Tinnitus and Vestibular Rehab

CDS 484/529 Aural Rehabilitation
What is Tinnitus?

- An auditory sensation NOT related to the perception of external stimuli
  - Where: in the ears or the head
- Can other people hear it?
  - Subjective tinnitus: a common form of tinnitus (Auditory phantom perception)
  - Objective tinnitus: an unusual form of tinnitus
Prevalence of Tinnitus

- 15 to 20% of the general population
- Only 0.5 to 1% of general population experience “disabling” tinnitus
- More frequent in the elderly
- Prevalence increases with hearing impairment
- Tinnitus in children is an underestimated problem
Main Complaints Associated with Tinnitus

- Constant annoyance
- Intrusive
- Emotional
Known Medical Problems with Tinnitus as a Symptom

- Noise exposure
- Medication/Ototoxicity
- Acoustic neuroma
- Vestibular diseases (Meniere's disease)
- Aging related HL (presbycusis)
- And other medical conditions

- The cause is idiopathic (unknown) for most cases
Often Associated with Tinnitus:

- **Hyperacusis:**
  - Abnormally strong reactions/perceptions to moderate sounds

- **Phonophobia:**
  - Abnormally strong reactions of the autonomic and limbic systems without abnormally high activation of the auditory system
Tinnitus

- Often, there is background, spontaneous auditory neurological activity in the brain.
- This perception may vary in loudness as everyday sounds change.
- When the natural balance in auditory system is upset by a hearing loss or auditory changes...
  - Neurological activity is altered, and this
  - The altered activity is then interpreted by the brain as sound.
- Neurological changes may then cause the perceived sound to be more noticeable and disturbing.
For some people, the presence of tinnitus is particular troubling, and so the brain treats it as important and focuses on it, increasing awareness.

This increased awareness can lead to stress (autonomic) response, resulting in further enhancement by the emotional (limbic) centers of the brain, and further disturbance of the tinnitus.
Tinnitus

- Additionally, the brain can try to compensate for the hearing loss by “turning up” the sensitivity of the hearing system.
  - I.e., Central Gain
- This not only amplifies the tinnitus but can also make ordinary sounds uncomfortably loud for some people, further adding to stress and anxiety.
- The result is a cycle of symptoms that can be self-reinforcing, leading to progressive worsening of the tinnitus over time.
- These factors have made tinnitus traditionally very difficult to treat.
Potential Mechanisms of Tinnitus

- Discordant damage to the outer hair cells and inner hair cells resulting in unbalanced stimulation of the dorsal cochlear nucleus
- Ionic imbalance in the cochlea resulting in damage to the hair cells
- Dysfunction of cochlear neurotransmitter systems resulting in over-stimulation of the inner hair cells
- Loss of peripheral inhibition in the central auditory system
Tinnitus acquires a negative association via...

- Prolonged, continuous presence of a neutral stimulus
- Fear of a new and unknown danger
- Negative/poor counseling
Can we “see” the Tinnitus?

Positron Emission Tomography
From a study conducted by Alan Lockwood and Richard Salvi
The Neurophysiological Model

- Stages of the tinnitus experience:
  - Generation: onset
  - Detection: awareness
  - Perception and evaluation: focus
  - Sustained activation of emotional (limbic) and autonomic (fight or flight) nervous systems
Negative Reactions to Tinnitus

- Anti-reassurance ("just live with it")
  - Negative counseling ("nothing you can do about it")
- Can turn someone who experiences tinnitus into someone who suffers from tinnitus
Methods of Treating Tinnitus
Sound Therapy

The role of sound therapy:

- To decrease the contrast between tinnitus and the background neural activity
- To interfere with the brain’s ability to detect a tinnitus signal
- To reduce abnormal gain in the auditory system
Sound Therapy

Sound therapies:
- Can include enriching sound environment
- Masking of tinnitus in which external sounds can make tinnitus inaudible is not advisable

Problems with this technique:
- Limited residual inhibition
- Adaptation phenomenon: the level of sound needed to mask tinnitus increases with time
Sound Therapy

- Avoid silence
- Many types of sound that can be used
- Devices for sound generation
  - HAs with or without tinnitus sound therapy
    - E.g., Widex Zen: fractal tones
  - Noise/sound generators (whole room or ear level)
- Neuromonics Treatment
  - Users listen to spectrally modified music designed to retrain the brain to ignore the ringing sounds and stop reacting negatively to them.
- Environmental sound enrichment
Sound Therapy

- A little more about Widex Zen: *fractal tones*
Tinnitus Counseling

- Explanation
- Encouragement
- Advice
Tinnitus Counseling

Counseling can be: Psychological/Educational

- Focuses on the reduction of distress caused by tinnitus
  - Should focus on education re: hearing, hearing loss, mechanisms of tinnitus
- Cognitive Behavioral Therapy (CBT) helps to identify the thoughts that underlie the feelings of distress
- Replace negative associations with more positive thoughts
Tinnitus Habituation

- **Stages leading to habituation:**
  - Decrease the level of stimulation from the cortical areas to the autonomic and emotional systems
    - Directive Counseling
  - Decrease the level of stimulation from the auditory subcortical centers
    - Again, this is usually accomplished with *Sound Therapy*
Methods of Treating Tinnitus (cont.)

- Pharmacological agents
- No known medical cure!
  - Some can induce tinnitus
  - Some can reduce tinnitus
Overall Goals of Tinnitus Treatment

- Aimed at inducing habituation of:
  - Tinnitus induced annoyance
  - Tinnitus perception
  - NOT A CURE!!!
Summary of Tinnitus Management

- Counseling is crucial
  - Education
  - Psychological
- Enriched sound environment,
  - Many devices available
  - Alterations to sound environment
- Avoid silence
BREAK
Vestibular Rehabilitation
Cross Section of the Inner Ear

![Diagram of the inner ear with labeled structures and concentration levels of ions and protein in fluids.]

**Figure 2-5.** Cross section of the inner ear.
A Review of Hearing & Balance: Crash Course A&P #17

https://www.youtube.com/watch?v=Ie2j7GpC4JU
The Functions of the Peripheral Vestibular System

- **Function of Utricle and Saccule**
  - Detect changes in *linear acceleration*

- **Function of the Semicircular Canals**
  - Detect changes in *curvilinear (angular) acceleration*
Central Vestibular System

Peripheral Vestibular

Labyrinth

8\textsuperscript{th} Nerve

Central Vestibular

Vestibular Nuclei

Eye Movement: 

\textit{Vestibulo-Ocular Reflex (VOR)}

Postural Control

CNS

Oculomotor pathway

Vestibulospinal pathway
Common Disorders of Vestibular and Balance Function

- Benign Paroxysmal Positional Vertigo (BPPV)
- Vestibular Neuritis
- Meniere’s Disease
- Perilymphatic Fistula
- Central Dizziness
- Vestibular Migraine
- Ototoxicity
- Acoustic Neuroma
- Superior Canal Dehiscence Syndrome
- Barotrauma
Goals of Vestibular Rehabilitation

- Minimize symptoms and functional disability
- Increase mobility and independence
- Reduce the risk of falls and injury
How Does the Vestibular Rehab Work?

- Enhances the body's natural recovery process
- Facilitates adaptation, plasticity, and compensation of existing neural mechanisms in the human brain.

Results in:

- Improvement in vestibulo-ocular control,
- Better postural strategies
- Increased motor control
Providers of Vestibular Assessment

- Audiologists
- GP Physicians and ENTs
- More rarely, physical therapists
Providers of Vestibular Rehab

- GP Physicians and ENTs
- Physical therapists
- Audiologists
- Occupational therapists
Vestibular Assessment

- VNG/ENG - videonystagmography
Videonystagmography (VNG eng testing)
National Dizzy and Balance Center

https://www.youtube.com/watch?v=FVHblu_1lD4
Vestibular Assessment

- Vestibular Evoked Myogenic Potential (VEMP) Testing

  • Neurophysiological assessment technique used to determine the function of the utricle and saccule of the inner ear.

  • Complements the information provided by caloric testing and other forms of inner ear (vestibular apparatus) testing.

  • Applications in the diagnosis of:
    • Superior canal dehiscence
    • Ménière's disease
    • Vestibular neuritis
    • Otosclerosis
    • Multiple Sclerosis
Vestibular Assessment

- Posturography

Sensory Organization Test
What Kind of Rehabilitation is Performed?

- Balance retraining
- Physical rehab exercises
- Strength training
- Vestibulo-ocular reflex retraining
- Gaze retraining
  - Increase foveal focus and reduce retinal slip
- Behavioral/body movement retraining
- Otolith Repositioning
Selection of a Rehab Plan is Determined by:

- **The type or location of pathology**
  1. Benign Paroxysmal Positional Vertigo (BPPV)
  2. Stable unilateral lesions
  3. Stable bilateral lesions
  4. Unstable unilateral lesions
  5. Non-vestibular balance disorders
     - Central disorders
     - Hypotension disorders
     - Muscle weakness
What Kind of Rehabilitation is Done?

- Counseling
  - Falls-Risk Assessment
  - Safety training and other mobility skills
  - Training in activities for daily living
Benign Paroxysmal Positional Vertigo (BPPV)

- Most common cause of sudden-onset, episodic vertigo
- Caused by dislodged otoconia/otoliths in semicircular canals
  - Can occur in anterior, posterior, or horizontal canals
- Easily diagnosed and treated
- Does not respond to medications
- Responds well to vesicular rehab
- Success rate is over 90%
- Recurrence rate is ~ 70%
Specific Interventions for BPPV

- The Epley maneuver and the Semont maneuver
- The Brandt-Daroff exercises
- Log roll exercises
Diagnosis of BPPV
The Dix-Hallpike Maneuver
A Positive Dix-Hallpike (left ear)
Treatment for BPPV
The Epley Maneuver
Other Therapy Selections

**Stable Lesions**

- **Stable unilateral lesions**
  - Adaptation Therapy (*tonic rebalancing*)
    - Goal: Promote rebalancing of the vestibular function
- **Stable bilateral lesions**
  - Substitution Therapy
    - Promote the use of alternative sensory inputs
Other Therapy Selections

Unstable Lesions

- **Unstable Lesions:**
  - Don’t respond well to vestibular therapies
  - If rehab fails: may use ablative procedures (stabilize the lesion)
Other Therapy Selections

- Non-vestibular balance disorders:
  - Psychogenic dizziness
    - Caused by a psychological disturbance
  - Brandt-Daroff exercises for postural vertigo
  - Central dizziness
    - Medication
    - Compensatory strategies
  - Other situations where there is irrational fear of situations in which balance is challenged
    - Psychotherapy
Vertigo is a sensation of spinning.
Vertigo is NOT a fear of heights!!!
Vertigo is a symptom.
Vertigo is NOT a diagnosis!!!
There are many kinds of Dizziness.
Vertigo is only one of them!!!
Also
Lightheadedness
Disequilibrium
Hypotension
Muscle weakness
Presyncope
Anxiety