry (> 8000 Hz) as needed
  - Word recognition scores at a comfortable level
  - Distortion product otoacoustic emissions (DPOAE) for 1 K to 10 K Hz with 6 or 8 frequencies/octave)

Audiological Assessment of Tinnitus: Audiogram versus DPOAE



Audiological Assessment of Tinnitus

- Tinnitus Assessment (for each ear)
  - Threshold for white noise to determine minimal level of background sound a person can hear
  - Match tinnitus pitch
    - Usually in 2000 to 4000 Hz region
    - High frequency tinnitus pitch (>8000 Hz) is possible
  - Estimate tinnitus “loudness”
    - Usually less than 10 dB … often only 1 or 2 dB
    - Loudness is > 15 dB in only about 1% of patients
  - Determine minimum masking level for tinnitus
    - Intensity level that “covers up” tinnitus
    - Often less than 30 dB even in contralateral ear
  - Measure loudness discomfort levels (LDLs) for tones and speech sounds to identify hyperacusis

Tinnitus Handicap Inventory

(Note: there are at least half dozen other inventories)

- **25 items with scores ranging from 0 to 100**
  - **Score of 4 for "yes", 2 for "maybe", and 0 for "no"**
  - **12 items on functional subscale, e.g.**
    - **"Because of your tinnitus do you have trouble falling to sleep at night?"**
  - **8 items on emotional subscale, e.g.,**
    - **"Does your tinnitus make you angry?"**
  - **5 items on catastrophic subscale**
    - **"Do you feel that you cannot escape your tinnitus?"**

Newman, Jacobson & Spitzer. Arch Otolaryngol Head & Neck Surg 122: 1996

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Evidence-Based Management of Troublesome Tinnitus: Practical Guidelines for the Practicing Professional

- **Counseling is Intervention**
  - **Obtain thorough medical and audiological history**
  - **Review all medications**
  - **Dispense current and accurate information on tinnitus**
  - **Answer all patient and spouse (significant other) questions about tinnitus**
  - **Rank tinnitus severity on 0 (no problem) to 10 (my life is ruined) scale**
  - **Rank patient's tinnitus, hyperacusis & hearing loss**
  - **Determine % of time patient is aware of tinnitus**
  - **Offer practical suggestions for sound enrichment**
  - **Always treat patient with compassion and empathy**

Patient/Family Counseling and Education

"Knowledge is power."

(Nam et ipsa scientia potestas est.)

Francis Bacon

(1561-1626)

Meditationes Sacrae [1597]

An Ounce of Prevention is Worth a Pound of Cure

by James W. Hall III, Ph.D.

Tinnitus is a symptom, not a disease. It's important to always remember this simple fact. When someone begins noticing an unusual sound in his or her ears, whether it's a ringing, buzzing, roaring, cricket sound, or any other sound or combination of sounds, the first logical step is to discover the underlying disorder related to the tinnitus. The exact type of tinnitus sound that a person hears is not important diagnostically. Almost all tinnitus is associated with a disorder in the auditory system – that is, somewhere within the ear or the nerves that carry signals from the inner ear to the hearing parts of the brain. By analyzing information from the patient (what health professionals call "taking a history") in combination with the results of diagnostic tests, a physician and an audiologist can usually rule out the diseases that include tinnitus as a symptom.

The majority of people with tinnitus do not have an active disease or pathology but, rather, damage or dysfunction within the inner ear that is related to exposure to high levels of sound and/or to the aging process. Nonetheless, until disease or pathology is ruled out with a thorough diagnostic assessment, it is irresponsible to simply offer to a person with tinnitus reassurance that "it's nothing to be concerned about…most people hear sounds like that."

Persistent or almost constant tinnitus is very different from the temporary ringing-type tinnitus – called spontaneous transient tinnitus – that most people notice from time to time. Spontaneous transient tinnitus typically occurs abruptly, often when a person is in a quiet setting. The ringing sound lasts only seconds, then fades away. Hearing might be muffled during this brief time period. The precise scientific explanation for spontaneous transient tinnitus is not known, but there is general agreement that it is a normal auditory experience and not a reason for concern about health or hearing.

Knowledge is Power.
– Francis Bacon

There is evidence, dating back more than 50 years, that tinnitus can be viewed as a normal auditory experience. In 1953, an otologist (a medical doctor specializing in the ear) and an audiologist conducted a very clever study (Heller and Bergman, 1953). Eighty people were enrolled as subjects in the study. Morris Heller, M.D., verified by medical history and a physical examination that the subjects had no ear disease, while Moe Bergman, Ph.D., performed an audiogram (a simple test of hearing losses) to confirm that the subjects had normal hearing sensitivity. One by one, the subjects were placed in a specialized sound-treated room. Upon emerging from the room, these normal-hearing subjects were asked if they heard anything. The vast majority (75 out of the 80, or 94%) reported that they heard some type of sound in the room. The three sounds described most often by the subjects were "humming," "buzzing," and "ringing," although a diverse collection of 23 other sounds were also noted (e.g., whistling, squeaking, and a thumping pulsation). Because of this study, we've learned that almost everyone will hear sounds…that is, tinnitus…in a very quiet setting.

It's reasonable to assume that most people who are reading an article in *Tinnitus Today* already hear their tinnitus. Therefore, you might think it's too late to prevent a problem that already exists. But there is a type of prevention that is important to focus on – the prevention of deteriorating quality of life sometimes brought about by persistent tinnitus.

Hearing Protection – The First Line of Defense

The old adage coined by Ben Franklin, "An ounce of prevention is worth a pound of cure," certainly applies in any discussion of the best treatment strategy for tinnitus. The most common single cause of hearing loss and tinnitus in adults is exposure to excessive sound levels. As a rule, sound levels that you have to shout over to be heard can cause inner ear damage. The source or type of sound – for example, rock or classic music, gunfire, machinery noise, factory noise, or fireworks – does not determine the risk for hearing loss. The two most important factors that determine the risk for hearing loss are the intensity (or loudness) of the sound and the length of time that a person is exposed to the sound. There is also a genetic factor in the susceptibility to noise-induced hearing loss. That is, some people are more likely to sustain damage to the tiny and delicate hair cells in the inner ear than others. Two people may be exposed to the same levels of noise for the same duration of time, for example, two factory workers or two musicians in an orchestra or a rock band. Despite the similarity in sound exposure, one person will develop a significant and permanent hearing loss, while the other person's hearing will remain normal.

Other risk factors are associated with the onset of tinnitus, among them middle ear problems (pressure imbalances behind the eardrum due to Eustachian tube dysfunction), sinus disease, temporomandibular joint (TMJ) disorders, high levels of personal stress, and some drugs used to treat health problems unrelated to tinnitus. In my clinical experience, a person will often first notice tinnitus when two or more of these risk factors occur during the same period of time. Prompt medical or, as appropriate, non-medical attention to each of these disorders can help prevent persistent tinnitus.

Professional Care – the Second Line of Defense

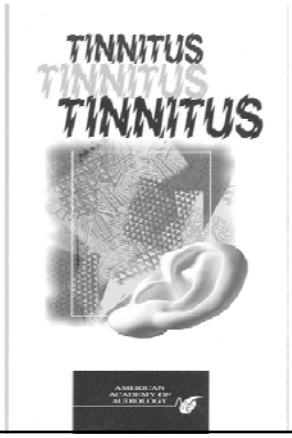
You may already have bothersome tinnitus. But you can prevent further deterioration in the quality of your life. In fact, you can almost always return to the quality of life you enjoyed in the past – before it was negatively affected by tinnitus. Knowledge is an essential ingredient in the process of restoring quality of life and of recovering from the debilitating effects of tinnitus. For a person with tinnitus, knowledge is truly power. What does a person with tinnitus need to know?

Sometimes, the silence can be like thunder.
– Bob Dylan

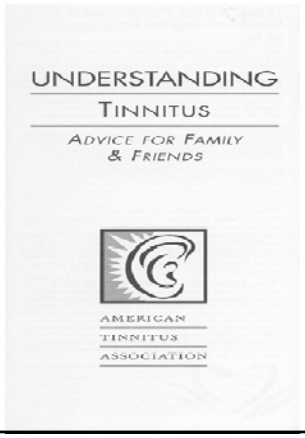
(continued on page 16)

Management of Tinnitus: Patient Education

American Academy of Audiology
www.audiology.org



American Tinnitus Association
www.ata.org



Tinnitus is a Symptom of Many Diseases and Disorders: Medical Management is Top Priority for Select Patients

- **Noise-induced cochlear dysfunction**
- **Presbycusis**
- **Temporal mandibular joint disorders**
- **Congenital sensory hearing loss**
- **Head injury**
- **Lightning injury**
- **Meniere's disease**
- **Otosclerosis**
- **Inflammatory disorders, e.g., arthritis**
- **Metabolic disorders, e.g., hyperlipidemia**
- **Neurologic disorders, e.g., multiple sclerosis**
- ***Vestibular schwannoma, e.g., eighth nerve tumor***

Some of the Common Drugs (among over 100 drugs) that may Enhance or (Rarely) Produce Tinnitus *(for > 3% of patients)*

Alka seltzer	**Aspirin**	**Celebrex**	**Cipro**
Claritin	**Effexor**	**Floxin**	**Lariam**
Lipitor	**Motrin**	**Norvasc**	**Pepcid**
Procardia	**Prozac**	**Pepto-bismol**	**Phenergan**
Septra	**Strepomycine**		**Tegretol**
Vancanese	**Vascor**	**Viagra**	**Vioxx**
Xanax	**Zithromax**	**Zoloft**	**Zyrtec**

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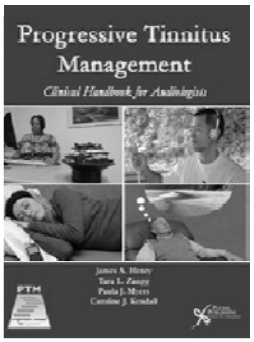
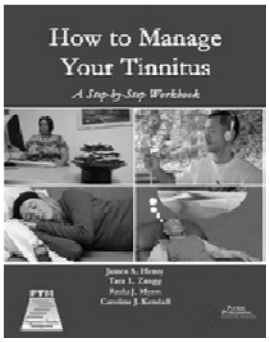
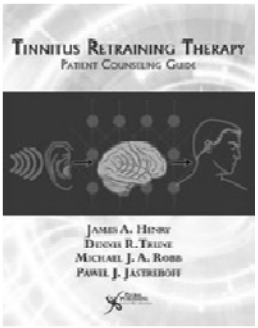
PROGRESSIVE TINNITUS MANAGEMENT: VA National Center for Rehabilitative Audiology Research (NCRAR) *James A. Henry and Colleagues*

James Henry

www.pluralpublishing.com







Tinnitus: Specific Management Approaches

- In depth counseling by audiologist experienced with tinnitus
- Written accurate information for patient and significant others
- Melatonin in the evening before going to bed
- Sound enrichment
  - Environmental sound device (< $25), e.g., Bed, Bath & Beyond
  - www.soundtherapy.com
  - Sound pillow
- Amplification if at all indicated (natural sound therapy)
  - Hearing aid (open fit hearing aids are especially useful)
  - Combination hearing aid/sound generator
- Cochlear implants (as indicated)
  - Baguley & Atlas. Cochlear implants and tinnitus. In Langguth, Hajak, Kleinjung, Cacace, Møller. *Progress in Brain Research, 166*: 2007

Melatonin in the Management of Tinnitus

Piccirillo JF. Melatonin. *Prog Brain Res. 2007;166*:331-3.
Melatonin is a neurohormone that is secreted by the pineal gland and known to impact the sleep-wake cycle. Melatonin is regarded to be a safe and natural sleep aid. Since many people with tinnitus suffer sleep disturbance, melatonin has been studied as a therapeutic agent for tinnitus. A review of the literature suggests that melatonin has a beneficial effect on tinnitus, especially for patients with sleep disturbance, but it does not seem to modify the strength or frequency of the tinnitus.

Melatonin and Sulodexide* in the Management of Tinnitus

**** used for the prophylaxis and treatment of thromboembolic diseases***

De Stefano et al. (2009). Treatment of central and sensorineural tinnitus with orally administered Melatonin and Sulodexide: personal experience from a randomized controlled study. *Acta Otorhinolaryngol Ital, 29*, 86-91

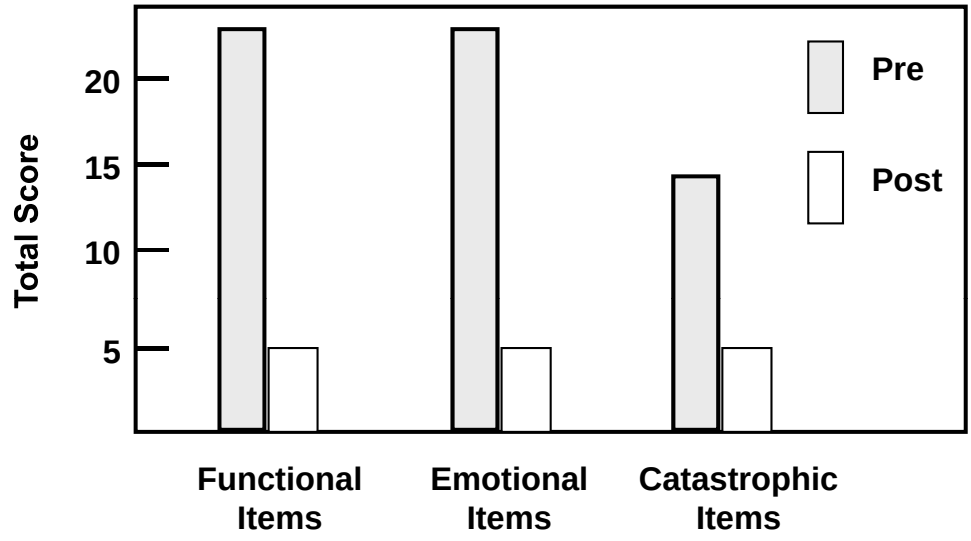
After randomisation, 34 patients were treated with Melatonin and Sulodexide, another 34 were treated with Melatonin alone, while the remaining 34 (control group) were managed without treatment in order to evaluate spontaneous variations in the quality of tinnitus. Patients were assessed prospectively with the Tinnitus Handicap Inventory … both pre- and post-treatment. Better results … were found in the group who received Melatonin and Sulodexide compared to those receiving Melatonin alone. No improvement was observed in the control group. In conclusion, Melatonin in combination with Sulodexide is, in our opinion, a viable treatment option for patients suffering from central or sensorineural tinnitus.

Sound Enrichment in the Management of Tinnitus

Environment Sound Machine
~ $25

Sound Pillow
~ $30

Benefit of Counseling in Tinnitus: THI scores before versus > 6 months after counseling *(Hall & Haynes, 2001)*



Custom Sound Therapy/Hearing Aid Devices as Part of a Tinnitus Management Program

Custom Sound Therapy/Hearing Aid Devices as Part of a Tinnitus Management Program

- **Open fit hearing aids**
- **Sound generation devices**
- **Combination hearing aid sound generation devices, e.g., Tinnitus control feature for:**
  - **Siemens Pure Carat 701, 501, and 301 hearing instruments**
  - **Siemens Life 701, 501, 301, and 101 hearing instruments**
- **Used with programs for**
  - **Microphone input (amplification**
  - **Noise (sound generation for tinnitus therapy)**
    - **White noise (equal intensity at each frequency)**
    - **Pink noise (equal intensity within each octave)**
    - **Speech noise (NBN in speech freqeuncy region)**
    - **High tone noise**
  - **Mixed (tinnitus therapy plus hearing aid)**

Tinnitus Retraining Therapy (TRT): The Neurophysiologic Model

"The model stresses (a) the importance of the basic principles of the functioning of the nervous system, such as the capacity to be habituated to signals that are emotionally neutral and do not carry important information, and (b) the fundamental feature of the nervous system -- its plasticity."

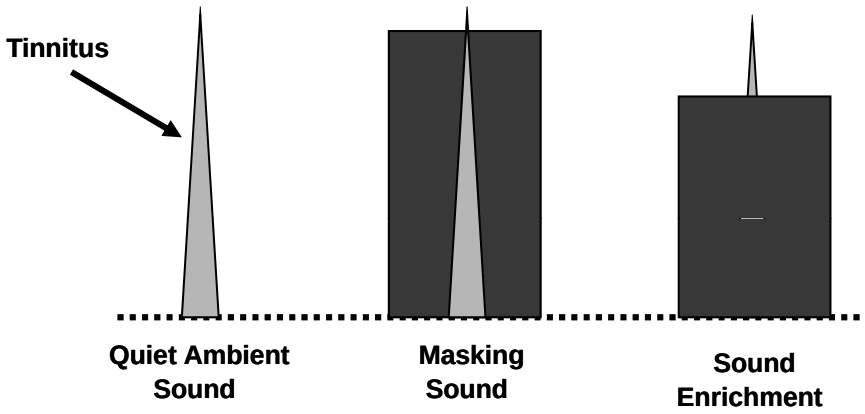
Jastreboff, Gray & Gold, 1996

Tinnitus Retraining Therapy (TRT): Recent Evidence of Positive Outcome

- Hatanaka A, Ariizumi Y, Kitamura K. (2008) Acta Otolaryngol. 2008 Apr;128(4):365-8.
  - decrease in THI from 49 to 28 after 6 months
- Madeira G, Montmirail Ch, Decat M, Gersdorff M. 2007. TRT: results after one year treatment. Rev Laryngol Otol Rhinol (Bord). 2007;128(3):145-8. [night-time treatment]
  - Improvement by Jastreboff category
    - ✓ 1. Tinnitus (n = 6), 100% improved
    - ✓ 2. Tinnitus with hearing loss (n = 16); 62% improved
    - ✓ 3. Hyperacusis (with or without Tinnitus) (n = 16), 88.5% improved
    - ✓ 4. Hyperacusis (with or without Tinnitus, exacerbated by noise) (n = 8), 75% improved.
- Herraiz C, Hernandez FJ, Toledano A, Aparicio JM. Tinnitus retraining therapy: prognosis factors. Am J Otolaryngol. 2007 Jul-Aug;28(4):225-9.
  - TRT is effective
- Henry JA, Schechter MA, Zaugg TL, Griest S, Jastreboff PJ, Vernon JA, Kaelin C, Meikle MB, Lyons KS, Stewart BJ. Clinical trial to compare tinnitus masking and tinnitus retraining therapy. Acta Otolaryngol Suppl. 2006 Dec;(556):64-9.
  - Tinnitus masking more effective than TRT at 3 months
  - TRT more effective than tinnitus masking at 18 months

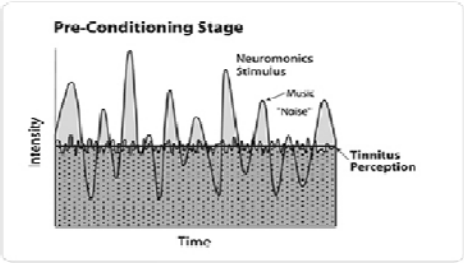
Sound Enrichment/Treatment

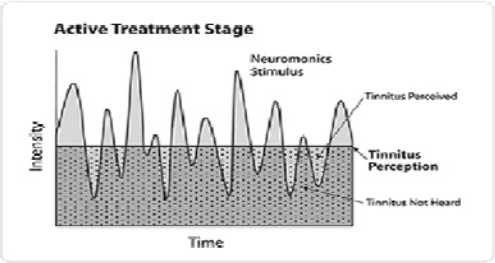
(Pawel Jastreboff)



Neuromonics Tinnitus Treatment: Five Step Treatment

- **Step 1: Comprehensive Personalized Assessment**
- **Step 2: Processor Configuration**
- **Step 3: Pre-Conditioning Stage**
- **Step 4: Active Treatment Stage**
- **Step 5: Maintenance Stage**





Intervention and Management of Tinnitus: Residual Inhibition

Roberts L. Residual inhibition. In B Langguth, G. Hajak, T Kleinjung, A. Cacace & A. R Moller (Eds.) *Progress in Brain Research 166*: 2007.

- **Feldman (1971) first reported brief reduction in tinnitus after the use of a masker for tinnitus relief, i.e., residual inhibition (RI)**
- **RI most effective when masker is in the frequency region of the hearing loss (and tinnitus)**
- **Mechanism of residual inhibition may be related to loss of efferent activity within CANS in persons with tinnitus, one mechanism of tinnitus**
- **Some patients with tinnitus experience sustained relieve from tinnitus after brief periods of masking (Danesh, 2007)**
  - **Perhaps measurement of responsiveness to RI should be determined in the clinical evaluation of tinnitus**

Evidence-Based Management of Troublesome Tinnitus: Practical Guidelines for the Practicing Professional
Summary

- **Tinnitus is a symptom, not a disease.**
- **Audiologic and medical diagnosis is essential.**
- **With general and short term management options, most patients (> 80%) return to the quality of life they enjoyed before the perception of bothersome tinnitus.**
- **Effective extended tinnitus management options are available, e.g., TRT or Neuromonics.**
- **All patients with bothersome tinnitus should have hope.**

Evidence-Based Management of Troublesome Tinnitus: Practical Guidelines for the Practicing Professional

Discussion and Questions