Mechanisms, Assessment, and Management of Tinnitus: Good News About a Bad Problem

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BIZARRO

Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

- What is tinnitus?
- Five steps toward relief from bothersome tinnitus
  - diagnostic audiologic assessment
  - counseling about tinnitus
  - medical consultation to rule out diseases associated with tinnitus
  - general management strategies
  - extended and specific tinnitus management options
- Original research and case studies
- Conclusions: The bottom line … there is hope for every person with bothersome tinnitus.

Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

SUBJECT: Terrified

Dear Dr. Hall--I hate to impose on you like this but I'm scared to death about tinnitus/hyperacusis (not sure which) and have no access to any knowledgeable doctor or anything.

I found your email on Jastreboff's TRT website and thought you might be able to help me. I realize this letter is long and includes a description of my own situation, but I'm not looking for a diagnosis or anything, just an opinion. Hopefully that will allay the panic.

Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

I've been afraid of tinnitus for ages but always just had a slight fuzz in the left ear and was OK with that and was rarely aware of it. Over Christmas I went off a high-dose antidepressant after 4 years (for OCD). I did have one withdrawal effect (dizziness)—which scared the heck out of me and made for a very stressful Christmas— and had to go back on the drug but at a very low dose.

Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

I was fine then for nine days. Back to normal. Then, one night I realized that all I could hear was tinnitus in my left ear—but it really wasn't all that loud—in fact it seemed just like the usual slight fuzz but I couldn't shake the awareness as usual. And the more I listened to it the louder it seemed to be.

So, that's the backstory. The real fear now is that I when I awaken in the morning, I'm quite OK, fairly normal—terrified of tinnitus—but not hearing anything unusual. Then, when I sit down to watch television or at the computer, the fuzzy/staticy sound they produce seem to bring about or enhance my detection of tinnitus. Similarly, I always used to sleep with the radio on very low (sometimes between stations just for the static) and now I can't do that. I have to sleep in silence.

Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

Other sounds of any kind, loud or soft, do not bother me—whether it be clanking dishes, slamming doors, birds, drills whatever Basically just fuzzy sounds or sounds that sound like tinnitus.

What really brought this fear to a head was reading Jastreboff and Hazell's book on TRT and reading about Category 4. I'm terrified, somehow, I've gone from OK with the tinnitus before Christmas to this Category 4—which they say has the lowest probability of success. Very scary!

Please if there's any way you could answer this email I would be really, really grateful. Is there any grounds to allay my fears or does this really sound like a Category four problem.

Thanks very much.

WD

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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.

TINNITUS ASSESSMENT AND MANAGEMENT:
Clinical Experience

Description of types of tinnitus for 119 patients presenting for consultation

ringing = 47
crickets = 21
high-pitch tone = 17
hissing = 13
humming =13
roaring = 6
static noise = 5
buzzing = 4
pulsing = 4

clicking = 2
frying sound = 2
mid-pitch tone = 1
screeching = 1
whizzing = 1
fizzing = 1
siren = 1
crackling = 1
running water = 1

TINNITUS ASSESSMENT AND MANAGEMENT:
Is ringing tinnitus really a pure tone?

- Ringing tinnitus is really a spectrum of multiple frequencies
  - Fowler, 1944
    - ✓Narrow band of frequencies (versus one)
  - Reed, 1960
    - ✓Patients couldn't match ringing to single frequency
  - Vernon & Meikle, 2003
    - ✓Tinnitus match > 3000 Hz for 75% of subjects
  - Norena et al, 2002
    - ✓More than one frequency identified by subjects as their ringing tinnitus pitch

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 10 million Americans who seek medical attention for their tinnitus.
- Tinnitus is debilitating for an estimated 2 million Americans.

Tinnitus in Military Personnel and Veterans: A Serious and Growing Health Problem

- Hearing Loss Now A Military Epidemic: Roadside Bombs Send Troops Home From Combat With An Alarming Rate Of Hearing Damage *(AP, San Diego, March 8, 2008)*
  - "Hearing damage is the No. 1 disability in the fight against terror, according to the Department of Veterans Affairs, and some experts say the true toll could take decades to become clear. Nearly 70,000 of the more than 1.3 million troops who have served in the two war zones are collecting disability for tinnitus, a potentially debilitating ringing in the ears, and more than 58,000 are on disability for hearing loss, the VA said."
  - "It's funny, you know. When it happened, I didn't feel my leg gone. What I remember was my ears ringing," said Former Staff Sgt. Ryan Kelly, whose leg was blown off below the knee in 2003. Today, his leg has been replaced with a prosthetic, but his ears are still ringing. "It is constantly there," he said. "It constantly reminds me of getting hit. I don't want to sit here and think about getting blown up all the time. But that's what it does."

Tinnitus in Military Personnel and Veterans: A Serious and Growing Health Problem (2)

- "Sixty percent of U.S. personnel exposed to blasts suffer from permanent hearing loss, and 49 percent also suffer from tinnitus, according to military audiology reports. The hearing damage ranges from mild, such as an inability to hear whispers or low pitches, to severe, including total deafness or a constant loud ringing that destroys the ability to concentrate. There is no known cure for tinnitus or hearing loss.

  The number of servicemen and servicewomen on disability because of hearing damage is expected to grow 18 percent a year, with payments totaling $1.1 billion annually by 2011, according to an analysis of VA data by the American Tinnitus Association. Anyone with at least a 10 percent loss in hearing qualifies for disability." (AP, March 8, 2008)

Tinnitus (and Hearing Loss) in Military Personnel and Veterans: A Serious and Growing Health Problem

- Soldier's story illustrates risks of hearing loss in war *(*Gregg Zoroya, *USA TODAY 8/4/2008)*
  - "Hearing loss is one of the most common ailments that affects troops sent back to combat, according to the Pentagon and government researchers. One in four soldiers serving in Iraq or Afghanistan have damaged hearing, the Army says. In addition, a recent study from the RAND Corp. reported one in five combat veterans suffer post-traumatic stress disorder (PTSD) or depression. Back pain, leg injuries and other muscular-skeletal problems are the top ailments of troops in the war zone, says Ellen Embrey, deputy assistant secretary of Defense for force health protection and readiness."

TINNITUS ASSESSMENT AND MANAGEMENT: Good News for a Bad Problem

- 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"

TINNITUS ASSESSMENT AND MANAGEMENT: 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

Tinnitus and Patient Characteristics
(psychiatry perspective)

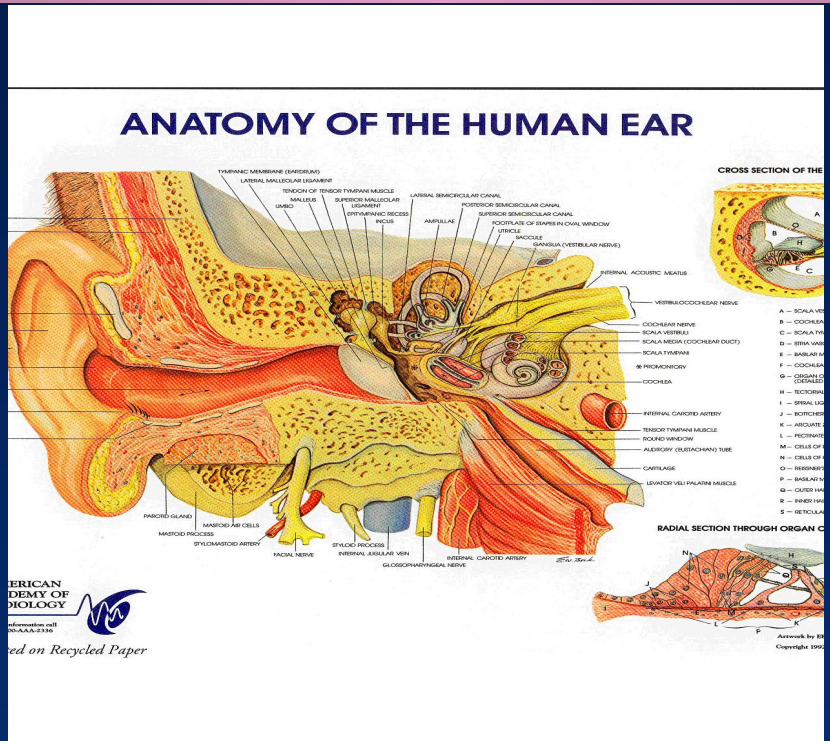
- Langguth et al. Tinnitus severity, depression, and the big five personality traits. In Langguth, Hajak, Kleinjung, Cacace, Møller. *Progress in Brain Research, 166*: 2007
  - "Big five personality traits
    - ✓ Neuroticism (anxiety trait): some correlation with tinnitus
    - ✓ Extraversion
    - ✓ Openness
    - ✓ Agreeableness: negative correlation with tinnitus (THI)
    - ✓ Conscientiousness
  - Tinnitus correlated with depression
  - Correlation of tinnitus with "unhappy triad" not yet defined
    - ✓ 1. Depression
    - ✓ 2. Anxiety
    - ✓ 3. Irritability

Jack Vernon
“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

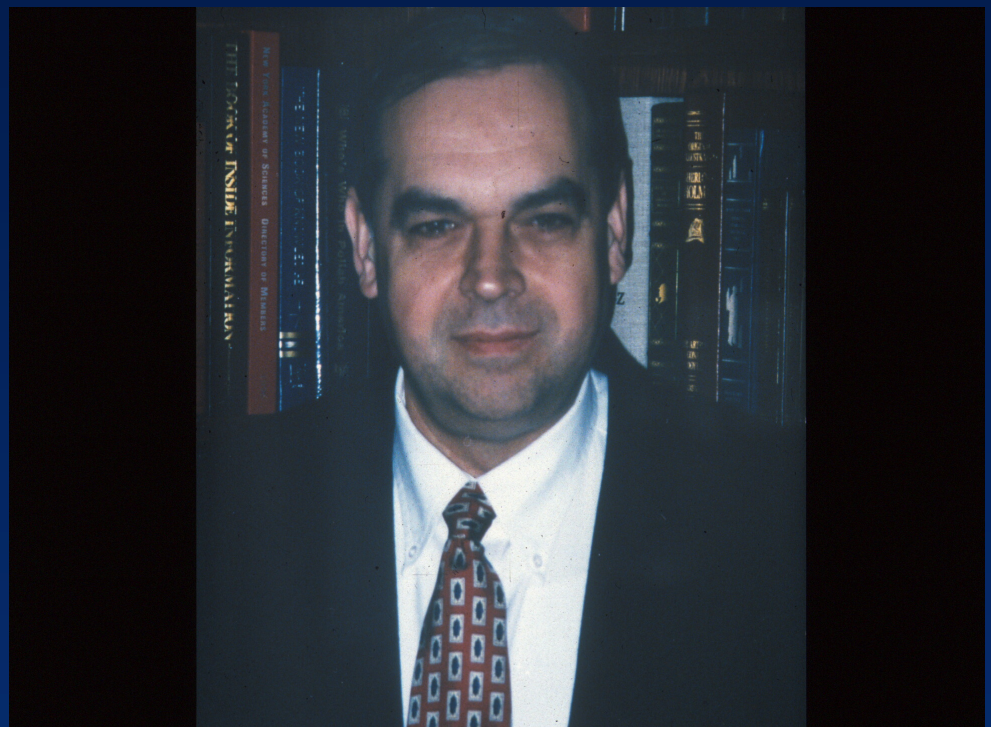
Current Theories and Publications on the Mechanisms and Management of Tinnitus

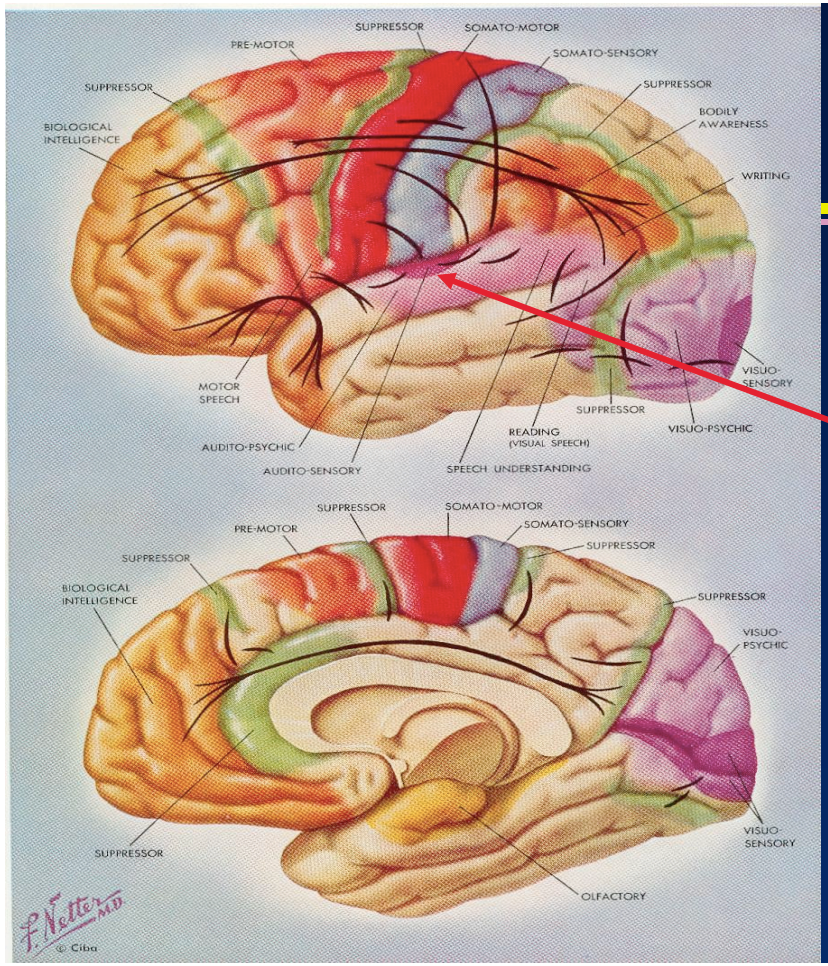
- Baguley DM. Mechanisms of tinnitus. *British Medical Bulletin 63*: 195-212, 2002.
- Eggermont JJ & Roberts LE. The neuroscience of tinnitus. TRENDS in Neuroscience 27: 2004.
- Eggermont JJ. Tinnitus: neurobiological substrates. *Drug Discovery Today 10*: 2005.
- Shore, Zhou & Koehler. Neural mechanisms 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”
(www.tinnitus-pjj.com)

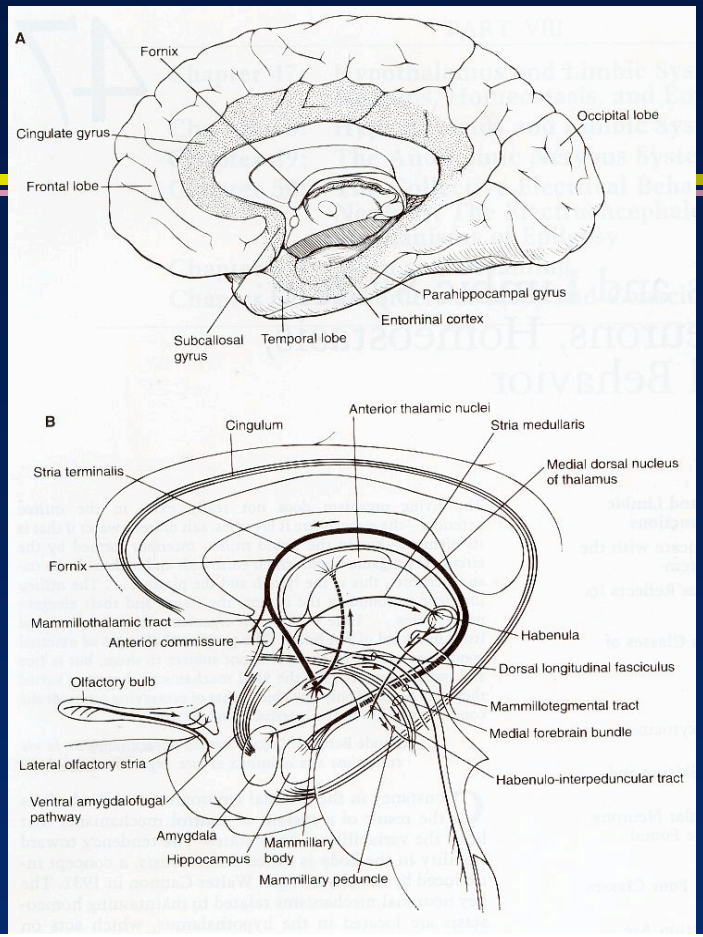




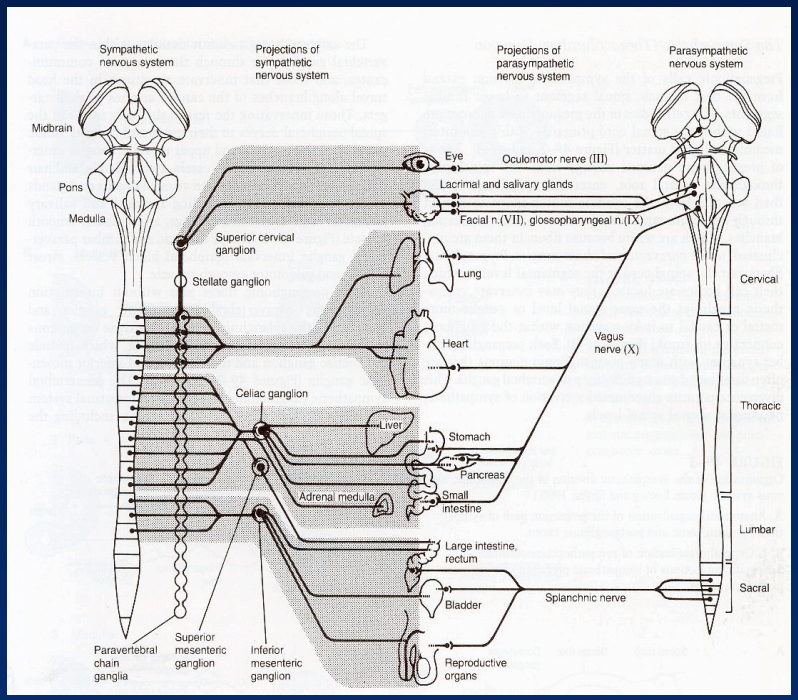
Tinnitus Anatomy & Physiology

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 ASSESSMENT AND MANAGEMENT:
fMRI Documentation of CNS Representation of Tinnitus

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

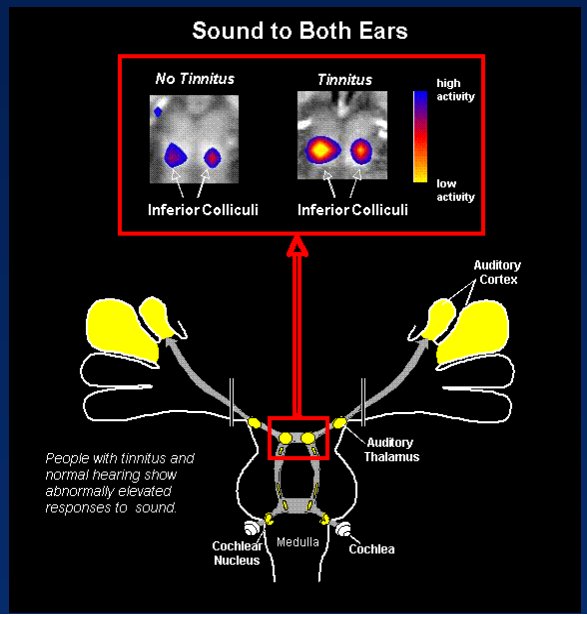
(Buffalo NY V.A. Medical Center and Univ. of Buffalo)

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

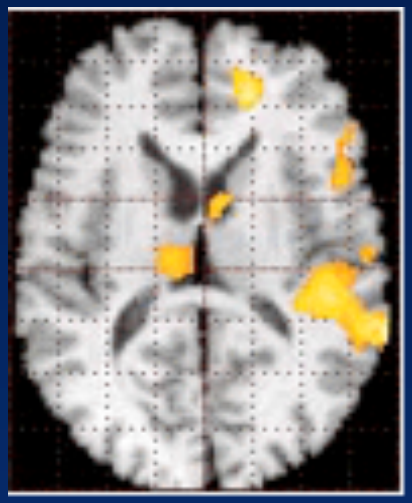
Neurology 50: 114-120, 1998.

TINNITUS ASSESSMENT AND MANAGEMENT:
fMRI Documentation of CNS Representation of Tinnitus

Brainstem



Cortex



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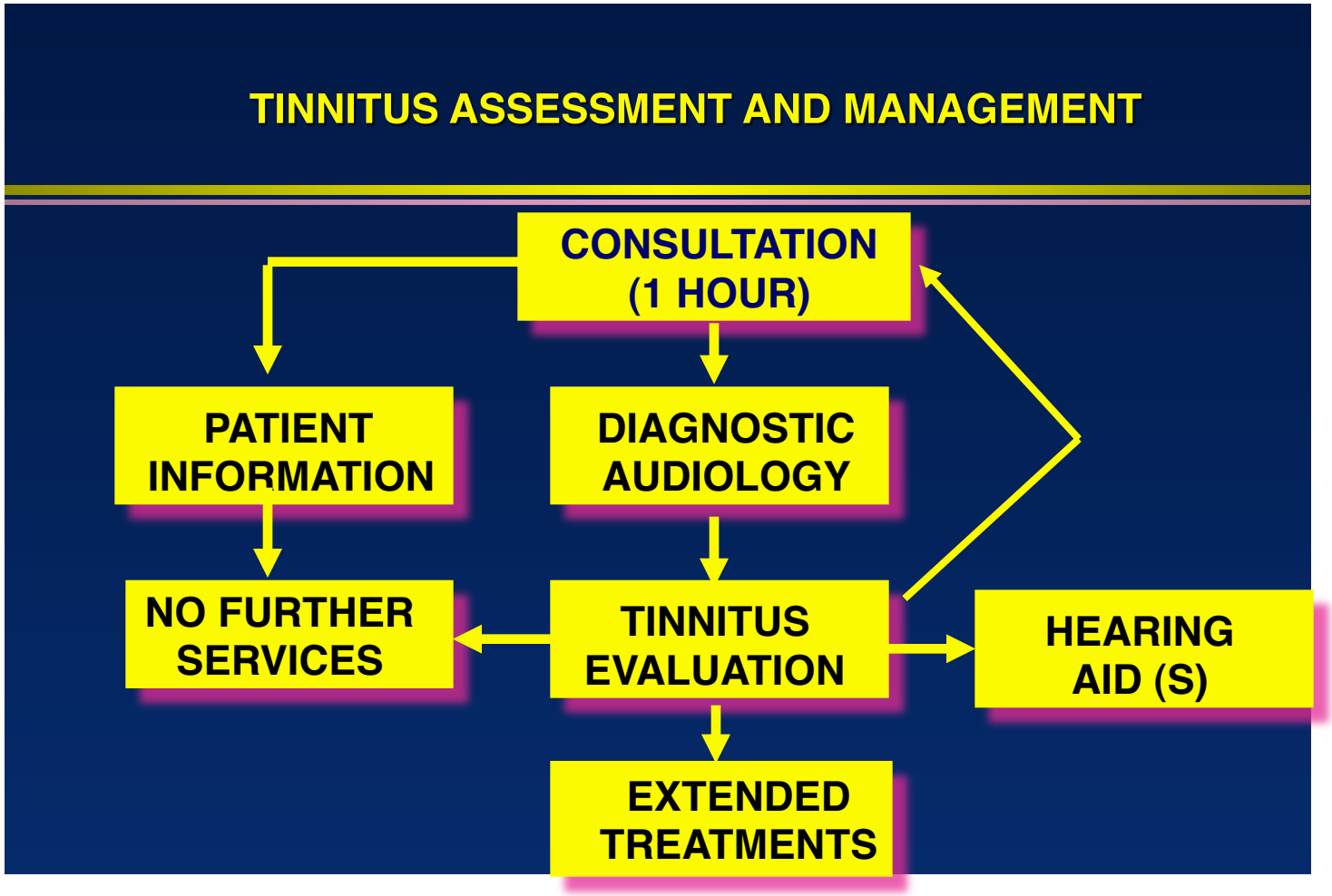
TINNITUS ASSESSMENT AND MANAGEMENT
CONSULTATION (1 HOUR)
PATIENT INFORMATION
DIAGNOSTIC AUDIOLOGY
NO FURTHER SERVICES
TINNITUS EVALUATION
HEARING AID (S)
EXTENDED TREATMENTS

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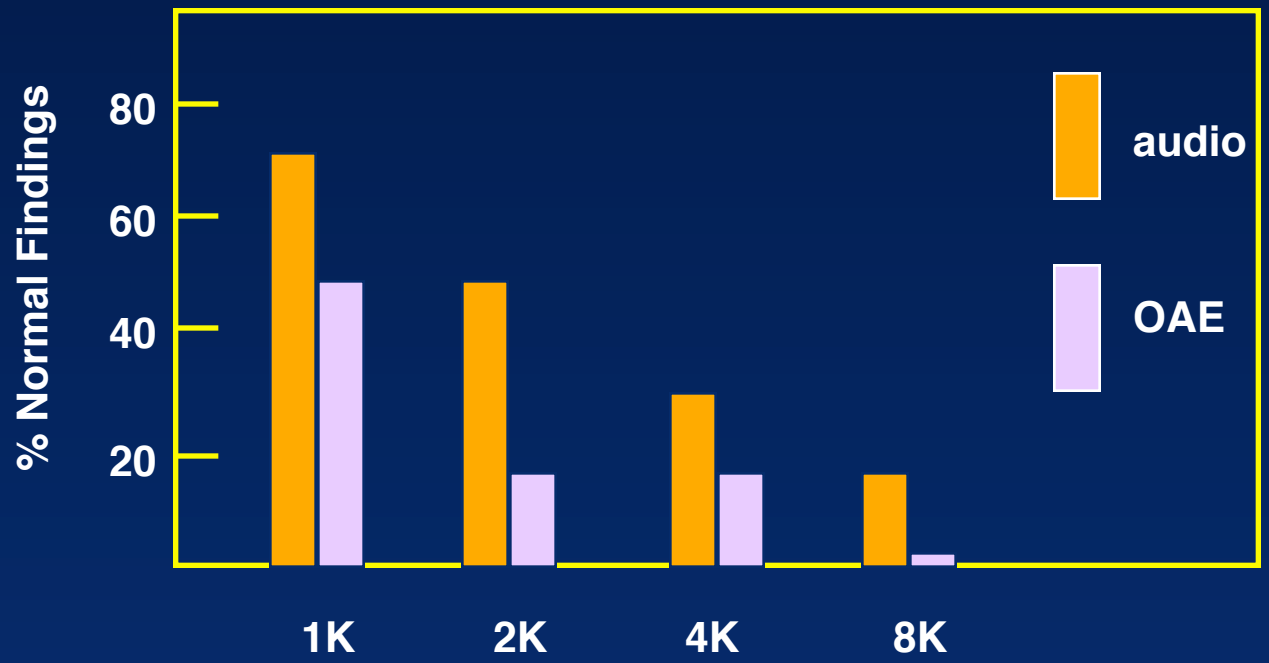
TINNITUS ASSESSMENT AND MANAGEMENT

❑ DIAGNOSTIC AUDIOLOGY

- Immittance measurement (no acoustic reflexes for patients with hyperacusis (54% of tinnitus patients)
- Pure tone audiometry (include inter-octaves > 2000 Hz)
- Word recognition scores (at comfortable level)
- Distortion product otoacoustic emissions (DPOAE) for 1 K to 10 K Hz (6 frequencies/octave)
- Neuro-diagnostic auditory brainstem response (ABR) as indicated

TINNITUS ASSESSMENT AND MANAGEMENT:
Audiogram versus DPOAE



TINNITUS ASSESSMENT: Otoacoustic emissions

- Granjeiro et al. Transient and distortion product evoked oto-acoustic emissions in normal hearing patients with and without tinnitus. Arch Otorhinolaryngol Head Neck Surg 134: 2008.
  - Subjects
    - ✓32 patients with tinnitus with hearing levels < 25 dB HL
    - ✓Control of 37 people age and gender matched without tinnitus
  - Results
    - ✓ TEOAE
      - 70% abnormal in tinnitus group
      - 16% abnormal in control group
    - ✓DPOAEs
      - 68% of tinnitus subjects had abnormal DPOAEs
      - 50% of normal group had abnormal DPOAEs

TINNITUS ASSESSMENT:
Auditory Brainstem Response (ABR)

- Kehrle et al. Comparison of auditory brainstem response results in normal hearing patients with and without tinnitus. Arch Otorhinolaryngol Head Neck Surg 134: 2008.
  - Subjects
    - ✓37 patients with tinnitus (pure tones ≤ 25 dB HL)
    - ✓38 without tinnitus
    - ✓Age 20 to 45 years
  - Among tinnitus patients
    - ✓Abnormal ABRs in at least one parameter for 43%
    - ✓Wave I-III latency interval increased in tinnitus group (is this a reflection of dysfunction in dorsal cochlear nucleus?)

TINNITUS ASSESSMENT AND MANAGEMENT

- **TINNITUS EVALUATION (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)*
  - Estimate tinnitus "loudness" *(usually less than 10 dB … often 1 or 2 dB)*
  - Determine minimum masking level for tinnitus *(often less than 30 dB)*
  - 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
  - 12 on functional subscale, e.g.
    - ✓ "Because of your tinnitus do you have trouble falling to sleep at night?"
  - 8 on emotional subscale, e.g.,
    - ✓ "Does your tinnitus make you angry?"
  - 5 on catastrophic subscale
    - ✓ "Do you feel that you cannot escape your tinnitus?"

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

Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

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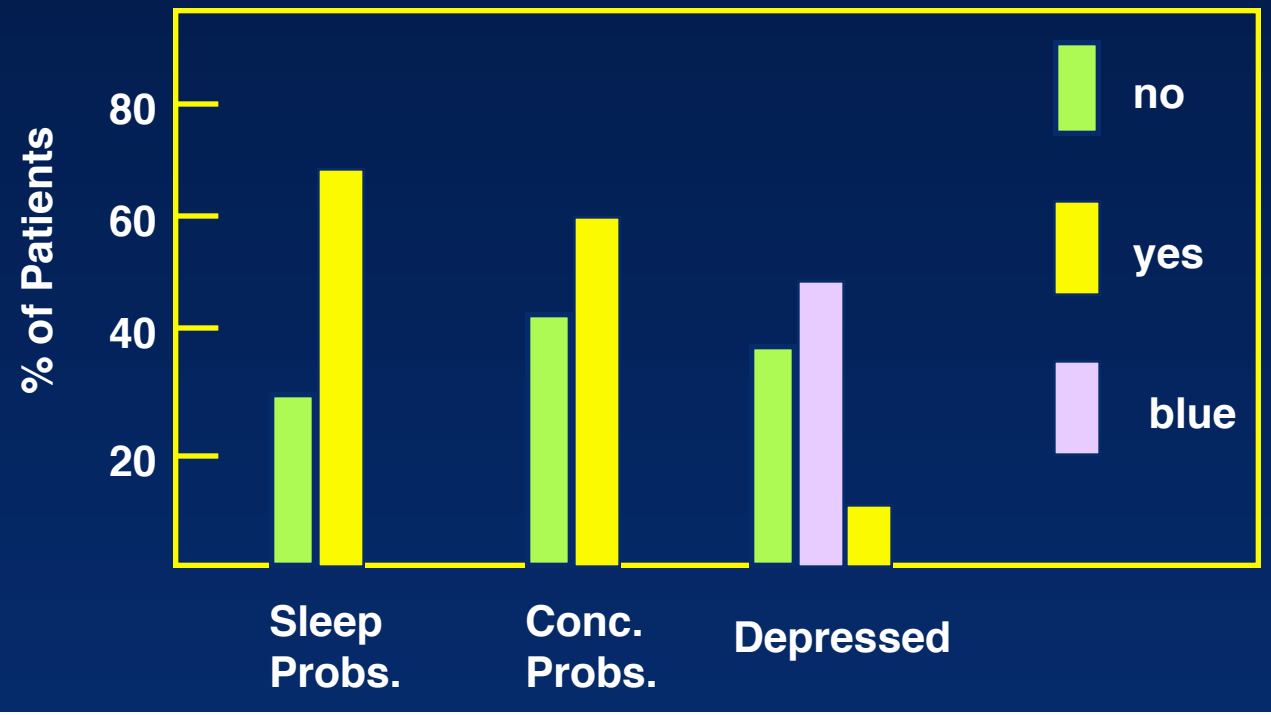
TINNITUS ASSESSMENT AND MANAGMENT

- **CONSULTATION**
  - Obtain thorough medical and audiologic history
  - Review all medications
  - Dispense current 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

CHARACTERISTICS OF PATIENTS WITH TINNITUS WHICH AFFECT QUALITY OF LIFE INCLUDE:

- Sleep problems, including deprivation
- Limited concentration when, e.g., reading, driving, working
- Anger
- Irritation
- Guilt
- Fear
- Anxiety
- Depression, including depression

TINNITUS ASSESSMENT AND MANAGEMENT:
Severity of tinnitus (N = 121)



Patient/Family Counseling and Education

“Knowledge is power.”
(Nam et ipsa scientia potestas est.)

Francis Bacon
(1561-1626)

Meditationes Sacrae [1597]

Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

Email Response to Terrified Patient

Dear Mr. D:

If you are near or in Florida, I would be happy to see you in my clinic. Without performing a complete evaluation of your hearing and tinnitus, I cannot be specific about treatments. I can tell you that all persons with tinnitus and hypercusis can be helped, and most progress to the point where they are unaware of their tinnitus. I can assure you that you do not need to panic about the condition.

I've enclosed several documents about tinnitus for your review.

If you do elect to make an appointment, call our receptionists at 352-273-5555 and ask for a tinnitus consultation and evaluation with me.

Best wishes ...

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 tones) 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.

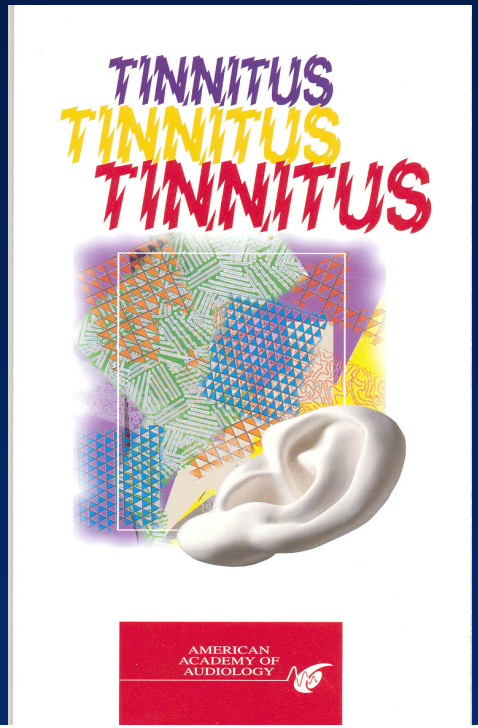
Professional Care – the Second Line of Defense

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)

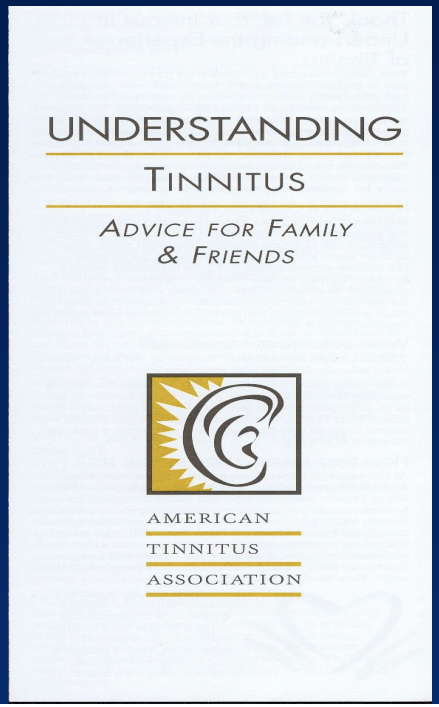
TINNITUS MANAGEMENT:
Patient Education



American Academy of Audiology

www.audiology.org

TINNITUS MANAGEMENT:
Patient and Family Education



Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

- Five steps toward relief from bothersome tinnitus
  - Diagnostic audiologic assessment
  - Counseling about tinnitus
  - Medical consultation to rule out diseases associated with tinnitus
  - General management strategies
  - Extended and specific tinnitus management options

TINNITUS IS A SYMPTOM OF MANY DISEASES AND DISORDERS, e.g.,

- 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*

Selected 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

Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

- Five steps toward relief from bothersome tinnitus
  - Diagnostic audiologic assessment
  - Counseling about tinnitus
  - Medical consultation to rule out diseases associated with tinnitus
  - General management strategies (~ 80% of patients)
  - Extended and specific tinnitus management options

Assessment & Audiologic Management of Tinnitus: General 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

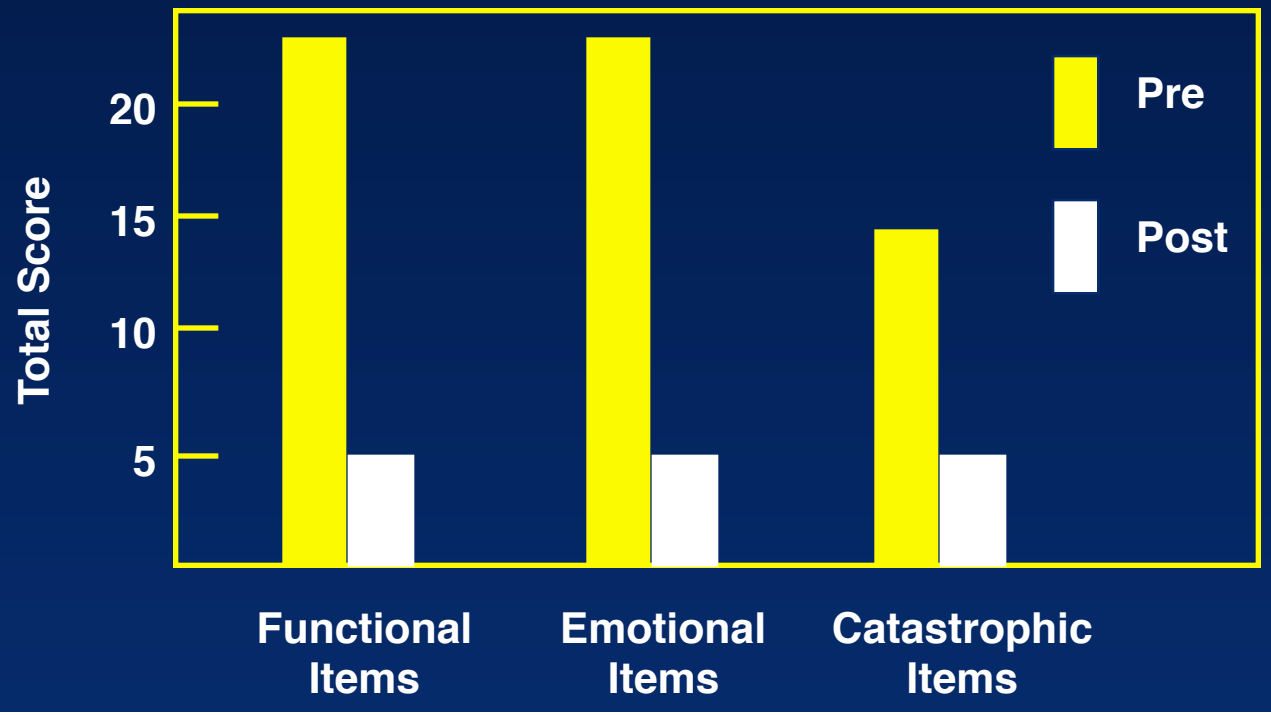
After randomisation, 34 patients were treated with Melatonin and Sulodexide, another 34 were treated with Melatonin alone, while the remaining 34 (control group) were managed without treatment in order to evaluate spontaneous variations in the quality of tinnitus. Patients were assessed prospectively 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 after counseling (> 6 months later)



Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

- Five steps toward relief from bothersome tinnitus
  - Diagnostic audiologic assessment
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  - General management strategies
  - Extended tinnitus management options
    - ✓Tinnitus retraining therapy (TRT)
    - ✓Neuromonics tinnitus treatment

Tinnitus Retraining Therapy: 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."

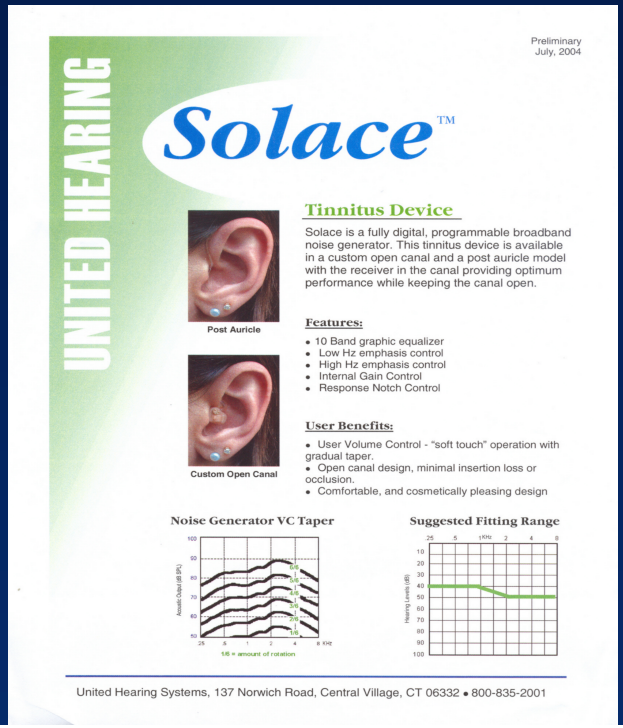
Jastreboff, Gray & Gold, 1996

TINNITUS MANAGEMENT:
Custom Sound Therapy Devices

General Hearing Instruments

New Orleans, LA

TINNITUS MANAGEMENT: Combination Hearing Aid and Sound Therapy Devices (Digital)



Preliminary
July, 2004

UNITED HEARING

Solace™

Tinnitus Device

Solace is a fully digital, programmable broadband noise generator. This tinnitus device is available in a custom open canal and a post auricle model with the receiver in the canal providing optimum performance while keeping the canal open.

Post Auricle

Custom Open Canal

Features:

- 10 Band graphic equalizer
- Low Hz emphasis control
- High Hz emphasis control
- Internal Gain Control
- Response Notch Control

User Benefits:

- User Volume Control - "soft touch" operation with gradual taper.
- Open canal design, minimal insertion loss or occlusion.
- Comfortable, and cosmetically pleasing design

Noise Generator VC Taper

1/8 = amount of rotation

Suggested Fitting Range

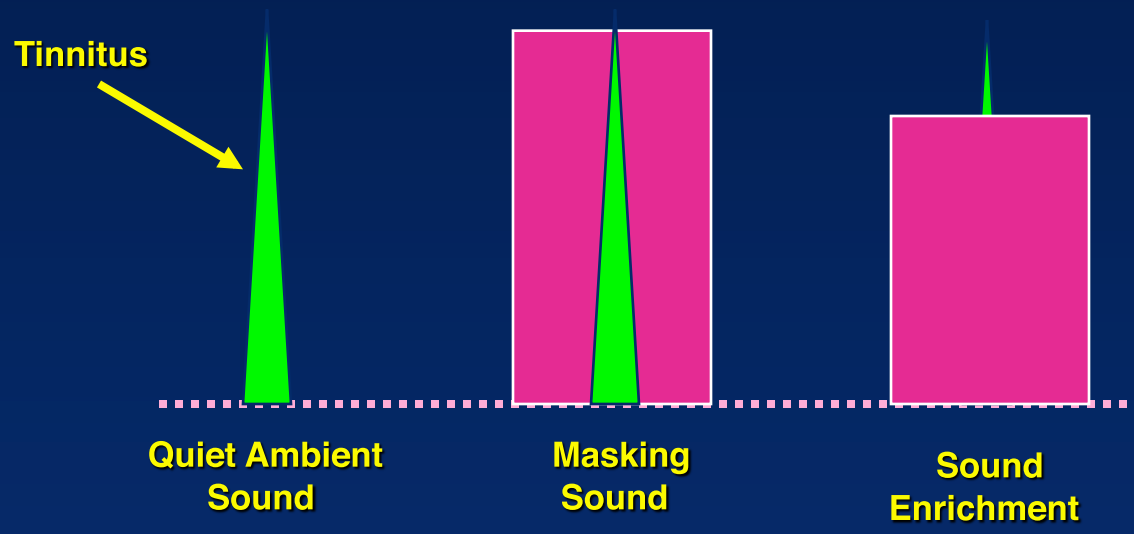
United Hearing Systems, 137 Norwich Road, Central Village, CT 06332 • 800-835-2001

United Hearing Systems

Central Village, CT

Sound Enrichment/Treatment

(Pawel Jastreboff)



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

Neuromonics Tinnitus Treatment: Five Step Treatment

"Step 1: Comprehensive Personalized Assessment

An audiologist conducts a thorough hearing (up to 12.5\kHz) and tinnitus assessment, discusses tinnitus history and provides some education about tinnitus and its causes. Once the hearing and tinnitus profile is determined, recommendations are made about the most appropriate treatment options including the Neuromonics Tinnitus Treatment."

Neuromonics Tinnitus Treatment: Five Step Treatment

"**Step 2: Processor Configuration**

Each individual's audiometric profile is used to make their prescription for their Neuromonics Processor. The Neuromonics device is small and lightweight (its about the same size and weight of a cell phone) and accompanied by high fidelity earphones. It delivers the acoustic component of the treatment.

The acoustic stimulus provides stimulation across a considerably wider range of frequencies than other available treatments, up to 12.5 kHz. The acoustic signals are distinct for each ear and correlated, and are provided in stereo. This further ensures stimulation of the multiple ipsilateral and contralateral pathways of the auditory system

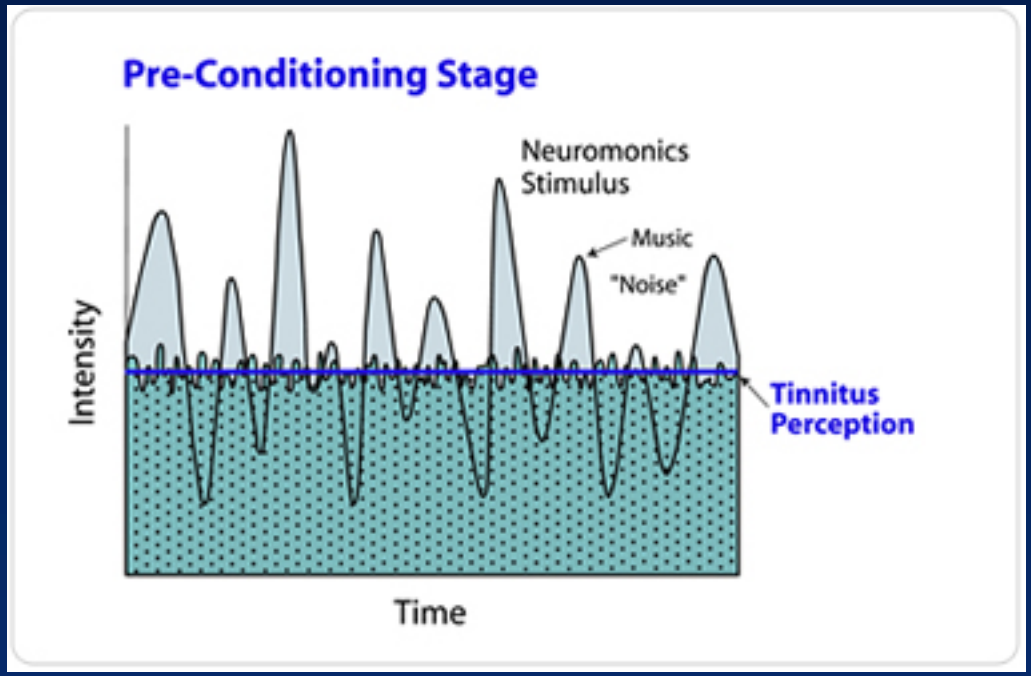
Neuromonics Tinnitus Treatment: Processor with Earphones

Neuromonics Tinnitus Treatment: Five Step Treatment

"Step 3: Pre-Conditioning Stage

During the Pre-Conditioning Stage, users are advised to listen to their device for at least two hours each day. In this initial stage, the device delivers an acoustic neural stimulus that provides a high level of interaction with their tinnitus perception. The benefits of this stage are relaxation, sleep and relief from tinnitus symptoms. Support and education is provided throughout this stage by an Audiologist.

Neuromonics Tinnitus Treatment: Pre-Conditioning Stage

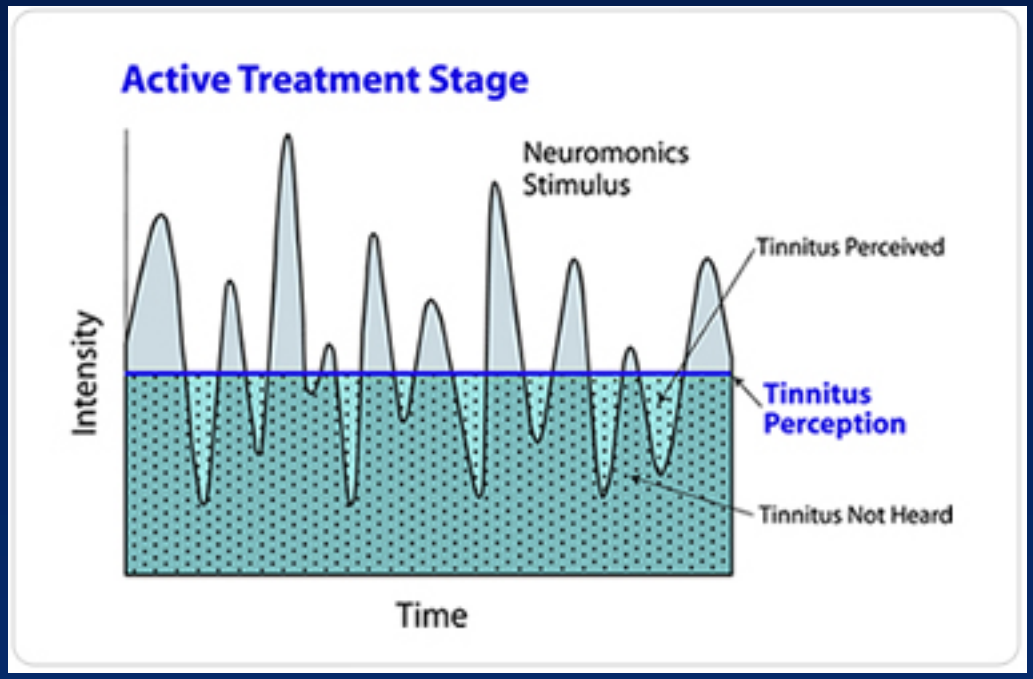


Neuromonics Tinnitus Treatment: Five Step Treatment

"Step 4: Active Treatment Stage

During this Stage, users also listen to the device for at least two hours per day. At this stage, an acoustic neural stimulus provides a lower level of interaction. Intermittent interaction with the tinnitus perception facilitates the de-sensitisation process, ie reprograms the brain to filter out the sound of the tinnitus. This process has proven to be efficient and effective at reducing the associated disturbance and impact on quality of life. ."

Neuromonics Tinnitus Treatment: Active Treatment Stage



Neuromonics Tinnitus Treatment: Five Step Treatment

"**Step 5: Maintenance Stage**

After a successful program of treatment lasting around six months, a maintenance program is devised for each individual to manage and control their tinnitus independently of clinician support. Many users find they may not feel the need to use the device any more. If they do continue listening, it's usually for less often and for less time each day to maintain the benefits achieved."

Tinnitus Retraining Therapy (TRT):Neuromonic Tinnitus Treatment Evidence of Positive Outcome

- Davis PB, Paki B, Hanley PJ. Neuromonics Tinnitus Treatment: third clinical trial. Ear Hear 28:242-59 2007
  - 80% of subjects at 6 months reported a level of tinnitus disturbance that was no longer clinically significant
  - No control group or non-Neuromonics subject group

Intervention and Management of Tinnitus:

Goodey R. Tinnitus treatment … state of the art. In B Langguth, G. Hajak, T Kleinjung, A. Cacace & A. R Moller (Eds.) *Progress in Brain Research 166*: 2007.

- Treatment options (table 1)
  - Correct causes
  - Cognitive counseling
  - Improve "normal" auditory input
  - Reduce aggravating and non-auditory factors
  - Disassociate emotional factors
  - Treat depression
  - Treat generators medically with drugs
  - Sound therapy
  - Centrally acting drugs
  - Magnetic and/or electrical stimulation
  - Other tinnitus coping strategies
  - Holistic support groups

Intervention and Management of Tinnitus

- Medical management for diseases and disorders, e.g.,
  - Ear disease (e.g., infection, Meniere's disease)
  - Sinus infections
  - Temporal mandibular joint (TMJ) disorder
  - Cochlear implant for severe-to-profound hearing loss
- Experimental medical management
  - Acamprosate
- Complementary and Alternative Medicine (CAM)
  - Enrico et al. Antioxidants, minerals, vitamins, and herbal remedies in tinnitus therapy. In Langguth, Hajak, Kleinjung, Cacace, Møller. *Progress in Brain Research, 166*: 2007
- Residual inhibition
- Cognitive behavioral therapy (CBT)

MEDICAL MANAGEMENT OF TINNITUS: Selected drugs used in attempts to treat tinnitus *(rarely successfully)*

- Niacin
- Local anesthetics (e.g., lidocaine, Tocainide)
- Anticonvulsants (e.g., Tegretol, Dilantin)
- Sodium fluoride, sodium amylobarbitone, sodium valproate
- Alcohol
- Naftidrofuryl
- Arlidin (a vasodilator)
- Chortrimeton (an antihistimine)
- Calcium channel blockers (e.g., Nimodipine)

Management of Tinnitus: Experimental Medical Management
(No conclusive evidence of benefit from replicated double blind clinical trials)

- Drugs, substances, and techniques considered for treatment of tinnitus
  - Clonazepam
  - Carbamazepine
  - Piribedil
  - Nimodipine
  - Baclofen
  - Caroverine
  - Trimetazidine
  - Zinc replacement
  - Low level laser “therapy”
  - Electro-stimulation
  - Trans-cranial magnetic stimulation
  - Acamprosate (calcium acetyl-homotaurinate)

Management of Tinnitus with Electrical Stimulation

- Mielczarek et al. Tinnitus treatment using electrical stimulation. Otolaryngol Pol: 61: 2007.
  - Subjects
    - ✓ 46 patients with severe tinnitus
    - ✓ Age range of 22 to 84 years (average 55)
    - ✓ Intervention
      - Treated using electrical stimulation
      - 0.15 to 1.15 mA
      - Silver electrode in EAC
      - Total of 15 stimulations given 2 or 3 times per week
  - Results
    - ✓ 71% of subjects noted “improvement”
    - ✓ 6 patients with disappearance of tinnitus
    - ✓ No control group or cross-over subject design

Management of Tinnitus with Trans-Cranial Magnetic Stimulation: Promising yet not ready for clinical application

- Kleinjung, T., Eichhammer, P., Langguth, B., Jacob, P., Marienhagen, J., Hajak, G., Wolf, SR., Strutz, J. (2005): Long-term effects of repetitive transcranial magnetic stimulation (rTMS) in patients with chronic tinnitus.Otolaryngol Head Neck Surg. April 132 (4): 566-569.

- Mennemeier, M., Chelette, KC., Myhill, J., Taylor-Cooke, P., Bartel, T., Kimbrell, T., Dornhoffer, J. (2008) Maintenance repetitive transcranial magnetic stimulation can inhibit the return of tinnitus. Laryngoscope. 2008 Jul;118(7):1228-32.

- Richter, GT, Menneneier, M., Bartel, T., Chelette, KC, Kimbrell, T., Triggs,W., Dornhoffer, JL. Repetitive transcranial magnetic stimulation for tinnitus: a case study. Laryngoscope. Oct;116(10):1867-72.

- Smith, JA., Mennemeier, M., Bartel, T., Chelette, KC., Triggs, W., Dornhoffer, JL. Repetitive transcranial magnetic stimulation for tinnitus: a pilot study. Laryngoscope. 2007 Mar;117(3):529-34.

Management of Tinnitus: Acamprosate
(Azevedo & Figueiredo. Rev Rasil Otorrhinolaryingol: 71, 2005)

- Acamprosate (calcium acetyl-homotaurinate)
  - Acts on both excitatory (glutamatergic) and inhibitory (GABA) systems
  - Theory is to reduce excitatory and increase inhibitory activity in the auditory system (especially central auditory system)
- Methodology
  - 50 patients with tinnitus (32 to 80 years)
  - Sensorineural auditory dysfunction
  - Ranked tinnitus from 0 to 10
  - Randomly assigned to 2 groups of 25 subjects each
    - ✓ Acamprosate (333 mg TID)
    - ✓ Placebo
  - Followed at 30 day intervals to 90 days
- Results
  - 47.8% improved > 50% for acamprosate
  - 11.1% improved in placebo group

Intervention and Management of Tinnitus: Recent Literature

- B Langguth, G. Hajak, T Kleinjung, A. Cacace & A. R Moller (Eds.) *Progress in Brain Research 166*: 2007.
- Goodey R. Tinnitus treatment … state of the art. *Progress in Brain Research 166*: 2007.

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

Management of Tinnitus: Complementary and Alternative Medicine (CAM)

- Vitamins and minerals
  - A, B1, B3, B6, B9, B12, C, E
  - Magnesium, calcium, potassium, manganese, selenium, zinc
  - Conclusions
    - ✓ Anecdotal reports of effectiveness
    - ✓ No clear evidence of benefit from clinical trials
    - ✓ Potential toxic effects of substances not yet studied
- Herbal
  - Pyto-complexes (plant derived substances with added ingredients that are biologically active)
  - Perceived as “natural”
  - Purity and quality control not assured
  - Most common are Gingko biloba, with 2 pharmacologically active substances
    - ✓ Flavonoid glycoside
    - ✓ Terpene lactones
  - Many other herbal “remedies” mentioned in tinnitus therapy
  - Conclusions
    - ✓ Anecdotal reports of effectiveness
    - ✓ No clear evidence of benefit from clinical trials
    - ✓ Potential toxic effects of substances not yet studied

Management of Tinnitus: Complementary and Alternative Medicine (CAM)

(Source: Prasad, Cole, Haase. www.hr.hpr.com)

- Mechanisms of sensory hearing loss
  - Oxidative stress
    - ✓ Reactive oxygen species
  - Excessive amounts of free radicals derived from oxygen and nitrogen
    - ✓ Free radicals are atoms or molecules with unpaired electron
    - ✓ Natural product of cellular activity
    - ✓ Highly likely to be involved in chemical reactions
  - Effect of free radicals minimized by production of enzymes
    - ✓ Superoxide dismutase (SOD)
    - ✓ Catalase
    - ✓ Glutathione peroxidase
    - ✓ Glutathione reductase
  - Acute and/or chronic inflammation
  - Secondary to varied etiologies, including:
    - ✓ High intensity noise and vibration
    - ✓ Ototoxic drugs (e.g., cisplatin, carboplatin, gentamicin
    - ✓ Meniere's disease
    - ✓ Aging

Management of Tinnitus: Complementary and Alternative Medicine (CAM)

(Source: Prasad, Cole, Haase. www.hr.hpr.com)

- Anti-oxidants
  - Rationale is reduce free radicals and oxidative damage to cells
  - Neutralize free radicals
  - Counteract the overproduction of reactive species
  - Reduce oxidative stress and inflammation
  - Multiple anti-oxidants in combination are most effective (vs. single anti-oxidant)
  - Mixtures of the above anti-oxidants also have been studied
  - Selection of appropriate anti-oxidant is important for effectiveness
  - All anti-oxidants can also act as *pro*-oxidants (free radicals)
  - Variables influence effectiveness of anti-oxidants, e.g.,
    - ✓ Amount of anti-oxidant
    - ✓ Gradient of oxygen pressure
    - ✓ Lipid environment
    - ✓ Oral versus injection
    - ✓ Herbs and herbal anti-oxidants
    - ✓ Form of anti-oxidant
  - Prior daily use of anti-oxidants useful for prevention of some etiologies, e.g.,
    - ✓ Noise induced hearing loss
    - ✓ Tinnitus

Management of Tinnitus: Complementary and Alternative Medicine (CAM)

(Source: Prasad, Cole, Haase. www.hr.hpr.com)

- Examples of anti-oxidants (micronutrients)
  - Vitamin A
  - Vitamin C
  - Vitamin E
  - Carotenoids (e.g., beta-carotene)
  - Magnesium sulfate
  - Coenzyme Q10
  - Alpha-lipoic acid
  - N-acetyl-cysteine (NAC)
- Premier Micronutrient Corporation (PMC)
  - www.mypmcinside.com
  - PMC anti-oxidant formulation

Management of Tinnitus: Complementary and Alternative Medicine (CAM)

(Source: Prasad, Cole, Haase. www.hr.hpr.com)

- Management of hearing loss with anti-oxidants
  - Vitamin E for
    - ✓ idiopathic sudden hearing loss (clinical)
    - ✓ Prevention of noise induced hearing loss (animals)
    - ✓ Cisplatin damage (animals)
    - ✓ Gentamicin damage (animals)
  - Magnesium sulfate for idiopathic sudden hearing loss
  - Alpha-lipoic acid for protection of
    - ✓ Noise induced hearing loss
    - ✓ Carboplatin cochlear damage


TINNITUS TABLETS
TINNITUS
Relief From
Ringing, Buzzing
and Roaring in the Ears
This all-natural, homeopathic formulation was developed for the temporary relief of ringing, buzzing and roaring in the ears, accompanied or not by loss of hearing, headache or vertigo. Easy-to-take sublingual tablets absorb quickly under the tongue. 75 tablets.
#40188 Tinnitus Tablets.....$9.99

Assessment & Audiologic Management of Tinnitus: Good News for a Bad Problem

Email Response from Terrified Patient

Dr. Hall:

Thank you very, very much for your kind words and generous response to my concerns about tinnitus. I can't tell how much they helped.

I can't imagine why you bother to take the time and thought to answer strangers' out-of- the-blue emails, which I realize you can't bill for, but I'm certainly grateful that you did in my case. I really appreciate it.

Kindly

WD

Tinnitus: A Serious Problem with Multiple Solutions

- **Conclusions**
  - 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.