TINNITUS

Steven Taylor, MD
Dana King, MD
OUTLINE

- Quiz
- Types and Prevalence
- Pathophysiology
- Workup
- Management
OBJECTIVES

- Describe some of the basic types of tinnitus
- Discuss theories regarding the etiology of tinnitus
- Discuss a few of the current treatments
- Describe newer treatments for reducing tinnitus
Difficulty with tinnitus

- Multiple causes, many of which are not fully understood

- Many identify it similar to neuropathic pain in cause and treatment

- Treatments work in varying degrees with individual patients depending on the etiology of tinnitus

- No “silver bullet”

However...
GOAL

- Tinnitus is not a diagnosis where you tell your patient, “learn to live with it.”
Which of the following commonly prescribed ENT medications is not known to cause tinnitus?

A. Oxycodone

B. Augmentin

C. Bactrim

D. Clindamycin
QUIZ

Which of the following commonly prescribed ENT medications is not known to cause tinnitus?

A. Oxycodone

B. Augmentin

C. Bactrim

D. Clindamycin
T or F. Tinnitus is always a subjective complaint.
T or F. Tinnitus is always a subjective complaint.

False
Which muscle(s) may be involved in muscular tinnitus?

A. Levator veli palatini

B. Stapedius

C. Tensor Tympani

D. B and C

E. All of the above
Which muscle(s) may be involved in muscular tinnitus?

A. Levator veli palatini

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D. B and C

E. All of the above
Which of the following is not a potential treatment for tinnitus?

A. Meditation

B. Cochlear Implant

C. Drug Therapy

D. Treatment of TMJ syndrome

E. All are potential treatments
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HISTORY

- Egyptians believed tinnitus was from a bewitched ear
  - Tx: Infusion of oils and herbs to outer ear

- Hippocrates and Aristotle noted that the buzzing in the ear went away when people spoke
PROGRAMME.
KANSAS CITY, MO.
APRIL 9-10, 1896.
PARLOR S, MIDLAND HOTEL,
Western Society of
Eye, Ear, Throat and Nose Surgeons.

April 9, 10 A.M.
Called to order by Dr. J. H. Thompson, President Kansas City Academy of Medicine.
Address of Welcome by Dr. C. Lester Hall President Missouri State Medical Society.
Response by Dr. R. S. Black, President Kansas State Medical Society.

DR. HAL FOSTER. - Acting Secretary.

Programme.
1. Two cases of opening of the lateral sinus for removal of infectious thrombus. Recovery in one case. Dr. C. Barck, St. Louis, Mo. Discussion opened by Dr. Wm. Scheppergrell, New Orleans, La.
2. "The Ocular Manifestations of Hysterical Syphilis." Dr. T. E. Evans, Louisville, Ky. Discussion opened by Dr. LeRoy Dibble, Kansas City, Mo.
3. Diabetic Retinopathy. Dr. Adam Ait, St. Louis, Mo. Discussion opened by Dr. F. D. Green, Pueblo, Colo.
4. A paper. Dr. A. E. Farnham, Milwaukee, Wis.

Afternoon Session. 2 P. M.
5. "When Should the Cautery Be Used?" Dr. Wm. C. Pipino, Des Moines, Ia. Discussion opened by Dr. W. L. Dayton, Lincoln, Neb.
7. The Use of Peroxide of Hydrogen in Diseases of the Nose and Ear. Dr. Wm. Scheppergrell, New Orleans, La. Discussion opened by Dr. J. W. Gaens, Kansas City, Mo.
8. A Case of Aschohma, Due to Nasal Obstruction and Aneurism of the Pharyngeal Artery, Dr. W. W. Hulette, Pueblo, Colo. Discussion opened by Dr. E. Logan, Kansas City, Mo.
9. Paper. Dr. Wm. Porter, St. Louis, Mo.

Fig 1.—Original 1896 program. Top left. Printed prior to meeting. Top right. Printed after meeting and adoption of official name. Bottom. Partial listing of papers and authors.
R.L Wegel stated in 1931 in an article published in Arch. Otolaryngology

"Tinnitus is a pathologic symptom . . . I am under the impression that the presence of tinnitus.....generally indicates an active or progressive lesion and that the cessation of it......is an indication that the degeneration or atrophy of tissue has been arrested...people entirely without tinnitus are extremely rare, if such cases exist at all."
Derived from the Latin word “tinnire” meaning to ring.

Affects 30 Million Americans
- Disturbing tinnitus in 3-5%
- 30% of population aged 55-99
- Prevalence
  - 26.6% in normal hearing
  - 35.1% in those with a hearing loss
Tinnitus is a symptom, not a disease.

Both subjective and objective tinnitus
- Subjective much more common
Objective
- Potentially more identifiable
- May be able to treat the underlying etiology

Subjective Tinnitus
- Much more common
- Prevalence of chronic tinnitus with noise induced hearing loss is 50-70%
### Types

#### Table 150.1 -- Objective Tinnitus

<table>
<thead>
<tr>
<th>Pulsatile</th>
<th>Nonpulsatile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronous with pulse</td>
<td>Spontaneous otoacoustic emission</td>
</tr>
<tr>
<td>Arterial etiologies</td>
<td>Patulous eustachian tube</td>
</tr>
<tr>
<td>Arteriovenous fistula or malformation</td>
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<tr>
<td>Paraganglioma (glomus tympanicum or jugulare)</td>
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<tr>
<td>Carotid artery stenosis</td>
<td></td>
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<tr>
<td>Other atherosclerotic disease (subclavian, external carotid)</td>
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<tr>
<td>Arterial dissection (carotid, vertebral)</td>
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<tr>
<td>Persistent stapedial artery</td>
<td></td>
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<tr>
<td>Intratympanic carotid artery</td>
<td></td>
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<tr>
<td>Vascular compression of cranial nerve VIII</td>
<td></td>
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<tr>
<td>Increased cardiac output (pregnancy, thyrotoxicosis)</td>
<td></td>
</tr>
<tr>
<td>Intracranial (Paget's disease, otosclerosis)</td>
<td></td>
</tr>
</tbody>
</table>

#### Table 150.2 -- Subjective Tinnitus Subtypes

<table>
<thead>
<tr>
<th>Pattern of hearing loss</th>
<th>Typewriter tinnitus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise-induced hearing loss</td>
<td>Exacerbated by sleep or rest</td>
</tr>
<tr>
<td>Presbycusis</td>
<td>Musical/complex</td>
</tr>
<tr>
<td>Unilateral</td>
<td>Associated affective disorder</td>
</tr>
<tr>
<td>High-frequency hearing loss</td>
<td>Intrusive (versus habituated)</td>
</tr>
<tr>
<td>Outer hair cell dysfunction</td>
<td></td>
</tr>
</tbody>
</table>

Somatic tinnitus:
- Temporomandibular joint dysfunction
- Cervical dysfunction
- Gaze-evoked
- Cutaneous-evoked
- General somatosensory modulated

Cummings, 5th ed. Ch 150, Tinnitus and Hyperacusis.
Subjective tinnitus
- Clinically - perception of sound in the absence of stimulation

Tonotopic organization
PATHOPHYSIOLOGY

- With damage to hair cells
  - Auditory cortex adjusts to chronic lack of output through cortical plasticity
  - Alteration in tonotopic map
Lesion Projection Zone shows a relative increase in neural response
- Deprivation of input leads to hyperactivity
That is one theory as to the cause of tinnitus, especially regarding tinnitus from noise exposure
- Nerve section doesn’t always cause tinnitus (and section can sometimes treat tinnitus)
- Those with damaged hair cells don’t always have tinnitus

Tinnitus may not always be from the ear, and may have a central component

Duration of tinnitus may also play a role
- Increased neural plasticity
More severe tinnitus may not go through the classical hearing pathway, but through a nonclassical pathway

- Synapses through the somatosenory pathways, limbic system
- Cause for phonophobia, hyperacusis
- TMJ causing tinnitus
- Electrical stimulation to behind the ear or skin of fingers has alleviated tinnitus
In short...

- the cause of tinnitus may vary, which can dramatically change the effectiveness of treatment
  - Some causes of tinnitus may be treatment for others
    - le- nerve section, salicylates

- Clinically, the most common reason for seeing tinnitus is most likely hair cell damage (noise, drugs), leading to nerve hyperfunction
What information do you want to know when eliciting a history for tinnitus?
WORKUP

- **Onset and duration**
  - Acute loud noise/blast injury can last 1-2 months
- **Subjective vs objective**
- **Unilateral/bilateral**
- **Worsening**
- **Pitch**
  - Lower frequency could be more indicative of Meniere’s
- **Social Hx**
  - Caffeine, Tobacco, Alcohol
- **Med/Surg Hx**
  - Diabetic, Prior ear surgery
  - Headache, TMJ, vertigo
  - Psych disorders
When should radiographic imaging, such as MRI, be strongly considered? (choose all appropriate)

In all cases of tinnitus
Unilateral tinnitus
Pulsatile tinnitus
High frequency HL on audiogram
Sudden SNHL
Normal discrimination
Trauma
When should radiographic imaging, such as MRI, be strongly considered? (choose all appropriate)

- In all cases of tinnitus
- Unilateral tinnitus
- Pulsatile tinnitus
- High frequency HL on audiogram
- Sudden SNHL
- Normal discrimination
- Trauma
The most common cause of continuous tinnitus with radiographic identifiable cause is

A. SNHL
B. CPA or IAC tumor
C. Multiple sclerosis
D. Brainstem stroke

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A. SNHL

B. CPA or IAC tumor

C. Multiple sclerosis

D. Brainstem stroke
Yield of imaging is low yield in tinnitus

Important to correlate clinical symptoms with radiographic findings.

Table 1  Recommendations for the radiographic evaluation of tinnitus. See text for specific protocols

<table>
<thead>
<tr>
<th>Clinical scenario</th>
<th>Imaging modality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous tinnitus</td>
<td>Contrast-enhanced MR of brain and temporal bones</td>
</tr>
<tr>
<td>Pulsatile tinnitus</td>
<td>Contrast-enhanced CT of head and temporal bones</td>
</tr>
<tr>
<td>Normal CT of head and temporal bones</td>
<td>Consider CTA for atherosclerosis, CT neck for jugular compression, or catheter angiogram for dural AVM</td>
</tr>
</tbody>
</table>
WORKUP

- **Self-Assessment Scales for Tinnitus**
  - Tinnitus Handicap Inventory
  - Tinnitus Effects Questionnaire
  - Tinnitus Coping Style Questionnaire
  - Tinnitus Severity Scale
  - Tinnitus Handicap Questionnaire
### Tinnitus Handicap Inventory (THI)

A 25-item self-report questionnaire that takes approximately 10 minutes to complete. Scoring takes 5-10 minutes with a score of 4 for Yes, 2 for Sometimes, and 0 for No.

<table>
<thead>
<tr>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

1. Because of your Tinnitus is it difficult for you to concentrate?  
   - Yes  
   - No  
   - Sometimes

2. Does the loudness of your Tinnitus make it difficult for you to hear people?  
   - Yes  
   - No  
   - Sometimes

3. Does your Tinnitus make you angry?  
   - Yes  
   - No  
   - Sometimes

4. Does your Tinnitus make you confused?  
   - Yes  
   - No  
   - Sometimes

5. Because of your Tinnitus are you desperate?  
   - Yes  
   - No  
   - Sometimes

6. Do you complain a great deal about your Tinnitus?  
   - Yes  
   - No  
   - Sometimes

7. Because of your tinnitus do you have trouble falling asleep at night?  
   - Yes  
   - No  
   - Sometimes

8. Do you feel as though you cannot escape from your Tinnitus?  
   - Yes  
   - No  
   - Sometimes

9. Does your Tinnitus interfere with your ability to enjoy social activities (such as going out to dinner, to the cinema)?  
   - Yes  
   - No  
   - Sometimes

10. Because of your Tinnitus do you feel frustrated?  
    - Yes  
    - No  
    - Sometimes

11. Because of your Tinnitus do you feel that you have a terrible disease?  
    - Yes  
    - No  
    - Sometimes

12. Does your Tinnitus make it difficult to enjoy life?  
    - Yes  
    - No  
    - Sometimes

13. Does your Tinnitus interfere with your job or household responsibilities?  
    - Yes  
    - No  
    - Sometimes

14. Because of your Tinnitus do you find that you are often irritable?  
    - Yes  
    - No  
    - Sometimes

15. Because of your Tinnitus is it difficult for you to read?  
    - Yes  
    - No  
    - Sometimes

16. Does your Tinnitus make you upset?  
    - Yes  
    - No  
    - Sometimes

17. Do you feel that your Tinnitus has placed stress on your relationships with members of your family and friends?  
    - Yes  
    - No  
    - Sometimes

18. Do you find it difficult to focus your attention away from your Tinnitus and on to other things?  
    - Yes  
    - No  
    - Sometimes

19. Do you feel that you have no control over your Tinnitus?  
    - Yes  
    - No  
    - Sometimes

20. Because of your Tinnitus do you often feel tired?  
    - Yes  
    - No  
    - Sometimes

21. Because of your Tinnitus do you feel depressed?  
    - Yes  
    - No  
    - Sometimes

22. Does your Tinnitus make you feel anxious?  
    - Yes  
    - No  
    - Sometimes

23. Do you feel you can no longer cope with your Tinnitus?  
    - Yes  
    - No  
    - Sometimes

24. Does your Tinnitus get worse when you are under stress?  
    - Yes  
    - No  
    - Sometimes

25. Does your Tinnitus make you feel insecure?  
    - Yes  
    - No  
    - Sometimes

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WORKUP

Is your tinnitus annoying?

No → Grade I
   No impairment

Yes → Does your tinnitus have major negative consequences on your life?

No → Grade II
   Slight impairment
   Sometimes annoying in defined conditions—eg, in quiet environment or in stressful situations

Yes → Are you able to work?
     Can you do your housework?
     Can you take care of your family?

Yes → Grade III
   Permanent annoyance with disturbances in private and professional areas

No → Grade IV
   Severe impairment
   Severe disturbances in private and working life, unable to work
More than 550 drugs/herbals have been associated with causing tinnitus

- Acute/chronic loud noise exposure
- Cerumen impaction
- Meniere’s disease
- Retrocochlear lesions
- Et al.
Clinically, the most common reason for seeing tinnitus is most likely hair cell damage (noise, drugs), leading to nerve hyperfunction

- Treat the hyperfunction

- The goal is not to cure, but to reduce the symptoms without creating adverse side effects from the medications

- There is no FDA approved medication for the treatment of tinnitus.
<table>
<thead>
<tr>
<th>Medications used to treat tinnitus</th>
</tr>
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<tbody>
<tr>
<td><strong>Anesthetics</strong></td>
</tr>
<tr>
<td>Lidocaine/ lignocaine (Xylocaine IV)</td>
</tr>
<tr>
<td>Procaine (Novocain IV)</td>
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<tr>
<td>Tocainide (Tonocard)-oral lidocaine analogue</td>
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<tr>
<td>Flecainide acetate (Tambocor)</td>
</tr>
<tr>
<td><strong>Antidepressants</strong></td>
</tr>
<tr>
<td>Nortriptyline (Pamelor)</td>
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<tr>
<td>Paroxetine (Paxil)</td>
</tr>
<tr>
<td>Fluoxetine (Prozac)</td>
</tr>
<tr>
<td>Sertraline (Zoloft)</td>
</tr>
<tr>
<td>Bupropion (Wellbutrin)</td>
</tr>
<tr>
<td>Amitriptyline (Elavil)</td>
</tr>
<tr>
<td><strong>Anticonvulsants</strong></td>
</tr>
<tr>
<td>Carbamezapine (Tegretol)</td>
</tr>
<tr>
<td>Phenytoin (Dilantin)</td>
</tr>
<tr>
<td>Primidone (Mysoline)</td>
</tr>
<tr>
<td><strong>Anti-anxiety Agents</strong></td>
</tr>
<tr>
<td>Alprazolam (Xanax)</td>
</tr>
<tr>
<td>Clonzaepam (Klonopin)</td>
</tr>
<tr>
<td>Diazepam (Valium)</td>
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<tr>
<td><strong>Antispastic</strong></td>
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<tr>
<td>Baclofen (Lioresal)</td>
</tr>
<tr>
<td><strong>Antihistimines</strong></td>
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<tr>
<td>Chlorpheniramine (Chlor-Trimeton)</td>
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<tr>
<td>Medeline</td>
</tr>
<tr>
<td><strong>Diuretics</strong></td>
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<tr>
<td>Furosemide (Lasix)</td>
</tr>
<tr>
<td><strong>Vasoactive medications</strong></td>
</tr>
<tr>
<td>Histamine</td>
</tr>
<tr>
<td>Hydrgine</td>
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<tr>
<td>Vinpocetine</td>
</tr>
<tr>
<td>Pentoxifyline (Trental)</td>
</tr>
<tr>
<td><strong>Herbs</strong></td>
</tr>
<tr>
<td>Ginkgo biloba</td>
</tr>
<tr>
<td>Black cohosh</td>
</tr>
<tr>
<td>Ligustrum</td>
</tr>
<tr>
<td>Mullein</td>
</tr>
<tr>
<td>Pulsatilla</td>
</tr>
<tr>
<td>St. John Wort</td>
</tr>
<tr>
<td><strong>Vitamins and minerals</strong></td>
</tr>
<tr>
<td>Magnesium (400 mg/d)</td>
</tr>
<tr>
<td>Calcium (1000 mg/d)</td>
</tr>
<tr>
<td>Potassium (2500 m/d)</td>
</tr>
<tr>
<td>Zinc</td>
</tr>
<tr>
<td>Manganese</td>
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<tr>
<td>Copper</td>
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<tr>
<td>Vitamin B12</td>
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<tr>
<td>Beta carotene</td>
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<tr>
<td>Selenium</td>
</tr>
<tr>
<td>Vitamin C</td>
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<tr>
<td>Vitamin E</td>
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<tr>
<td>Niacin</td>
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</tbody>
</table>
Other treatment modalities include

- Sound therapy
- Hearing aids
- Acupuncture
- Cochlear implant
- Cognitive Behavioral Therapy
- Tinnitus Retraining Therapy
- Repetitive Transcranial Magnetic Stimulation
Cochrane Reviews

- Antidepressants Sep 2012
  - TCA (nortriptyline, amitriptyline, trimipramine) x 4 studies
  - SSRI (paroxetine) x 1 study
  - Trazodone x 1 study

- 610 patients total

- Did not find enough evidence to prove the efficacy of these agents in the management of tinnitus.
Ginkgo Biloba March 2013
- 4 studies
- 1543 patients

No evidence that Ginkgo biloba is effective for tinnitus when this is the primary complaint.
Anticonvulsants July 2011
- Gabapentin, Carbamazepine, flunarizine, lamotrigine
- 7 studies (453 patients)
- Do not have a beneficial effect
- Side effects in 18% of patients
MANAGEMENT

- Hearing aids Jan 2014
- Theory that use of HA can reprogram the auditory system using neural plasticity

- Only 1 RCT, 91 patients
  - Not definitive
  - More evidence needed
Sound therapy (Masking) Nov 2012
- White noise
- 6 trials, 553 patients

No significant change seen, but poor evidence
Cognitive Behavioral Therapy Sep 2010

- Psychological treatment that uses relaxation, remodelling thoughts and challenging situations to improve the patient's attitude towards tinnitus
- 8 trials (468 patients)
- No effect in tinnitus loudness, BUT
  - Significant improvement in depression associated with tinnitus and increased quality of life
Tinnitus retraining therapy March 2010
- Counseling and sound therapy
- 1 study, 123 patients
- Showed benefit, but evidence and large amounts of data lacking.
MANAGEMENT

- Acupuncture Oct 2009
  - No data yet in Cochrane
- Another review July 2012
  - 7 studies
  - 229 patients in treatment arms

- No significant difference
- Need more data
No Cochrane review data yet, but protocols also present, for Zinc, neurophysiological testing, and low level laser for tinnitus treatment
MANAGEMENT

- Transcranial magnetic stimulation Oct 2011
  - 5 studies
  - 233 patients
  - Decrease in the loudness of tinnitus

- Research still needed regarding type of rTMS wavelength
MANAGEMENT

- **rTMS**
  - Magnetic stimulation to the auditory cortex thought to reduce neural overactivity

- **“Long-term Effects of Repetitive Transcranial Magnetic Stimulation in Unilateral Tinnitus”**
  - Unilateral tinnitus
  - Failed medical treatment
    - Benzo OR SSRI + Gingko x 2 months
  - 61 patients.
    - 30 ipsilateral, 31 contralateral
  - 1 Hz rTMS x 5 days
  - Improved visual analog score and tinnitus handicap inventory
  - Faster results with ipsilateral stimulation

Other medications work on increasing blood flow to the ear, to maximize its function.

- Why salicylate is used in many tinnitus formulations
  - Clear Tinnitus, Ring Stop, and Quietus

- Arches Tinnitus Formula
  - Ginkgo, Zinc, and Garlic
CONCLUSION

- Tinnitus is a complex disease process that is not yet fully understood
  - Main theory includes hyperfunction due to neural plasticity in an area of decreased stimulation

- Tinnitus is a symptom, not a disease. Treatment of the disease, if possible, should be undertaken (ie- depression, headache, etc)

- Goal is to treat the symptom without creating adverse side effects
  - Treatment might be multimodal
QUESTIONS?
REFERENCES

- (For additional references, see specific slides)