

Agenda – Tinnitus General Overview

Part I:

- Definition
- Epidemiology
- Causes
- Demographics
- Pathophysiology

Part II:

- Study Snapshot

Part III:

- Tinnitus Assessment
- Tinnitus Management with Sound Therapy
- Case Studies

Learning Objectives

- Define tinnitus and describe the main causes.
- Name at least four tinnitus assessment tools and describe their purpose in tinnitus management.
- Describe the difference between tinnitus treatment and tinnitus management.

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Why Talk about Tinnitus?

- **Tinnitus management**
 - Becoming more commonly available
- **Sound therapy with hearing aids more commonly available**
 - E.g., Sonic's Tinnitus SoundSupport on the SoundDNA platform
- **Complex Topic**
 - Overview is helpful for HCPs considering – or interested in – offering sound therapy with hearing aids

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First, a Quiz

- What do the following notable people from history have in common?
 - Ludwig von Beethoven
 - Charles Darwin
 - Michelangelo
 - Vincent van Gogh

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Another Quiz

- What do the following celebrities have in common?
 - Alex Trebek
 - Barbra Streisand
 - David Letterman
 - Liza Minelli

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Part I:

Definition, Epidemiology, Causes,
Demographics, Pathophysiology

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Definition – What Is Tinnitus?

- **Simply, ringing in the ears**
 - Ringing, buzzing, hissing, chirping, whistling, or other sounds
 - Pulsatile – in sync with heart
- **Intermittent or continuous**
- **Varies in loudness**
 - Often worse when background noise is low



Classification of Tinnitus

- Dauman & Tyler (1992)
- Tinnitus Classification

Pathology	Severity	Duration	Site	Etiology
Normal	Acceptable	Temporary	Middle Ear	Noise-induced
Pathological	Unacceptable	Permanent	Peripheral	Meniere's Disease
-	-	-	Central	Ototoxicity
-	-	-	-	Presbycusis
-	-	-	-	Unknown etiology

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Epidemiology & Causes

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Epidemiology

Tinnitus Facts:

Affects MILLIONS of Americans

- 50 million experience it
- 20 million find it burdensome
- 2 million find it debilitating
- ~15% of the general population

Note!

- Prevalence increases in the clinic population

Why?

- A common symptom of patients seeking treatment for ear- and hearing-related concerns

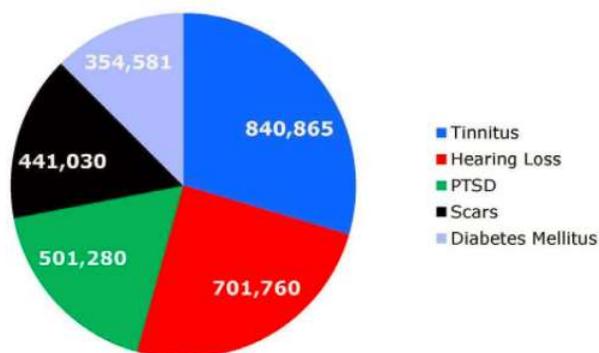
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Epidemiology



Top Service-Connected Disabilities for U.S. Veterans at the end of FY 2011

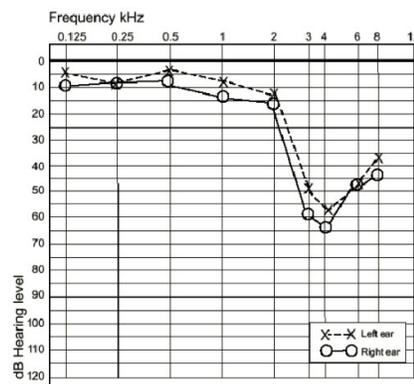


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Causes

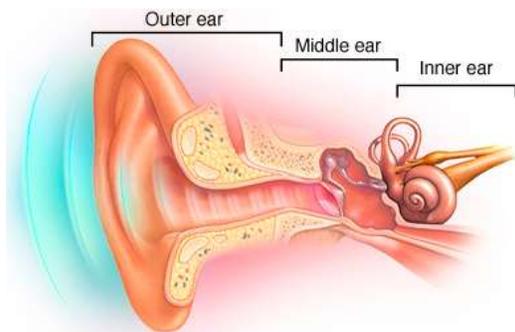
- Tinnitus is not a disease
- Symptom of an auditory disorder
- Hearing loss is the most common cause
- Noise-induced > Age-related
- What else?



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Causes



- **Outer ear disorders:**

Cerumen, foreign body touching the tympanic membrane

- **Middle ear disorders:**

Middle ear infection, Eustachian tube dysfunction, vascular changes, otosclerosis, benign tumors, spasms

- **Inner ear/retrocochlear:**

Sensorineural hearing loss, vestibular conditions (e.g., Meniere's disease, labyrinthitis), acoustic neuroma/vestibular schwannoma

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Causes

- **Blood vessel disorders:**

Blood pressure problems, vascular conditions, head or neck aneurisms, atherosclerosis, arteriovenous malformation, head and neck tumors

- **Injuries:**

Trauma to the head, ear or neck; temporomandibular joint (TMJ) problems

- **Medications:**

Anti-inflammatory drugs (e.g., aspirin, ibuprofen, quinine), diuretics, certain sedatives, antidepressants, antibiotics and chemotherapy agents



Demographics

Demographics

- Are some people more susceptible than others to tinnitus?
- Can we identify potential risk factors?
 - Study: Shargorodsky et al. (2010), American Journal of Medicine
 - N=14,000

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Demographics

Who is most likely to have frequent (daily) tinnitus?

- ✓ Individuals with hearing loss
- ✓ Persons exposed to loud recreational or occupational noise
- ✓ Adults between the ages of 60-69

Any other groups likely to have frequent tinnitus?

- ✓ Non-Hispanic whites
- ✓ Adults with hypertension
- ✓ Former smokers
- ✓ Those with generalized anxiety disorder...

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Demographics

- Tinnitus review article by Marc Fagelson (2014)
- Reports some 50% (or more) of tinnitus sufferers have a co-morbid psychological injury or illness
 - E.g. Post-traumatic stress disorder (PTSD)
 - Depression
 - Anxiety
 - Obsessive compulsive disorder
 - Stress, etc.

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Pathophysiology

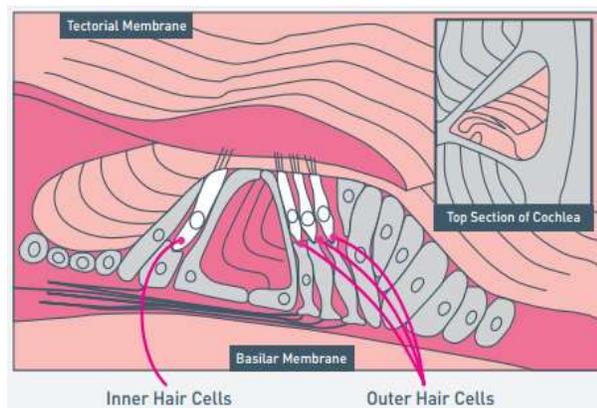
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Pathophysiology

Definition

- Functional or anatomical changes associated with a disease or condition



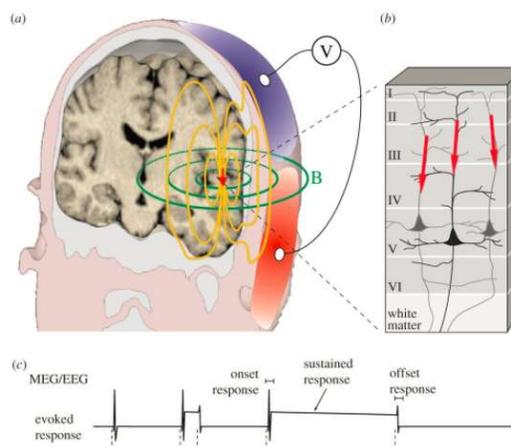
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Pathophysiology

First – What is spontaneous activity?

- Involuntary neural processes that occur within the brain / nervous system



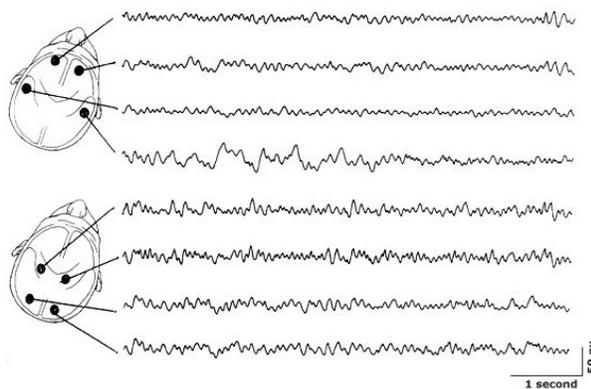
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Pathophysiology

Examples:

- Background sounds arising from active hair cells in the cochlea
- Action potentials firing in the auditory nerve
- Electroencephalographic (EEG) activity



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Pathophysiology

Spontaneous Activity

- It's Normal!
- Occurs in the normal auditory nervous system
- We don't hear it because we adapt to it

Why discuss it?

- Because when something alters typical spontaneous activity, it may lead to tinnitus...

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Pathophysiology

OHC damage (noise, aging):

- Alters spontaneous activity in auditory nerve fibers
- Neural changes start to occur
- Synapses at higher neural levels reorganize, re-tune
- They respond to the edge (border) of the remaining healthy parts of the cochlea
- Re-tuned neurons continue to fire in the absence of sound
- Produces a pitch similar to frequencies bordering the hearing loss, close to frequency of maximum hearing loss

Excessive neural noise—heard as tinnitus sound



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Part II: Study Snapshot

Activities that influence Tinnitus

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Study

“Differences Among Patients That Make Their Tinnitus Worse or Better”

- Tao Pan, Richard S. Tyler, Haihong Ji, Claudia Coelho, and Stephanie A. Gogel (2015)

Purpose:

- To identify activities that influence tinnitus, and
- To determine trends among variables

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Method

258 patients were asked the following two questions:

1. “When you have your tinnitus, which of the following makes it worse?”
2. “Which of the following reduces your tinnitus?”

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Table 1

- Patients' answers to the question “When you have your tinnitus, which of the following makes it worse?”

What makes tinnitus worse?	Present study, %
1. Being in a quiet place	47.7
2. Emotional or mental stress	36.4
3. Having just recently been in a noisy situation	36
4. Being in a noisy place	32.2
5. Lack of sleep	27.1

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Table 2

- Patients' answers to the question “When you have your tinnitus, which of the following reduces your tinnitus?”

What reduces patients' tinnitus?	Present study, %
1. Nothing makes it better	30.6
2. Being in a noisy place	22.5
3. Other	21.7
4. Relaxation	14.7
5. Not sure	14.7
6. When first waking up in the morning	8.9
7. Being in a quiet place	7.4

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Results Summary

(Table 1) Things that made tinnitus worse included:

- Being in a quiet place (48%), stress (36%), being in a noisy place (32%), and lack of sleep (27%)
- Almost 6% of patients suggested coffee/tea and 4% said certain foods made their tinnitus worse

(Table 2) Things that made tinnitus better included:

- Noise (22%)
- Relaxation (15%)

Trends indicated that:

- For those whose tinnitus is not worse in quiet, it is usually not reduced by noise
- For those whose tinnitus is not worse in noise, it is usually not reduced in quiet

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Conclusions

- There are dramatic differences among patients
- Such differences need to be considered in management plans



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Part III:

Assessment, Management, Case Studies

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Assessment

Why assess tinnitus?

- CPT code 92625
- Characterizes the sound
- Documents diagnosis
- Determines management
- Reassures patients
- Initiates a pathway that help is on the way 😊



Assessment

Tinnitus Assessment

- Pure tone audiometry
 - HF >8 kHz, inter-octaves, MCLs, UCLs
- Speech audiometry
 - SRT, WRS
- Tympanometry, acoustic reflexes
- DPOAEs (esp. if normal hearing to 8 kHz)

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Assessment

Tinnitus Assessment

- Pitch Matching
- Loudness Matching
- Octave Confusion Test
- Minimum Masking Level
- Loudness Discomfort Level
- Residual Inhibition
- Subjective Questionnaires



ti **Tinnometer**
Revolutionary Tinnitus Assessment

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Assessment

- **Pitch matching:**

Identifies the center pitch of the tinnitus. Common tinnitus tones or sounds are presented to the patient, who then identifies the sound that most closely matches the tone or sound heard in the ear. Pitch matching provides an important baseline for sound therapy.

- **Loudness matching:**

Ascertains the loudness of the tinnitus. The patient must choose the closest level of a tone among two different ones. The intensity is recorded in dB Sensation Level (SL).

- **Test for octave confusion:**

Confirms the octave of tinnitus pitch. Patients sometimes confuse the pitch of their tinnitus with a tone one octave from it. With this test, a tone is presented at one octave above and below the selected frequency to confirm the correct octave.

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Assessment

- **Minimum masking level:**

Indicates when tinnitus is no longer heard. A masking signal is presented in ascending steps until the patient reports the tinnitus is undetectable.

- **Loudness discomfort level:**

Finds the upper loudness limit of sound. It is the volume at which a presented sound becomes uncomfortable for a patient. This measurement is particularly useful for those with hyperacusis.

- **Residual inhibition:**

Determines if tinnitus can be reduced with sound. A masking signal, presented to the ear for 60+ seconds, reveals if the tinnitus is completely or partially reduced. In some cases, there is no change, or it is increased.

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Tinnitus Assessment Guidance						
Ear :	Tinnitus pitch Match (Hz)	Tinnitus Band With	Threshold Intensity (dB SPL)	Tinnitus Band Octave	Tinnitus Slope %	Relative Tinnitus Intensity (SL)
Right						
Left						
Ear :	Masker Center Frequency (Hz)	Masker Band With	Masker Intensity (dB)	Masker Band Octave	Masker Slope %	
Right						
Left						
Ear :	Masker relative Frequency Pitch Mask- Masker	Relative Width	Relative Intensity (SL)	Octave Difference	Slope Difference	
Right						
Left						
Diagnosis:						

Assessment

Questionnaires – assess the impact of tinnitus on a patient's health and well-being

- Tinnitus Handicap Inventory
- Tinnitus Reaction Questionnaire
- Tinnitus Functional Index
- Tinnitus Severity Index

Assessment

Tinnitus Handicap Inventory – 25 Questions

		Yes (4)	Some- times (2)	No (0)
1F	Because of your tinnitus is it difficult for you to concentrate?			
2F	Does the loudness of your tinnitus make it difficult for you to hear people?			
3E	Does your tinnitus make you angry?			
4F	Does your tinnitus make you feel confused?			
5C	Because of your tinnitus do you feel desperate?			
6E	Do you complain a great deal about your tinnitus?			
7F	Because of your tinnitus do you have trouble falling to sleep at night?			
8C	Do you feel as though you cannot escape your tinnitus?			
9F	Does your tinnitus interfere with your ability to enjoy social activities (such as going out to dinner, to the movies)?			
10E	Because of your tinnitus do you feel frustrated? [25 Total Questions]			

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Total Per Column

Total Score

<input type="text"/>	<input type="text"/>	<input type="text"/>	
x4	x2	x0	
<input type="text"/>	+	<input type="text"/>	+
<input type="text"/>		<input type="text"/>	= <input type="text"/>

Assessment

Tinnitus Handicap Inventory – Severity Scale

Grade	Score	Description
1	0-16	Slight: Only heard in quiet environment, very easily masked. No interference with sleep or daily activities.
2	18-36	Mild: Easily masked by environmental sounds and easily forgotten with activities. May occasionally interfere with sleep but not daily activities.
3	38-56	Moderate: May be noticed, even in the presence of background or environmental noise, although daily activities may still be performed.
4	58-76	Severe: Almost always heard, rarely, if ever, masked. Leads to disturbed sleep pattern and can interfere with ability to carry out normal daily activities. Quiet activities affected adversely.
5	78-100	Catastrophic: Always heard, disturbed sleep patterns, difficulty with any activity.

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Assessment

TINNITUS HANDICAP INVENTORY Screening Version

Instructions: The purpose of this questionnaire is to identify problems your tinnitus may be causing you. Check **Yes**, **Sometimes**, or **No** for each question. Do not skip a question.

	Yes (4)	Sometimes (2)	No (0)
1 Because of your tinnitus, is it difficult for you to concentrate?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2 Do you complain a great deal regarding your tinnitus?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3 Do you feel as though you cannot escape your tinnitus?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4 Does your tinnitus make you feel confused?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5 Because of your tinnitus, do you feel frustrated?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6 Do you feel that you can no longer cope with your tinnitus?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7 Does your tinnitus make it difficult for you to enjoy life?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8 Does your tinnitus make you upset?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9 Because of your tinnitus, do you have trouble falling asleep at night?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10 Because of your tinnitus, do you feel depressed?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Total	_____	_____	_____

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Tinnitus Management

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Management

Tinnitus Treatment vs. Tinnitus Management



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Management

Tinnitus Treatment

- Aims to substantially decrease or eliminate the perception of tinnitus, e.g.
 - Medical Interventions
 - Surgical Intervention
 - Pharmacological Intervention
 - Repetitive Magnetic Stimulation & Neuromodulation

Tinnitus Management

- Aims to improve the way patients react to their tinnitus, e.g.
 - Counseling
 - Cognitive Behavioral Therapy
 - Habituation & TRT
 - Maskers, Support Groups, Stress Management
 - HA's & Tinnitus Instruments

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Management



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Management

American Tinnitus Association

- Sound therapy refers to the use of external noise to reduce a patient's reaction to tinnitus

Sound therapy can be used in one of three ways to manage tinnitus (Fagelson, 2014)...



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Management

- As a distracting sound – to divert the patient’s attention away from their tinnitus
- As a relaxing sound – to decrease stress or anxiety
- As a masking sound – to reduce the contrast of the tinnitus in one’s listening environment to promote habituation



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Management

How do hearing aids fit into sound therapy?

- Properly fitted hearing aids alone will provide tinnitus relief for some patients



Why does it work?

- Amplification makes ambient noise audible

As Distracting Sound:

- Hearing aids amplify external sounds
- Divert attention from the perception of tinnitus
- Help the listener focus on soft, external sounds that otherwise may not be heard
- Provide improved communication for the hearing loss

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Management

How do hearing aids with sound generators fit into sound therapy?

- Another tool to manage the patient's reaction to tinnitus



Why does it work?

- Certain sounds known to provide tinnitus relief
- Can add per HA program 1-4

As a Relaxing Sound

- Calm sounds
 - ❖ Stable/Neutral
 - ❖ Rhythmic
 - ❖ Serene

As a Masking Sound

- Broadband/modulated sounds
 - ❖ White noise
 - ❖ Red noise
 - ❖ Pink noise

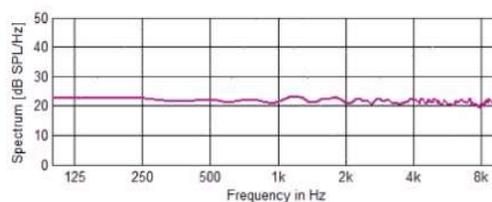
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White sound

- White noise
- Most common sound in tinnitus therapy
- Broadband signal
- Flat spectrum
- Represented by equal amounts of energy for each frequency

- Sounds like static noise, or /sh/ sound



Spectrum of white noise

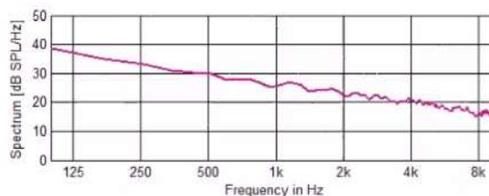
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Pink sound

- Pink noise
- Consists of equal energy per octave
- Broadband signal
- Decreases in power by 3 dB per octave
- May be more tolerable for patients with mild to moderate hearing loss

- Doesn't sound as strong as white noise



Spectrum of pink noise

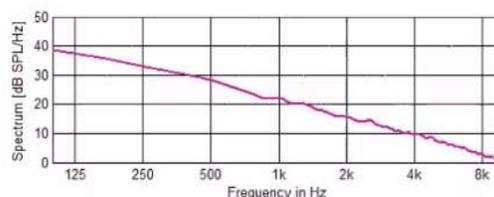
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Red sound

- Red noise
- Broadband signal
- Has more energy at lower frequencies than pink noise
- Decreases in power by 6 dB per octave
- Softer sound quality compared to white or pink noise

- Resembles a waterfall or heavy rainfall



Spectrum of red noise

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Other sounds

A variety of sounds can be used in sound therapy

- It's beneficial to address the varying needs of individual patients

Questions to address

- What works best with their hearing loss configuration?
- What are their preferences?
- Natural vs. Broadband sounds
- How does their tinnitus change during the week?
- Over the course of a day?
- Does sound modulation (amplitude changes) better help to mask tinnitus?

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Case Studies

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Case study 1

Patient A – College student

- Mild HF SNHL

Wants to improve reaction to mild tinnitus while:

1. Studying at library
2. Watching TV
3. Concentrating during weekly exams

Sound Therapy Programs

- Program 1 – General
 - Distracting/Amplification alone
- Program 2 - Studying
 - Masking
 - Modulated Pink Noise
- Program 3 - TV
 - Relaxing
 - Nature sound
- Program 4 - Exams
 - Masking
 - Unmodulated Pink Noise

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Case study 2

Patient B - Accountant

- Sloping SNHL

Wants to improve reaction to moderate tinnitus while:

1. Working at office
2. Reading at night
3. Quiet hobby (painting) on weekends

Sound Therapy Programs

- Program 1 - General
 - Distracting/Amplification alone
- Program 2 - Working
 - Masking
 - Modulated Red Noise
- Program 3 - Reading
 - Relaxing
 - Nature sound
- Program 4 - Hobby
 - Masking
 - Unmodulated Red Noise

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Case study 3

Patient C – Computer Programmer

- Severe HF SNHL

Wants to improve reaction to **severe** tinnitus at ALL times, esp. as stress levels change:

1. Morning
2. Afternoon
3. Evening

Sound Therapy Programs

- Program 1 - General
 - Masking
 - White Noise - Unmodulated
- Program 2 - Morning
 - Masking
 - White Noise – Spirited modulation
- Program 3 - Afternoon
 - Masking
 - White Noise – Bustling modulation
- Program 4 - Evening
 - Masking
 - White Noise – Mild modulation

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Questions?



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SoundDNA Platform



Tinnitus SoundSupport



Sonic Vimeo

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Final Comments

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- Any Questions?
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