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Noise is any unwanted sound
A disturbance, especially a random and persistent disturbance, that obscures or reduces the clarity of a signal
Ways to describe noise
– Intensity, Frequency, Nature, Duration

A better method is to use a personal dosimeter
This will measure the intensity of the environment
Once you measure the intensity of sounds you are placing yourself into, you may start making some changes
FREQUENCY
• At any volume high frequency sounds are more damaging than sounds containing low frequencies
• Most hearing protectors reduce sounds in the high frequencies more aggressively than the lows

DURATION
• This ties into the intensity of a sound
• These duration times are based on daily exposure levels, so they are cumulative for a 24 hour period

NATURE
• Both of these sound types can cause damage
• If the steady state noise is loud enough and you are in the environment long enough it can cause just as much damage as an impulse sound
The Four P's of NIHL

- It develops Painlessly
- It Progresses over time
- It's Permanent
- And it's 100% Preventable

How Does a NIHL Happen?

- Acoustic trauma such as an explosion, or a one time exposure to an extremely loud sound (fireworks, gun, bombs)

How Does a NIHL Happen?

- Daily exposure to moderately loud sounds that add up to damage over time (factory work, farming equipment, working a music concert)
**TEMPORARY THRESHOLD SHIFT (TTS)**

- After an exposure to high noise levels the outer hair cells experience a temporary threshold shift
- During this time a person may experience
  - Reduced hearing ability (hearing loss)
  - Aural fullness (stuffed feeling in their ears)
  - Tinnitus

**TTS RECOVERY**

- As the name states this type of threshold shift is temporary
- After several hours or even days in a more quiet environment the person’s hearing thresholds should return to normal and the tinnitus should dissipate
- The greater the threshold shift the longer it will take to recover

**WHAT HAPPENS TO HAIR CELLS**

- May only involve the stereocilia and can somewhat be repaired
- Involve the entire hair, which undergoes apoptosis and dies
A good rule of thumb is the 3 foot rule:
- If you have to raise your voice to be heard by someone standing 3 feet away from you, then the noise level is most likely too loud.

Repeat exposure to loud noise can lead to permanent hearing loss.

When the hearing loss is caused from noise exposure we label that loss a Noise Induced Hearing Loss (NIHL).

With the permanent hearing loss comes other issues such as:
- Stress, reduced productivity, concentration and communication difficulties.
- This can contribute to workplace accidents making it difficult to hear warning signals and understand speech.
What happens to hair cells

- After repeat exposure, more severe damage is seen in the stereocilia of the outer hair cells.
- More definitive damage can occur when the hair cell itself disappears.
  - Supporting cells can also be damaged or disappear as well.


Frequency Matters

- 4000 Hz Octave Band Noise
- 500 Hz Octave Band Noise

Images from: http://oto2.wustl.edu/bbears/noise.htm

Physiologic Changes in the Organ of Corti

Images from: http://www.studyblue.com/notes/note/n/hearing-system-
• After initial exposure
  – Loss of sensitivity to high frequency sounds
  – A confined notch centered around 4000 Hz
After continued exposure
- The notch at 4000 Hz deepens and widens involving more frequencies
- Remember progressive high frequency hearing losses can go undetected by patient's for years as there is no loss of loudness

What can cause a noise induced hearing loss?
- Industry
- Farming
- Military
- Music
- Home appliances

Most workers at live music venues are exposed to more noise than noise standards allow
- New term "music induced hearing loss"
- It's not noise it's music
  - Musician don’t want to wear hearing protection
  - A concert isn’t the same with the volume turned down
“Noise is part of NASCAR”

Noise measures taken:
- In the pit during a race at 130 dBA
- In the stands during a rack at 96 dBA
- 114 dBA in the race car during practice
- During the race 140 dB

Most racing associations do not require drives and crew members to wear hearing protection.

**THE STANDARDS**
OSHA and NIOSH

**DEVELOPMENT OF OSHA STANDARD**
- Part of the US Department of Labor
- OSHA was created by the Occupational Safety and Health Act of 1970
- The specific standard for occupational noise exposure is OSHA standard 29 CFR 1910.95
OSHA STANDARDS FOR NOISE

<table>
<thead>
<tr>
<th>Noise Level</th>
<th>Exposure Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 dBA</td>
<td>8.0 hours</td>
</tr>
<tr>
<td>92 dBA</td>
<td>6.0 hours</td>
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<tr>
<td>95 dBA</td>
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<td>2.0 hours</td>
</tr>
<tr>
<td>100 dBA</td>
<td>1.5 hours</td>
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<tr>
<td>102 dBA</td>
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</tr>
<tr>
<td>105 dBA</td>
<td>0.5 hours</td>
</tr>
<tr>
<td>110 dBA</td>
<td>30 minutes</td>
</tr>
<tr>
<td>115 dBA</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

Image from: www.deapeline.com

HEARING PROTECTION REQUIREMENTS

DEVELOPMENT OF NIOSH STANDARD

- Part of the CDC (Centers for Disease Control and Prevention)
- Conducts research and provides information, education, training, and recommendations regarding occupational safety and health
- Recommended Exposure Limits (REL) are based on scientific data
OSHA NIOSH

- Measures sound levels continuously over time and converts that into a noise dose
- Provides a more accurate estimate of risk
- Alert users in real time of the need to use hearing protection

Noise dosimetry

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Hearing protection selection

Which One is Right for Me?
### Earmuffs

**Pros**
- Easy to fit/wear
- Good for short use
- Options for radio and electronics

**Cons**
- Can become hot/heavy with extended wear

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### Bands

**Pros**
- Convenient for intermittent noise

**Cons**
- Lower attenuation than earplugs
- Noise can transmit through the band

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### Earplugs

**Pros**
- Comfortable for extended use
  - Can be custom made
  - Disposable or reusable
  - Cooler in hot/humid environments
  - High levels of attenuation

**Cons**
- Needs a good fit to attain rated attenuation

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CUSTOM EAR PLUGS

• Generally are easier to place and can provide similar amount of reduction as muff s
• There are several different variety of custom ear plugs

EAR PLUGS WITH FILTERS

• Some ear plugs have filters added into the housing offering
  – A more flat level of noise reduction
  – Different levels of attenuation

FILTERED EAR PLUGS
**Images from: Etymotic.com**

**How do I protect Myself?**

- NRR are not measured with the dBA weighted sound

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**SO WHAT DO I DO WITH THIS INFORMATION**

How do I protect Myself?

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**NOISE REDUCTION RATING**

- NRR are not measured with the dBA weighted sound
REVISIONS TO NRR RATING

- The EPA and ANSI believe the current standard may not reflect real-life working conditions well enough
- Proposing a new rule to test both active and passive hearing protection devices
- Will also retest devices every 5 years since material and designs can change over the years

THE NEW LABEL

- Noise Reduction Rating

OUR ROLE IN THIS

- Education
  - To help modify behaviors
  - To teach about the auditory system
  - Different types of hearing protection
  - OSHA standards
- Impressions for custom ear plugs
- Hearing tests and hearing aid fittings
- Tinnitus counseling and treatment
• Noise is any unwanted sound or disturbance that reduces signal clarity
• A NIHL can occur from a one time acoustic trauma or from prolonged daily exposure
• OSHA and NIOSH have standards for allowable noise limits
• There are many different types of hearing protection out there, none better than the other unless your patient won’t wear it