

**Basic Course in Occupational and Environmental Medicine, Part III  
Orlando, Florida, October 30, 2011**

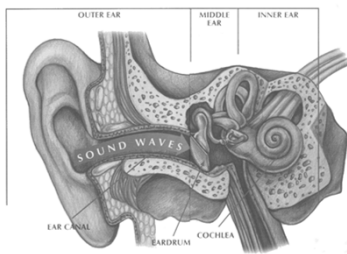
**Noise Induced Hearing  
Loss and Hearing  
Conservation**

AOCOPM Basic Course in  
Occupational Medicine  
**AOA Annual Osteopathic  
Medical Conference**  
Orlando, Florida  
Sunday, October 30, 2011

**Objectives**

- Develop an understanding of hearing.
- Learn how noise causes hearing loss.
- Learn about how workers can be protected from hearing loss.
- Learn about the OSHA standard regarding hearing loss.
- Learn the basics of an effective hearing conservation program.

**The Human Ear**



**Effects of High Noise**

- May cause stress and anxiety
- Interferes with speech and ability to communicate
- May cause sleep difficulties
- Temporary hearing shifts
- Pain (very high levels)
- Can damage hearing



**Hearing Loss**

**Types of Hearing Loss:**

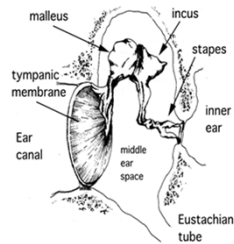


- **CONDUCTIVE**
- **SENSORI-NEURAL**
- **MIXED**
- **NON-ORGANIC**

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## Conductive

Occurs from a dysfunction of the outer or middle ear that can usually be treated with medicine or surgery; a deficit of loudness only.

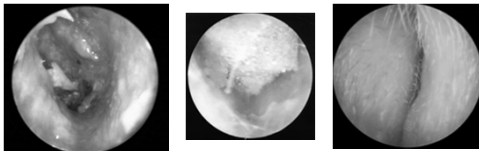
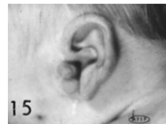


## Characteristics

- Maintain soft speaking voice
- Excellent speech discrimination when speech is loud enough
- Typically either low frequency or flat hearing loss (equal at all frequencies)

## Causes

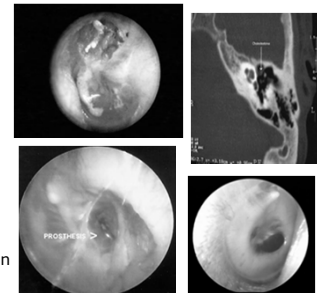
- **Outer Ear:**
  - Occlusion/foreign body
  - Congenital Atresia
  - External Otitis



Photo's courtesy of Dr. Roy F. Sullivan, Ph.D.

## Causes

- Blocked Eustachian Tube, reduced middle ear pressure, TM retraction and eventual effusion
- Otitis Media
- TM Perforation
- Ossicular fixation
  - Otosclerosis
- Ossicular Disarticulation
- Cholesteatoma



Photo's courtesy of Dr. Roy F. Sullivan, Ph.D.

## Treatment

- Conductive hearing losses are due to problems that occur in the outer and middle ear which are usually temporary and/or treatable with antibiotics or surgery
- For those few people who have uncorrectable conductive hearing losses, hearing aids are of significant benefit as sound remains clear if it is made loud enough

## Sensori-Neural

- Dysfunction of the inner ear or auditory nerve, usually permanent and untreatable; results in loudness deficit and distorted hearing.



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### Characteristics of SNHL:

- Inappropriately loud voice
- Tinnitus
- High frequency loss common, but any configuration possible
- Speech sounds distorted
- Background noise makes listening more difficult
- Hearing aids may help



### Causes

- Genetics/Congenital
- Disease
  - Mumps, measles
  - Meningitis, CMV
- Ototoxic drugs
- Head trauma
- Presbycusis
- Meniere's Disease
- Acoustic Neuroma
- Noise Exposure:
  - Prolonged exposure to hazardous noise causes hearing loss by the physical destruction of the hair cells in the cochlea.



### The "4 P's"

#### Noise induced hearing loss is:

- **Painless**
- **Progressive**
- **Permanent**
- **Preventable!**



From Siemens Hearing Solutions

### Noise Induced HL

- Loss can be sudden, as with acoustic trauma from an explosion
- More often gradual onset that may go unnoticed
  - NIHL also known as noise-induced permanent threshold shift (NIPTS), typically takes years of exposure, gradual erosion of hearing that eventually affects communication
- Amount of loss varies from person to person
- Risk of noise-induced progression stops if no longer noise exposed, but aging invariably worsens loss
  - For most, aging effects aren't significant before age 50+

### Classic Symptoms

- Generally affects 3000-6000 Hz range first
- Typically bilateral and symmetrical
- Tinnitus common
- Reduced speech comprehension, particularly in background noise. Why?
  - Vowels are low frequency sounds that carry 90% of speech energy. ("I can hear you talking...")
  - Consonants are higher frequency sounds that carry most of the meaning of speech. NIHL begins in high frequencies. (but I can't understand what you are saying.)

### Treatment

- Sensori-neural hearing loss is due to problems that occur in the inner ear and are almost always permanent and untreatable.
- Hearing aids will benefit most people with sensori-neural loss, but results can vary.

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### Other Types

- **Mixed**
  - Combination of Conductive and Sensori-neural
- **Central**
  - Occurring within central nervous system (cortex, brainstem, or ascending auditory pathways) as opposed to peripheral organs of hearing (cochlea and middle ear).
- **Non-Organic:**
  - No medical or physical reason for hearing loss; may be voluntary or involuntary
- **Malingering:**
  - Consciously faking or exaggerating a hearing impairment

### Non-organic

#### Symptoms that should alert you to malingering:

- Substantial, equal hearing loss at all frequencies or no response to pure tones at all in one or both ears.
- Inconsistent results, or markedly different than prior results.
  - Unilateral "deafness" without significant medical history unlikely
- Exaggerated attention to test, may press on earphones, difficulty hearing you call them back for testing or to your directions (normal voice level is around 60 dB), but can hear you when your back is turned or when there are no visual cues.
- Unconscious development of a non-organic hearing loss – a compensatory protective device, a psychogenic problem -- the patient believes the impairment is real.

### The Cost of Hearing Loss

- Over 30 million people with significant hearing loss
- 10 million attributed to noise
- 10 million people with debilitating tinnitus
- 242.2 million dollars is estimated to be paid out yearly for disability alone for NIHL
- Noise induced medical problems: hypertension, anxiety, elevated cortisol levels
- Contributes to: sleeplessness, fatigue, poor concentration, stress, poor productivity

### Hearing Conservation Program

How to be successful

### History of Hearing Conservation

- Air Force Standard 1949
- Civilian Standard, Walsh-Healey Public Contracts Act of 1935 gave Labor Department authority to regulate companies having contracts with Federal Government, Noise standard not released till 1969
- 1969 MSHA, 1970 OSHA regulatory agencies came into existence
- Regulation OSHA/ MSHA vs. Standards NIOSH/ANSI
- 1971 OSHA applied noise regulation to all companies in US
- 1972 OSHA publishes *Criteria for a Recommended Standard, Occupational Exposure to Noise*
- 1981 OSHA Hearing Conservation Amendment
- 1983 Revised Version 29 CFR 1910.95 is what we work under now

### Who Needs a Hearing Conservation Program?

29 CFR 1910.95

"The employer shall administer a continuing, effective hearing conservation program whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A scale"

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## OSHA Standard Requirements

- **Employee exposures at/above AL for even one workshift per year requires:**
  - Employees to be in a Hearing Conservation Program
  - Have initial/annual training and audiometric tests
- **Exposures at/above PEL require:**
  - Exposure Controls - engineered controls/hearing protectors

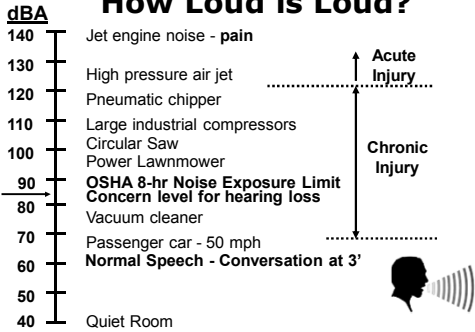


## Key elements to a good Hearing Conservation Program

- Noise Monitoring
- Engineering Controls
- Periodic Audiometric evaluation
- Worker Education
- Selection of appropriate HPDs
- Administrative Controls

*Note: An audiologist or physician must be responsible for the program*

## How Loud is Loud?



## Not all Hearing Loss is Work Related



## OSHA Noise Exposure Limits

Limits Vary with Length of Workshift

Shift Duration (Hours)	Permissible Exposure Limit - "PEL" (dBA)	Action Level - "AL" (dBA)
8	90	85
10	88	83
12	87	82

## Permissible Exposure Limits

- OSHA PEL is 90dB over 8 hours TWA
  - Cut time in half for every 5dB increase.
  - 90dB= 4 hours, 95dB= 2 hours.
- NIOSH is different
  - Cut time in half for every 3dB
  - 88dB= 4 hours

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### Measuring Noise

- Frequency-weighted Sound Pressure is measured in units of decibels (dB)
- For hearing protection, we measure the "A-weighted" frequency range
  - Includes broad range of frequencies
  - Emphasizes the human speech frequencies
  - Expressed as "dBA"



### Engineering Controls

- Anything done by the employer to reduce noise.
  - Maintenance
  - Modifying equipment
  - Substitution of equipment
  - Isolation
  - Acoustic material



### Audiometric Testing Program

- Baseline Audiogram
- Annual Audiogram
- Standard Threshold Shift (STS)
- Follow-up Procedures
- Audiometric Test Requirements
- Monitor the effectiveness of the hearing conservation program

### Definition of STS

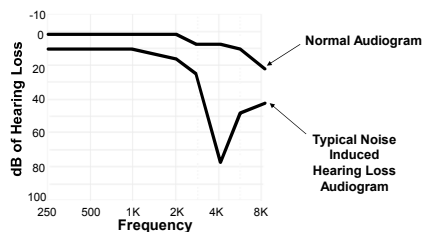
#### Positive STS:

- + 10 dB average at 2000, 3000 and 4000 Hz  
or
- + 15 dB at 1000, 2000, 3000 or 4000 Hz

#### Negative STS:

- 10 dB average at 2000, 3000 and 4000 Hz  
or
- 15 dB at 1000, 2000, 3000 or 4000 Hz

### Audiometric Hearing Tests



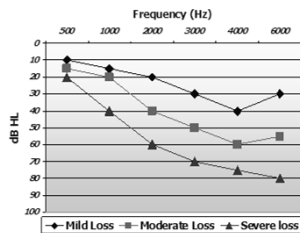
### Degrees of Hearing Loss

- Normal Hearing 10 - 25 dB HL
- Mild Hearing Loss 30 - 45 dB HL
- Moderate Hearing Loss 50 - 65 dB HL
- Severe Hearing Loss 70 - 85 dB HL
- Profound Hearing Loss > 90 dB HL

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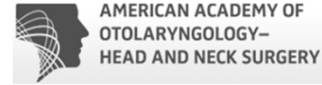
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### Audiogram Configurations: Progressive noise-induced hearing loss



### Referral Criteria

Two sources for Referral Criteria:



### Record Keeping Rule for Hearing Loss

- Hearing loss is reportable when:
  - A STS occurs (an average 10 dB or greater change for thresholds averaged at 2, 3, and 4 k Hz in either ear from the current baseline audiogram) and . . .
  - Hearing thresholds for the current audiogram show an average of 25 dB or greater at 2, 3, and 4 k Hz from audiometric zero for the shifted ear

### Record Keeping Rule for Hearing Loss

CFR 1910.1020 (medical records standard)

Enacted in 1999 supersedes rules for records retention in 1910.95 (hearing conservation standard) revised in 1983

Length of employment plus 30 years

### Worker Education

### Worker Education

- Anyone exposed to 8 hours TWA of 85dB are required to have annual training.
  - Effects of noise
  - Advantage and Disadvantage of types of HPDs (hearing protection devices)
  - The selection, fit, and care of HPDs
- The requirements may be done by different folks at different times of the year, as long as it is done annually.

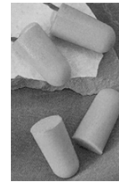
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**Hearing Protection Devices**

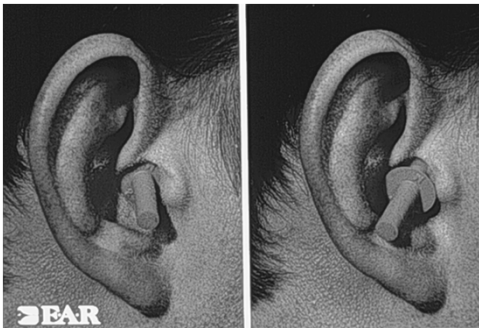
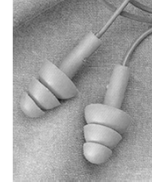
- Must be worn if 85dB TWA 8 hours, before baseline is done
- Employer must provide at least one variety of plug and one variety of muff
  - Someone must be available to fit and discuss care of product used
- Most employers use NRR (noise reduction rate) to select product

**Hearing Protection Devices**

**Disposable or Re-Usable Ear Plugs are convenient and easiest to use**



**Use Earplugs with USEPA Noise Reduction Ratings (NRRs) 30 dB or higher**



**Hearing Protective Devices**

**Ear Muffs may also be used**



*However, templebars on safety glasses interfere with the sealing surfaces on ear muffs*

**Hearing Protective Devices**

**For Very High Noise Levels  
- 100 dBA and Higher -  
Use Double Hearing Protection**



**Hearing Protective Devices**

**Double the Device - Double the Protection?**

**NOPE**

NRR of best device - 7 divided by two and subtract from TWA then subtract 5dB for second device

**Example**

TWA of 110 dB, two devices one 20NRR one 15 NRR,  $(20-7)/2=7$   
 $110-7= 103 -5$  for second device =98 NOTGOOD ENOUGH!!!

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### Recommendations

- Provide greater protection than OSHA Noise Standard requires
  - Employees should wear hearing protection when entering or working in areas where noise levels are at or above 85 dBA
  - Based on evidence that hearing damage occurs below OSHA noise limit



### NIOSH recommends that the labeled NRRs be derated as follows:

- Earmuffs: Subtract 25% from the manufacturer's labeled NRR
- Foam earplugs and custom molded earplugs: Subtract 50% from the manufacturer's labeled NRR
- All other earplugs including semi-inserts: Subtract 70% from the manufacturer's labeled NRR

### Summary

- Know Exposure Limits
- Perform Noise Monitoring
- Use feasible engineering or administrative controls
- HC Program if > AL
- Audiometric Testing
- STS notification and follow up
- Record on 300 log
- HPD for all at no cost
- Annual training
- Access to information and Training Materials
- Recordkeeping

### Tips

- One of your jobs is to help your clients protect themselves and their workers
  - Consider taking the CAOHC course
  - Partner with a good Audiologist
  - Make sure your clients are administering good baseline testing
  - Make sure your clients are using a good hearing questionnaire for new hires
  - Make sure your clients are doing proper education of their workers
  - Don't forget to educate workers to protect hearing outside of work

### Questions?



*"It could be one of those things that crawl into your ear and lay eggs, and the eggs hatch and burrow into your—nose. It looks fine."*