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Principles of Tinnitus: Evaluation & Management II

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Agenda

- Introduction
- Counseling
- Sound Therapy Options and More
- Walk Through
- Practice Considerations
- Summary, Q & A
Tinnitus Evaluation

- Loudness Match (reviewed by Henry et al., 2005)
  - After you match pitch, you can start the matched frequency below threshold and slowly increase in 1 to 2 dB steps until match the level of the tinnitus
  - Can also use 1kHz to match level
  - Average 10-15 dB SL
  - Repeat several times in each ear and take the average

- Minimum Masking Level (reviewed by Henry et al., 2005)
  - Start by finding threshold for white noise in both ears
  - Lowest level we can play noise to mask tinnitus
  - Monaural L and R and Binaural conditions
  - Obtain threshold for white noise first
  - 1 to 2 dB steps increase
  - Can try other types of noise
Tinnitus Evaluation

- Residual Inhibition
  - Phenomenon where tinnitus is reduced or eliminated following auditory stimulation
  - Can be difficult to achieve
  - Present noise at 10 dB above MML for 1 minute, shut off noise and start timing or indicate how much reduced
    - Neural adaptation (Young & Sachs, 1973)
Approaches Overview

- Numerous approaches to tinnitus have been developed over the past few decades
  - Sound therapies (Many variations with and without counseling)
  - Cognitive Behavioral Therapy influenced Counseling (Many contributors)
    - Tinnitus Activities Treatment (Tyler and colleagues)
    - Integrated Approach to Tinnitus Patient Management (Sweetow and colleagues)
  - Tinnitus Retraining Therapy (Jastreboff and colleagues)
  - Progressive Tinnitus Management (Henry and colleagues)
  - Patient Centered Therapy (Acceptance of tinnitus as part of me (Mohr and colleagues))
  - Acceptance and Commitment Therapy (Hesser, Westin, and others)
  - Mindfulness based tinnitus stress reduction (Gans)
  - Combination of the above or modified approaches (Many others)

Tinnitus Retraining Therapy (TRT)

- Jastreboff started development of TRT in the 1980s
- Based on a neurophysiological model where auditory and non-auditory regions were responsible for troublesome tinnitus
- Treatment should be focused on altering these connections
- Sound therapy focused not on masking but relief
- Treatment focused on making tinnitus neutral stimulus rather than eliminating its perception
TRT

- Neurophysiological Model According to TRT
  - Psychoacoustic characterization does not relate to distress
  - Not everyone has distress
  - 4 Stages
    - Neural change resulting in creating signal
    - Detection of signal in subcortical regions
    - Perception and evaluation of the signal
    - Sustained activation of limbic system and ANS
      - 4th stage critical for distress

TRT

- Outline of Treatment
  - Initial contact, history, and inventories
  - Audiological evaluation/Medical evaluation
  - Patient categories
    - 0-4 based on impact on life, hearing loss, and sound sensitivity
TRT

- Outline of Treatment
  - Counseling
    - Understand the normal functioning auditory system
    - Explain role of pattern recognition and relationship to conditioning
    - Explain source of tinnitus and role of auditory and non-auditory regions
    - Heller and Bergman 1953 explanation
    - Brain perceives as a negative that establishes aversive conditioning

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### Table 1 Categories of Tinnitus and Hyperacusis Patients

<table>
<thead>
<tr>
<th>Category</th>
<th>Hyperacusis</th>
<th>Prolonged Sound-Induced Exacerbation</th>
<th>Subjective Hearing Loss</th>
<th>Impact on Life</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Present</td>
<td>—</td>
<td>Present</td>
<td>High</td>
<td>Counseling only</td>
</tr>
<tr>
<td>1</td>
<td>Present</td>
<td>Present</td>
<td>Not relevant</td>
<td>High</td>
<td>Hearing aid with stress on enrichment of auditory background</td>
</tr>
<tr>
<td>2</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>High</td>
<td>Sound generators set at threshold, very low increase of sound level</td>
</tr>
</tbody>
</table>

Hypacusis: significant sensitivity to environmental sounds typically associated with LDLs below 100 dB HL. Prolonged sound-induced exacerbation of tinnitus/hyperacusis when the effects persist to the following day, subjective hearing loss perceived subjectively by a patient as having a significant impact on patient's life; impact on life: the extent of impact of tinnitus and/or hyperacusis on patient's life; common treatment for each category involves counseling and the use of enriched auditory background.
TRT

- Outline of Treatment
  - Counseling
    - Vicious cycle
    - Understanding the source helps de-mystify the tinnitus and allow habituation to occur
      - Tinnitus is normal, side effect of hearing loss, not a sign of danger, compensatory plasticity, Music of the brain
    - Habituation is a natural process, examples given
    - Use of parables
      - Floor board at night
      - New refrigerator
      - Baby crying at night or sound of first name
    - Return to these concepts in subsequent appointments

TRT

- Outline of Treatment
  - Sound therapy
    - Use of sound set at a mixing-point to diminish perception and help in habituation process
    - Use categories to determine approach
    - Sound should be relaxing and soothing, not perceived as bothersome
      - Environmental sounds
      - Ear Level Sound generators
      - Hearing aids and combo devices
Approaches Overview

- The Audiologist and Cognitive-behavioral therapy and tinnitus
  - CBT-based approaches (Adjustment Counseling)—Audiologist provided
    - CBT-based approaches (Adjustment Counseling)—consists of application of CBT principles often with sound-based therapy and other techniques like relaxation training, imagery, and etc.
      - Robert Sweetow, PhD: “patient may reject a purely psychological approach, instead patient should be counseled on physiological origin, but the reaction is ultimately a psychological interpretation”
      - Sweetow-Integrated Approach is the basis of the Widex Zen Therapy
Tinnitus Activities Treatment

- Developed by Tyler and Colleagues and is based in principles of CBT
- Interactive counseling with sessions covering topics
  - Thoughts and Emotions
  - Sleep
  - Hearing and Communication
  - Concentration
- Picture-based materials are used to reinforce the concepts
- Attention on issues patient is having, discussing strategies to specific issues, and involves use of diaries and homework (activities)
- https://www.medicine.uiowa.edu/oto/research/tinnitus-and-hyperacusis

Activities

1. Practice focusing on your tinnitus and then on something else
2. Identify activities you would enjoy
3. Try different low-level sounds in the background

Tinnitus Diary

- Write down your thoughts and worries about tinnitus
  1. My tinnitus will...
  2. 
- Check to see if these thoughts match what actually happens
  1. 
  2. 
- List the alternative ways of thinking about tinnitus that you find helpful
  e.g. I have tinnitus, but it is really a small part of my life.
  1. 
  2. 
- We will discuss your thoughts next visit.


Tinnitus Diary

- After two weeks, stop keeping this diary.
- The goal of this diary is to help you make changes in your daily life so you are doing more activities where your tinnitus is better and fewer activities where your tinnitus is worse.
- The diary will also help you find alternative activities you may engage in to take your mind off your tinnitus.

5 Point (Holistic) Approach: Step by Step

1. Source: Counsel
2. Habituation & Cognitive Restructuring: Counsel
3. Sound Therapy: Treatment
4. Distraction: Treatment
5. Diet, Lifestyle, Sleep, Cure?: Treatment
Holistic: Characterized by the treatment of the whole person, taking into account mental and social factors, rather than just the physical symptoms of a disease.

5 Steps

- Combination of CBT based counseling and components of neurophysiological models of tinnitus and TRT
- Interactive counseling with emphasis on modern neurophysiological research findings
- Sound therapy (including amplification)
- Relaxation strategies
- Application of CBT in restructuring maladaptive thoughts and behaviors with acknowledgement of subconscious element
- Broken into 5 counseling steps
  - Source
  - Habituation-Cognitive Restructuring
  - Sound therapy
  - Distraction
  - Diet, Sleep, Lifestyle
5-Steps

- **Application**
  - History and preference for medical evaluation prior to being seen
  - Tinnitus scales
  - Audiometric evaluation
  - Review findings, educate on normal hearing, their hearing, tinnitus theory, their tinnitus, demystify, and discuss difficulties they are having

5-Steps

- **Application**
  - **Instructional counseling**
    - Source: A & P, tinnitus theory, role of non-auditory regions, gating theory
      - Role of the limbic system in memory, attention, and stress response; i.e. both conscious and subconscious pathways implicated
    - **Adjustment Counseling**
    - Habituation: Habituation counseling of brains process of determining salience of a signal, give examples
    - Cognitive Restructuring: Identifying negative automatic thoughts and maladaptive behaviors and developing alternatives
5-Steps

- Application
  - Adjustment counseling
    - How is the tinnitus affecting the patient
      - To address emotional aspects
      - Identify and correct maladaptive thoughts
      - Understand the relationship between tinnitus, stress, fear, thought, behavior, and quality of life
      - The reaction is the results of the maladaptive thoughts not the tinnitus itself
      - Identify alternative thoughts, behaviors, and strategies

- Application
  - Adjustment Counseling
    - Progressive muscle relaxation
    - Deep Breathing
    - Guided imagery
5-Steps

• Application
  • Sound therapy options
    • Many options including Hearing Aids
      • Stimulate system responsible for generation of tinnitus
      • Help reduce attention to tinnitus by shifting focus of treatment
      • Help patient to hear better and reduce listening fatigue
      • Broken Arm Analogy

5-Steps

• Application
  • DISTRACTION
    • When you notice or bothered do something positive!
    • Try not to actively engage the tinnitus
      • I can’t just tell you not to think about it
5-Steps

- Application
  - Sleep hygiene
    - Scheduled
    - Exercise and eat healthy, just not right before bed
    - Keep room comfortable temperature
    - Use sound therapy (e.g. sound pillow)
    - Don’t watch TV, eat or read in bed
    - Any many more

- Lifestyle
  - Diet and Exercise

Question

Which Approach is Best?
When performed by a seasoned clinician significant differences were found (Henry et al. 2014). The difference is YOU!

- We are going to switch topics to treatments beyond counseling.
- At the end of today we are going to walk through a step-by-step of implementing many of these strategies
  - Holistic Approach: 5-Step Program
Sound Therapy Options

Tinnitus Treatment

- SOUND THERAPY
  - Masking (cover up)
  - Tinnitus Retraining Therapy (habituate by reduced reaction and perception)
    - Sound Generators or Noisers
  - Neuromonics (program uses music preconditioning stage and active stage)
  - Okamoto Notch Music
  - Sound Cure (Modulated tones)-No Longer Available
  - CR Neuromodulation
  - Levo System
  - Phase Inversion
  - Amplification
Proprietary Approaches

- Neuromonics (music)
- Sound Cure
- Acoustic Coordinated Reset Neuromodulation - Desyncra
- Okomoto Notched Music (music)
- Phase-Out
- Widex Zen (music-like)
- Levo Otoharmonics

Proprietary Approaches

- Neuromonics
  - 6 month program that uses binaurally correlated music that intermittently covers patient's tinnitus perception
    - Phase/Stage I ~8 weeks
    - Phase/Stage II ~16 weeks
  - Evidence: Neuromonics has shown improvement compared to broad band noise and counseling only (Davis et al. 2008), but limited evidence and inadequate study design temper enthusiasm for any greater benefit than other sound therapy
Proprietary Approaches

- **Sound Cure (Serenade)**
  - Based on low pulse rates with CI shown to suppress tinnitus perception (Zeng et al. 2011)
  - Amplitude modulate and Frequency modulated sounds to drive neural plasticity
  - Suppression of tinnitus more successful compared to white noise (Reavis et al., 2012)
  - Evidence: unaware of published randomized control trial
  - No longer commercially available

Proprietary Approaches

- **Acoustic Coordinated Reset Stimulation now called Desyncra**
  - Tass et al. (2007, 2011)—Individualized auditory stimuli above and below the Tinnitus Frequency are presented as short tones to re-normalize pathological neural synchrony.
  - The purpose to correct or “reset” abnormal neural oscillatory activity through desynchronization.
  - Worn at a low level 4-6 hrs per day
  - Evidence: There has been 8 original reports in 3 different populations. Studies have in general showed benefit in reducing tinnitus complaints. However, small sample sizes, lack of appropriate controls, have limited enthusiasm (Wegger et al. 2017).
Proprietary Approaches

- Music Therapy-Notch Therapy
  - Okamoto et al., 2010—Music with individualized frequency composition, where Tinnitus Frequency is notched out of music
  - Based on Pantev et al. (1999) that showed notched music can reduce cortical activity to the notch center frequency possibly through lateral inhibition
  - Evidence: Some small trials have shown subjective and MEG based benefit, but notch width did not influence as hypothesized (Wunderlich et al. 2015)
  - A variation of notch-based therapy is available in Signia hearing aids
    - Tinnitus pitch is matched and software creates a notch around that frequency (0.5 octave band) in the programming of the device.
    - Strauss et al. (2015) showed greater improvement in subjective tinnitus distress compared to conventional fitting
Proprietary Approaches

- Phase Inversion (Phase – out)
  - Match the tinnitus and then emit sound that is 180 degrees out of phase, i.e. phase cancellation, works for feedback
  - Vermeire et al. (2007) found reduction in tinnitus symptoms in 60% of subjects
  - Problem is a neural signal is not an acoustic signal (Meeus et al., 2010), found no sound cancelling, contributed effect in 2007 to inclusion
  - Evidence: None

- Levo by Otoharmonics
  - Based on work out of Uruguay (Pedemonte et al. 2010)
  - Attempt to “reinstall the normal balance in the central processing”
    - Opposite of notch?
    - Match tinnitus
  - Play sound while sleeping
  - Evidence: Theodoroff et al. (2017) performed a randomized control trial
    - Compared Levo pitch match to Levo with noise to bedside sound generator in 60 participants
    - Looked at TFI, Loudness match, and Numeric rating scale (NRS) of loudness
    - Participants used for 3 months
    - All groups showed benefit, no difference was observed for Loudness match; TFI decreased most with Levo system, but no difference if stimulus was pitch matched or noise; The NRS was best for the Levo pitch matched group, which was statistically significant, but was only 0.7 points better on a 10-pt scale which diminishes any enthusiasm for clinical significance
    - Main take away, ear level sound therapy is more effective than a table side sound generator, but pitch matched noise vs white noise makes no difference
Approaches with bi-modal stimulation

- Stimulus timing dependent plasticity
- Somatosensory modulation
  - Neuromed: Tongue stimulation paired with sounds (D’Arcy et al. 2017)
  - Shore Lab: C2 or near trigeminal ganglion or region where strongest modulation (Marks et al. 2018)

Changing Tinnitus vs. Changing Perception

- Masking, TRT, TAT, etc seek to lead to habituation
- AC Reset, Levo, Notch-Therapy, STDP seek to augment tinnitus
- Enriched acoustic environment
  - Norena and Eggermont (2005) showed placing animal in enriched noise environment after noise exposure prevented map reorganization and changes in spontaneous firing
  - Vanneste et al., 2012 tried in humans with established tinnitus and found a worsening of tinnitus
    - Difference in preventing onset and already existing tinnitus
Non-Proprietary Approaches

- Silence is not your friend, have sound around you, do not mask, but mix
  - Where to start: Environmental sounds, white noise player, MP3 player, CD player, Apps, etc.
  - Play sound as much as possible, but at least several hours per day, should mix with tinnitus
  - You can download online for free from ATA website, also purchase from amazon.com, itunes, there are even apps for 99 cents.

Non-Proprietary Approaches

- What kind of Sound??????
  - White noise, pink noise, modulated, music
  - Continuous (ocean, rain, white noise, pink noise, and etc)
  - Meaningless but relaxing (not actively listen)
  - Do not use a bothersome sound
  - There is no great evidence showing any specific sound is better than another for tinnitus management; though amplitude modulated sounds may be more effective in reducing perception (Tyler et al. 2014; Reavis et al. 2012)
Non-Proprietary Approaches

- What kind of Sound??????
  - What is the benefit of shaping sound to tinnitus?
  - What level
    - Cover perception (masking/suppression)
    - Mixing level (TRT)
    - Softest level to achieve relief (TAT)
    - Other
    - Again there is well-demonstrated evidence of effectiveness of masking vs. mixing for habituation (Tyler et al. 2012).

Non-Proprietary Approaches

- MP3 Player, iPod, Smartphone
  - Fukuda et al. (2011) examined use of portable music players for TRT.
  - Found comparable reduction in tinnitus compared to hearing aids and ear level sound generators
  - Low-Cost
  - Customize sound (sound is subjective)
  - There is an app for that too!
  - Consider wireless earbuds/PSAP
Amplification and Tinnitus

Amplification

- **AMPLIFICATION** (Searchfield et al., 2010; Parrazzini et al., 2011; McNeill et al., 2012)
  - Kochkin et al. (2011)-Hearing aids provided substantial tinnitus relief in 34% of patients
    - Enriched soundscape
    - Partial masking of Tinnitus
    - Reduced listening fatigue
    - Change focus of treatment
    - Linear octave frequency transposition (Peltier et al., 2012)
      - Reduced tinnitus perception, classical amplification and non-linear frequency compression did not.
- **WHAT IS YOUR PATIENTS PRIMARY COMPLAINT?**
  - Very common, “I can’t hear because of the tinnitus”
Amplification

- AMPLIFICATION & Sound Generator
  - Henry et al. (2015)-Compared hearing aid to hearing aid with sound generator
  - Both groups saw improvement
  - The hearing aid + sound generator group saw a mean reduction in TFI 6.4 points higher, which approached significance
  - Both groups received counseling

Amplification

- AMPLIFICATION & Counseling
  - Henry et al. (2016)-RCT comparing masking and TRT to tinnitus education group with hearing aids and wait list controls in Veterans.
  - All saw decrease in tinnitus compared to wait-list
  - Masking, TRT, and Education with hearing aids were all effective; there was no significant difference between the approaches
  - Missing: group with hearing aid alone and no counseling
    - Bauer et al. (2017) showed that TRT + hearing aid compared to hearing aid and limited counseling both showed improvement but slightly greater in the TRT group; counseling component not well-controlled
Advantage-Amplification

- **AMPLIFICATION**
  - If you have a hearing loss and tinnitus, hearing aids with a combo sound generator (noisier) are very effective, WHY?
    - Stimulate the pathways that are contributing to tinnitus
    - Turns the lights back on!
    - At same time be able to provide constant noise for retraining, should be set so mixes with tinnitus (can’t habituate to what can’t perceive)
    - Set it and forget it!
    - Move focus of treatment from tinnitus to auditory system and hearing loss

Amplification and Tinnitus: Tips

- Keep it simple!
  - Fit to your preferred prescriptive methods using real-ear verification
  - Recommend: mic + sound therapy in most situations as much of the day possible
  - Patient control: Prefer to set at level in the office, mixing point and leave. Don’t want them constantly adjusting and bringing attention back to tinnitus. But depends on patient!
  - Remind patient we don’t want them to monitor the treatment (though they will at first) but set and forget!
  - Wear at least 8 hrs per day and use sound therapy at night in bedroom (e.g. soundpillow)
  - Provide sound therapy to both ears, even if tinnitus unilateral
Amplification and Tinnitus: Tips

- There is an app for that!
  - Sound options are expanding with environmental sounds and/or use of smartphone
  - Manufacturer based Apps
  - SimplyNoise, SimplyRain, Relax Melodies
  - Pitch Match- Whist
- Fukuda et al. (2011) examined use of portable music players for TRT.
  - Found comparable reduction in tinnitus compared to hearing aids and ear level sound generators
- Low-Cost
- Customize sound (sound is subjective)
- Downside: battery drain
Amplification Summary

- Sound therapy summary
  - Keep it simple
  - Don’t forget the therapy part
    - Once they reduce perception of time aware of tinnitus and annoyance significantly, reduce the level of the sound therapy one perceptual notch
    - Sound should not be bothersome, but relaxing, preferably passive listening
Other Considerations and Treatments

Sound Sleep

- SLEEP HYGIENE
  - Sleep is critical,
    - No Naps, Bedroom = Sleep, Exercise (but not right before bed), Healthy Diet
    - Sound Pillow
    - Melatonin (run by physician)
    - Tinnitus wakes me up???
      - Early Flight Analogy
      - I have had 2 patients report tinnitus 24/7, and claimed they even had tinnitus in their dreams
**Lifestyle**

- **BE ACTIVE**
  - Physical activity associated with lower levels of tinnitus severity (Carpenter-Thompson et al. 2015)
  - Adolescents and adults with higher physical activity were less likely to report tinnitus (Loprinzi et al. 2013)

**Diet**

- **Zinc** (DeBartolo et al. 1989)
  - Reduced tinnitus in people with zinc deficiency
- **Low cholesterol diet and antilipid therapy** (Sutbas et al. 2007)
  - Reduced tinnitus severity with diet and therapy
- **Taurine** (Brozoski et al. 2010, rats)
  - Reduce tinnitus in rats (glycine agonist)
- **Caffeine abstinence** (Claire et al. 2010)
  - No effect on reducing tinnitus
Health Eating Index

https://www.cdc.gov/healthyweight/healthy_eating/index.html

Spankovich & Le Prell (2013)
Diet

- 2176 participants from 1999-2002
- HEI and reported tinnitus
- Weightings & Strata applied
- Adjusted for age, sex, race, education, smoking, noise exposure, diabetes, hypertension, and hearing loss
  - 3 Models

- Tinnitus
  - In the past 12 months have you ever had ringing, roaring or buzzing in your ears? (Yes or No)
  - How often did this happen (Always, At least once per day, at least once a week, at least once a month, less frequently than once per month)
  - Code: Tinnitus (in past year) coded as yes or no
  - Code: Persistent tinnitus coded as least once per month or greater, less than once per month or No were coded as not having persistent tinnitus

Table 3. Covariate adjusted healthy eating index (bottom 40% vs. top 60%) and persistent tinnitus with sample weights applied.

<table>
<thead>
<tr>
<th>Healthy eating index (HEI)</th>
<th>Poorer HEI</th>
<th>Better HEI</th>
<th>P-trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1 odds ratio (95% confidence interval)</td>
<td>1.0 (referent)</td>
<td>0.64 (0.43, 0.94)</td>
<td>0.02</td>
</tr>
<tr>
<td>Model 2 odds ratio (95% confidence interval)</td>
<td>1.0 (referent)</td>
<td>0.72 (0.48, 1.09)</td>
<td>0.12</td>
</tr>
<tr>
<td>Model 3 odds ratio (95% confidence interval)</td>
<td>1.0 (referent)</td>
<td>0.67 (0.45, 0.98)</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Model 1: Age and sex.
Model 2: Age, sex, smoking, race/ethnicity, diabetes, noise exposure and high frequency pure tone average.
Model 3: Age, sex, smoking, race/ethnicity, diabetes and noise exposure.
Table 4. Covariate adjusted healthy eating index subscales and persistent tinnitus with sample weights applied.

<table>
<thead>
<tr>
<th>Subscales of HEI</th>
<th>Poorer intake</th>
<th>Better intake</th>
<th>P-trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total fat*</td>
<td>1.0 (referent)</td>
<td>0.69 (0.49, 0.99)</td>
<td>0.04</td>
</tr>
<tr>
<td>Saturated fat</td>
<td>1.0 (referent)</td>
<td>0.88 (0.56, 1.37)</td>
<td>0.56</td>
</tr>
<tr>
<td>Sodium</td>
<td>1.0 (referent)</td>
<td>0.96 (0.67, 1.38)</td>
<td>0.84</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>1.0 (referent)</td>
<td>0.79 (0.55, 1.15)</td>
<td>0.21</td>
</tr>
<tr>
<td>Grain</td>
<td>1.0 (referent)</td>
<td>0.74 (0.51, 1.08)</td>
<td>0.10</td>
</tr>
<tr>
<td>Fruit*</td>
<td>1.0 (referent)</td>
<td>0.61 (0.41, 0.91)</td>
<td>0.02</td>
</tr>
<tr>
<td>Vegetable</td>
<td>1.0 (referent)</td>
<td>1.25 (0.90, 1.79)</td>
<td>0.19</td>
</tr>
<tr>
<td>Meat and meat alt.</td>
<td>1.0 (referent)</td>
<td>1.01 (0.62, 1.65)</td>
<td>0.95</td>
</tr>
<tr>
<td>Dairy</td>
<td>1.0 (referent)</td>
<td>0.99 (0.66, 1.48)</td>
<td>0.95</td>
</tr>
<tr>
<td>Variety</td>
<td>1.0 (referent)</td>
<td>0.95 (0.61, 1.50)</td>
<td>0.83</td>
</tr>
</tbody>
</table>

*p ≤ 0.05; Adjusted for age, sex, smoking, race/ethnicity, diabetes and noise exposure.

Diet

- **HEALTHY DIET**
  - Health living-Diet and Exercise (get physician approval)
  - Eat healthy-Nutrient Dense: diet rich in green leafy vegetables, onions, mushroom, broccoli, berries, seed & nuts, tomatoes, colored veggies, Eat much as you want!
  - Make protein your side dish: grass fed beef and skinless chicken breast
Diet

**HEALTHY DIET**

- Avoid: fried food, processed foods (including deli meats), reduce dairy intake, and reduce white foods (white flour, white rice, white pasta, white potatoes, white sugar)
- Basically eat lots of whole fruits and veggies, reduce high glycemic index foods
- Eat good amount of protein but not too much!
- TALK WITH A NUTRITIONIST/DIETITIAN
Cure Train

- Over the Counter Agents
  - Ringstop, Lipo-Flavonoid, Tinnitus Relief
  - No evidence any work greater than a placebo effect
  - Robert DiSogra, AuD has some good reviews an textbook available through Oak Tree Products
Cure Train

- Iowa Women’s Health Study (2011)
- Men’s SELECT Study (2011)
- Chronic vs. Acute Prevention
- http://www.nytimes.com/2013/06/09/opinion/sunday/dont-take-your-vitamins.html?pagewanted=all&_r=0

Tinnitus Treatment

- Surgical
- Pharmacological
- Other
Surgical (reviewed by Soleymani et al., 2011)

- Cochlear Implant
  - Success rate > 90%
  - Complete suppression in 37 to 61% of cases
  - Tinnitus development in 5 to 12% of cases
  - Low rate (Zeng et al., 2011)

- Stereotactic radiosurgery
  - Unpredictable

- Cochlear and vestibulocochlear nerve ablation
  - Approximately 40 to 85% see no improvement in tinnitus
  - Those who do see benefit usually related to pathology removal

- Microvascular decompression
  - Sometimes causes typewriter tinnitus
  - Some relief, but not for persons with long-standing tinnitus

- Deep brain stimulation and extradural stimulation
  - Some promise, but needs further study (Cheung & Larson, 2010)

- Vagus nerve stimulation
  - Treatment for epilepsy
  - Engineer et al., 2011
  - External ear stimulation?

- Transcranial Magnetic Stimulation (not surgical)
  - Highly variable effects, with reduction for seconds, minutes, to days

- Low-level laser therapy (not surgical)

- Somatosensory Stimulation
  - Susan Shore Lab
Pharmacological

- Currently there is no FDA approved substance for the treatment of tinnitus

Lidocaine—Can suppress tinnitus and worsen in others (Hartigh et al., 1993)

- Alters fast voltage gated sodium channels
- Only works for tinnitus when given intravenously
- Can have serious side effects on cardiovascular and central nervous system
- Tocainide (Salvi et al., 2009) limited effect
- Anti-seizure medications
  - Gabapentin—GABA analogue
    - Aazah et al., (2011) no difference to placebo
  - Carbamazepine
    - Typewriter tinnitus (Nam et al., 2010)
    - Sanchez et al., (1999), may provide relief to those who find relief from lidocaine
  - Vigabatrin—Anti-GABA
    - Side-effects, ataxia and psychotic episodes

- Benzodiazepines-Psychoactive drugs to enhance GABA
  - Diazepam (Valium)
    - Kay (1981) no effect
  - Lorazepam (Ativan)
    - Busto et al., 1986 showed onset with withdrawal
  - Clonazepam (Klonopin)
    - Han et al., 2012 showed improvement in tinnitus compared to Gingko biloba
  - Alprazolam (Xanax)
    - No effect in salicylate model in animals (Salvi et al., 2009)
    - Johnson et al (1993) showed improvement, but not replicated
NMDA and Glutamate antagonist-Block primary excitatory neurotransmitter
- Caroverine
  - Domesien et al., (1998) no effect
- Acamprosate (Campral)
  - Alcohol abuse drug
  - Brazil workers (Azevedo et al., 2005)
  - Sharma et al (2012) Improvement in 92.5%
- Memantine
  - Blocks NMDA, Alzheimer drug
  - Figueiredo et al., 2008: no effect
- Gingko biloba
- AM-101
  - NMDA antagonist called Ketamine, i.e. special K
  - Recent trials showed was ineffective for tinnitus

Tricyclic antidepressants
- Amitriptyline--- May improve or worsen tinnitus (Langguth et al., 2010)
- Perhaps related to increased glutamate activity
- Cyclobenzaprine (Flexeril)
  - High does (30 mg) reduces tinnitus (Coelho et al., 2012)
• Antidepressants
  • Paroxetine (Paxil) and Sertaline (Zoloft)
    • Selective serotonin reuptake inhibitor
    • Minimal effect on tinnitus, except when accompanied by depression
    • Salvi et al., (2009) deter the use of SSRIs for treatment of tinnitus in nondepressed patients
    • Tang & Trussell (2017) showed that serotonin enhances signals in the DCN but only from multisensory cells, and actually decreases input from auditory fibers; this can enhance the potency of non-auditory signals in the classical auditory pathway

• Potassium channel modulators
  • Maxipost—may play a role in regulating resting potential and spontaneous neural activity
  • Lobarinas et al. (2011) in rat suppressed behavioral measures of tinnitus
Other Treatments

- Neurofeedback training
  - Guntensperger et al. (2017): some promise but lack of guidelines
- Hypnosis
- Laser Therapy
- Wearable Magnets
- Hyperbaric Oxygen Therapy
  - Maybe acute but support for chronic tinnitus is limited
- Acupuncture/Accupressure
- Essential Oils

Counseling Patients and Family Members: The Placebo Effect is Your Friend (J Hall III)

- Tinnitus Research
  - Placebo effect is a very clear factor in outcome
  - Accounts for up to 40% of apparent benefit from “treatment”
  - Control (non-treatment) group is essential in tinnitus research
- Clinical Service
  - Placebo effect can contribute significantly to improved patient outcome
  - Placebo effect is enhanced by:
    - Perceived and actual expertise of the audiologist (clinician effect)
    - Good bedside manner
    - Confident and compassionate interactions with patient
Tinnitus Assessment and Management is Primary Care Audiology

**Assessment and Management**

1. **Source:** Counsel
2. **Habituation & Cognitive Restructuring:** Counsel
3. **Sound Therapy:** Treatment
4. **Distraction:** Treatment
5. **Diet, Lifestyle, Sleep, Cure?:** Treatment

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5 Point (Holistic) Approach: Step by Step
Step by Step

- Medical Evaluation
- History and Structured Interview to direct assessment and counseling
- Inventories to direct counseling (TFI, THI, TRQ, and etc.)
  - Tinnitus and Hearing Survey (Henry et al.)
- Go over Game Plan!
- Assessment (audio, tinnitus eval, and etc)
- 5 Point Holistic Approach
  - Holistic meaning comprehensive whole person not pseudoscience
Case Walk Through

- Male patient, Age 66
- Patient complains of gradual decrease in hearing
- Reports history of occupational and recreational noise exposure including firearms
- Denies dizziness/vertigo, aural fullness, or ear pain
- Medications include baby aspirin, Lipitor (statin), lisinopril (high bp)
- Denies any other significant medical history, non-smoker, drinks socially
- Denies any blurred vision, numbness/tingling in extremities, slurred speech
- Did report having some anxiety and stress in the past and taking medication, but has not needed for decades
- Tinnitus is perceived in both ears, slightly louder in the left ear
- Denies pulsatile sensation, but occasional clicking (when stressed)
- Describes tinnitus as a high pitch electrical high wire sound
- Has noticed tinnitus for at least 10 years, but has been more bothersome the past 2 years
- Recently retired, exercises at least 30 min a day, diet is moderately healthy, oldest son is having drug problems
- THI 70, TFI indicates greatest effects on sleep, hearing, and concentration
- Feels like if tinnitus was gone everything else would be fine

What testing will you start with?

- Next lets walk through audio and speech testing
- What next?

Pitch Match = 4000 Hz
Loudness Match = 55 L and 45 R
Min Mask Level = 25 R, 30 L, 20 B
5 Point Holistic Approach: Step by Step

1. Source: Counsel
2. Habituation: Counsel
3. Sound Therapy: Treatment
4. Distraction: Treatment
5. Diet, Lifestyle, Sleep, Cure: Treatment

Counseling: How to Introduce Source Theory

- What to discuss with patient?
  - Normal Auditory System
  - Hearing Loss (their results)
  - Tinnitus Causes
    - Commonly hearing loss
  - Tinnitus as a Normal Precept
  - Tinnitus Neuroscience
Summary on Hearing and Hearing Loss

- We hear with our brain not our ears
- The most common type of hearing loss is high frequency sensorineural hearing loss
- When hearing loss occurs are brain changes (neural plasticity) to try to compensate
  - This can result in?
What causes tinnitus?

- Early theories suggested everyone has tinnitus!
- Heller and Bergman (1953)
- Ear-lids Analogy?

More recent research using imaging
- Tinnitus Modulation (gaze, cutaneous)
- Auditory and Non-auditory regions implicated
  - Attention/Salience
  - Memory
  - Emotion/Stress
Non-Auditory Factors Analogies

- Tinnitus and Limbic Response
  - Makes sense for brain to view as an alarm
    - Normal reaction to not like
    - Car Engine Analogy (e.g., breathing)
    - Visiting Friend Analogy
Source Summary

- Likely numerous contributions at various levels of system
- What to take away
  - Tinnitus is a side effect of neural change as a result of damage to hearing or other neural insult
  - This neural change results in a signal that is being interpreted in the brain as sound when no external sound is present
  - Tinnitus is not likely one single physiological disruption but involves both auditory and nonauditory regions of the brain
  - The brain's interpretation of the tinnitus as a salient feature results in attention that can initiate a cascade of responses, which can result in the brain viewing tinnitus as negative or meaningless
  - Tinnitus is a psychophysiological phenomenon

5 Point Approach

- Source: Counsel
- Habituation and Cognitive Restructuring: Counsel
- Sound Therapy: Treatment
- Distraction: Treatment
- Diet, Lifestyle, Sleep, Cure: Treatment
Habituation

- When a new stimulus becomes “well known” and loses relevance, habituation can fail when associated with a negative evaluation.
- Brain does this all the time!
  - Shoes on feet
- It is the brain's natural process to habituate to meaningless stimuli: this is why a doctor may tell you “you will learn to live with it”
- Sound is subjective
  - Learned positive and negative associations based on experiences

Cognitive Restructuring

- Identify and correct maladaptive thoughts and behaviors
- What is the patient’s perception of tinnitus
- Do they display cognitive distortions: e.g. all or none thinking, jumping to conclusions, disqualifying positive
- Help identify alternative thoughts and behaviors
- For example, patient stops going to concerts because of tinnitus
Tinnitus: CBT/DBT

- Can be very helpful even without sound therapy
- Bring up idea of other therapy options at first visit, do not setup for failure
  - Relaxation techniques
    - Breathing and Imagery (see ATA website)
    - Progressive muscle relaxation
    - Yoga, Tai Chi
  - Other adjunctive therapy, e.g. Cognitive Behavioral Therapy
    - Tinnitus and Depression/Anxiety?
    - Hyperarousal
  - Do not make tinnitus a central part of your life, it shouldn’t be
    - Internet searches, chat rooms, on search for the cure!
    - How can you habituate to something you are focused on.

5 Point Approach

- Source: Counsel
- Habituation: Counsel
- Sound Therapy: Treatment
- Distraction: Treatment
- Diet, Lifestyle, Sleep, Cure: Treatment
5 Point Approach: Tinnitus Treatment

- **SOUND THERAPY (General Tips)**
  - Silence is not your friend, have sound around you, do not mask, but mix
    - Where to start: Environmental sounds, white noise player, MP3 player, CD player, Apps, etc.
    - Play sound as much as possible, but at least several hours per day, should mix with tinnitus
    - You can download online for free from ATA website, also purchase from amazon.com, itunes, there are even apps for 99 cents.

- **AMPLIFICATION**
  - If you have a hearing loss and tinnitus, hearing aids with a combo sound generator (noiser) are very effective, WHY?
    - Stimulate the pathways that are contributing to tinnitus
    - Turns the lights back on!
    - At same time be able to provide constant noise for retraining, should be set so mixes with tinnitus (can’t habituate to what can’t perceive)
    - Set it and forget it!
    - Move focus of treatment from tinnitus to auditory system and hearing loss
5 Point Approach

- Source: Counsel
- Habituation and Cognitive Restructuring: Counsel
- Sound Therapy: Treatment
- **Distraction**: Treatment
  - Diet, Exercise, Sleep, Cure: Treatment

**Attention and Distraction**

- **DISTRACTION**
  - When you notice or bothered do something positive!
  - Try not to actively engage the tinnitus
    - I can't just tell you not to think about it
Whatever you do, do not think of a number right now!

Attention and Distraction

- Exercises
  - Switch attention from one stimulus to another
  - Start with something like the ring on your finger or shoes on feet
    - Forgot your shoes already???
  - Eventually move to tinnitus with caution
    - Focusing on tinnitus can change quality such as pitch and loudness and can demonstrate that altered attention can change these qualities as well as reaction
    - Incorporate sound therapy and relaxation techniques
    - Do so slowly
5 Point Approach

- Source: Counsel
- Habituation: Counsel
- Sound Therapy: Treatment
- Distraction: Treatment
- Sleep, Lifestyle, Diet, Cure: Treatment

Sound Sleep

- SLEEP HYGIENE
  - Sleep is critical,
    - No Naps, Bedroom = Sleep, Exercise (but not right before
      bed), Healthy Diet
    - Sound Pillow
    - Melatonin (run by physician)
    - Tinnitus wakes me up???
      - Early Flight Analogy
      - I have had 2 patients report tinnitus 24/7, and claimed they
        even had tinnitus in their dreams
5 Point Approach: Lifestyle

- BE ACTIVE and Exercise
  - Run by physician

- Eat Healthy: more veggies and fruit, less processed food and high glycemic index foods
  - DASH diet, Med Diet
  - Run by physician
What I tell my patients?

- My tinnitus story
- Tinnitus is not a sign you are going crazy, the response you are having is normal to a sound your brain cannot resolve
- Good news is the brain can habituate and this is its natural process (forgot those shoes again)
- Good news is we can use sound, distraction, and other techniques to improve habituation
- Avoid internet and “support” groups; I will keep you informed if a cure is developed (get off the cure train)
- Don’t let the tinnitus control your life, you may not be able to turn off the sound, but you can change attention, thoughts, and behaviors (i.e. response)
- Be healthy, eat healthy, exercise, improve sleep hygiene
  - Will not cure tinnitus but can help alleviate stress, increase physical activity, which can alter brains response
  - Tinnitus can be viewed as an alarm, but that does not have to be negative

5 Point Approach

- What I tell my patients?
What if they are mentally unstable?

- Refer out when you feel uncomfortable
- Listen to the patient, offer what advice you can, discuss their stress level and need for more intensive counseling beyond what you provide
- Patient was a 40 something old female with reported clicking (like Morse code)
  - Claimed her physician drugged her and she was implanted with devices to monitor her activity
    - Has proof from a “doctor” seen in California that uses a special scanner to locate implants

Practice Considerations

- Setup a referral network
- Bill for your diagnostics (e.g. CPT 92625) and for your time (Out-of-Pocket)
  - Consider your break-even hourly rate
- Most patients only require 1 session
- Market service
- Be flexible with approach
  - Shadow a seasoned clinician
- Create handouts (I have provide mine as a template)
- Have demo devices and stock of assistive devices on hand
There is no one best approach to tinnitus management, the individual patient may benefit more from one approach vs another.

There is a strong clinician effect, you make the difference.

Keep on top of the literature and advances.

5 simple steps to counseling:
  - Source, habituation, sound therapy, distraction, lifestyle
  - Find a referral network
  - Leave the patient with hope

QUESTIONS????????