

Introduction

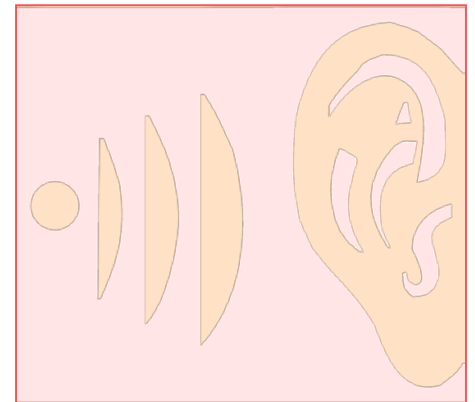
- NIHL is the second most common form of acquired hearing loss(after presbycusis).
- Noise is the most pervasive hazardous agent in the workplace.
- NIHL is one of the most common occupational disease.
- NIHL is the second most frequently self-reported occupational injury.
- NIHL is listed as one of the eight most critical occupational diseases and injuries requiring research.
- NIHL is permanent, irreversible and prevalent BUT preventable.

Hearing disorder caused by environmental agent

- | ● Disorder | ● cause |
|---|--|
| ● NIHL | ➤ Noise exposure |
| ● Noise-induced tinnitus | ➤ Sudden intense noise or excessive pressure |
| ● Acoustic trauma | ➤ Organic solvents, heavy metals, CO, Aminoglycoside, furosemide |
| ● Ototoxicity due to chemicals and drug | ➤ Neurotoxin |
| ● Damage to auditory cortex | ➤ Noise, barotrauma, air embolism |
| ● Ear disorders due to diving | ➤ Radiation to head & neck |
| ● Radiation- induced damage | ➤ Slog burn, foreign objects |
| ● Trauma to external and | |

Types of Hearing Loss

- **Conductive Hearing Loss**
 - *Involvement of Outer and/or Middle Ear*
 - Most often this is medically or surgically treatable.
- Head trauma
- Burns
- Acoustic trauma (Sound explosion)



Conductive hearing loss

- Otosclerosis
- Tympanosclerosis
- TM perforation
- Middle ear effusion
- Laxity of TM
- Disruption of ossicular chain



Types of Hearing Loss

- **Sensorineural Hearing Loss**
 - *Inner Ear*
 - Most often is permanent and not medically/surgically treatable.
 - Treatment usually involves aural rehabilitation which includes the fitting of amplification devices.
- **Ototoxic hearing loss**
- Ototoxic substances: Heavy metals, cyanide, benzen, dimethyl sulfoxide, methylmercry, carbon monoxide, aniline dye, etc

Sensorineural Hearing Loss

- Presbycusis
- Metabolic disorders
- Infectious hearing loss
- CNS disease
- Meniere disease
- Noise-induced hearing loss

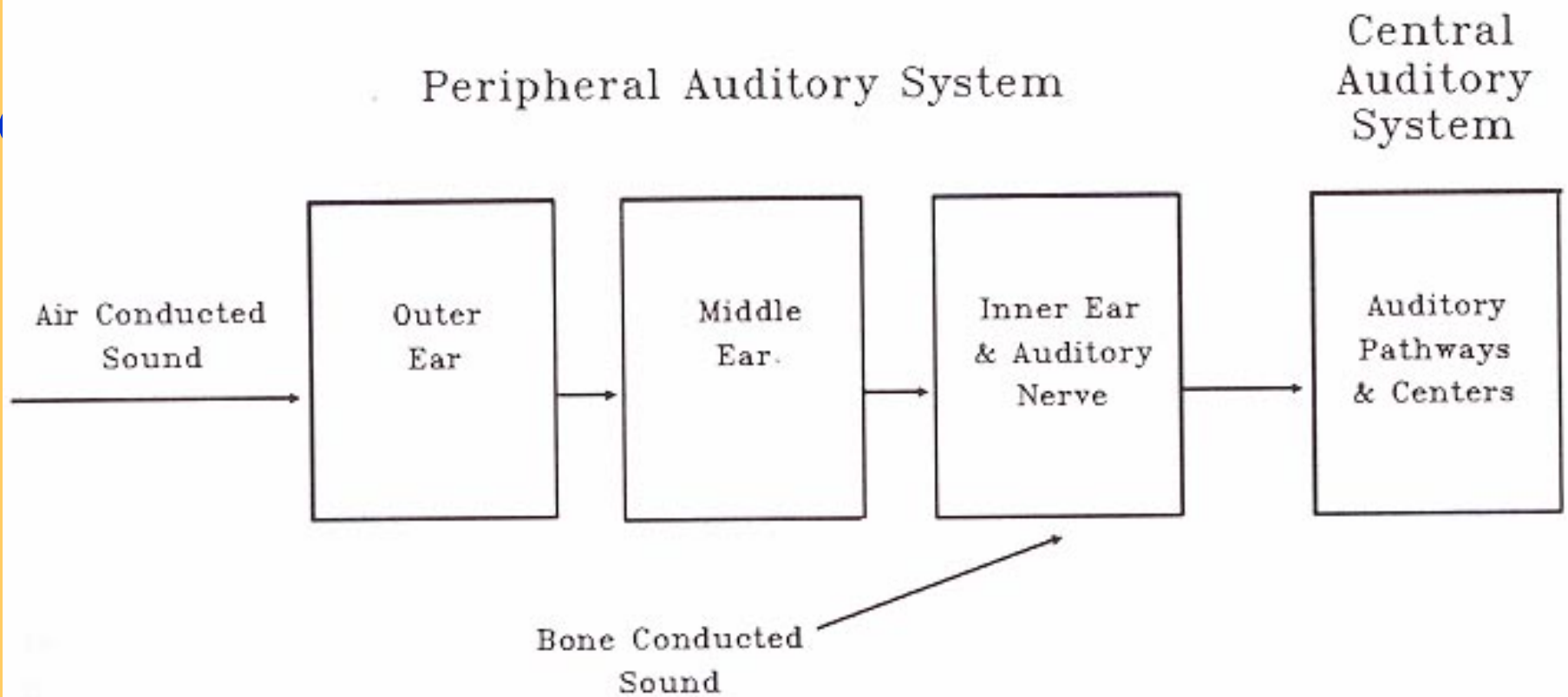
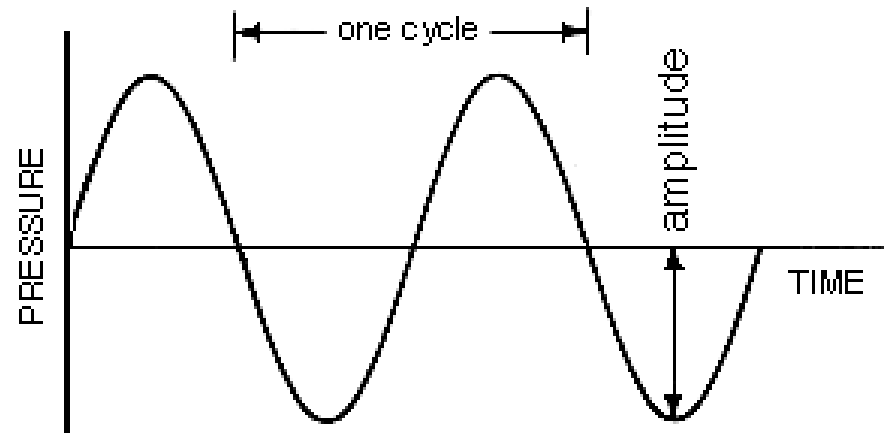


Figure 1. Schematicized pathways for air- and bone-conducted sound.

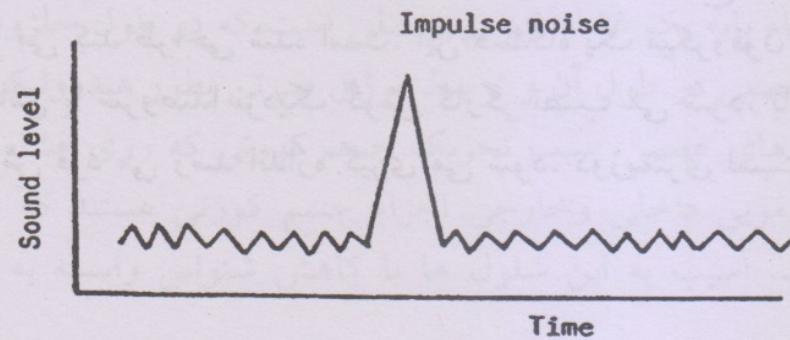
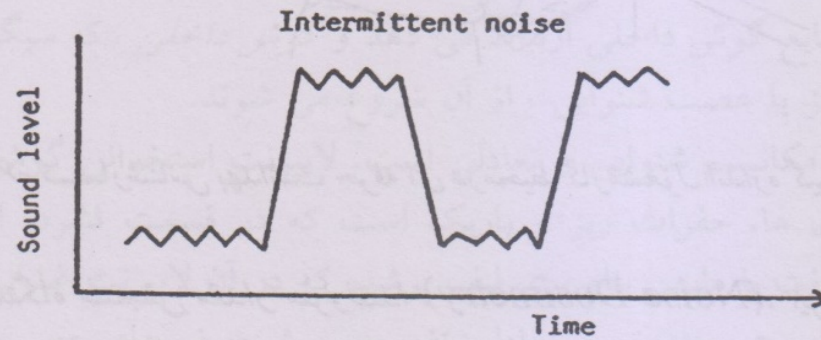
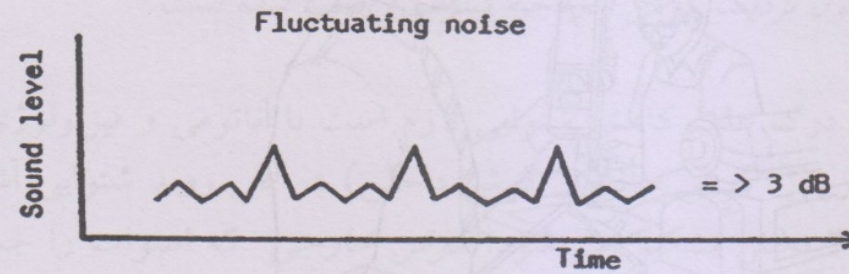
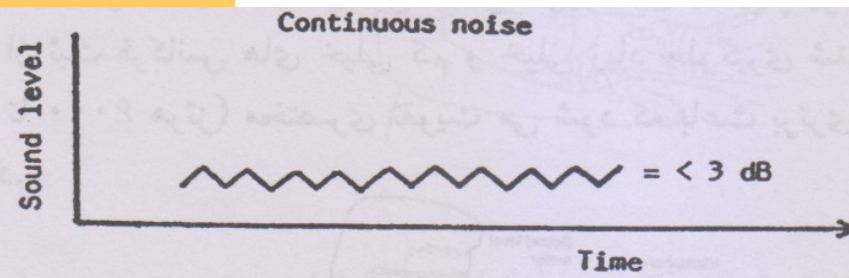
Decibels and Hertz

- **Hertz (Hz)**
 - Frequency
 - Pitch
- **Decibels (dB)**
 - Amplitude
 - Loudness

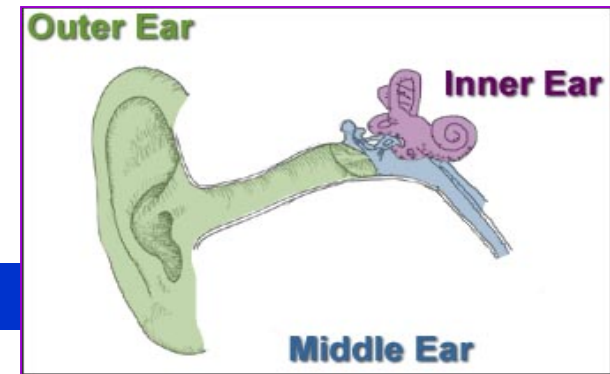


Continued

- Continuous or steady-state noise.
- Interrupted noise
- Impact or Impulse noise
- ❖ The relative hazard depends on the: intensity, duration and frequency.



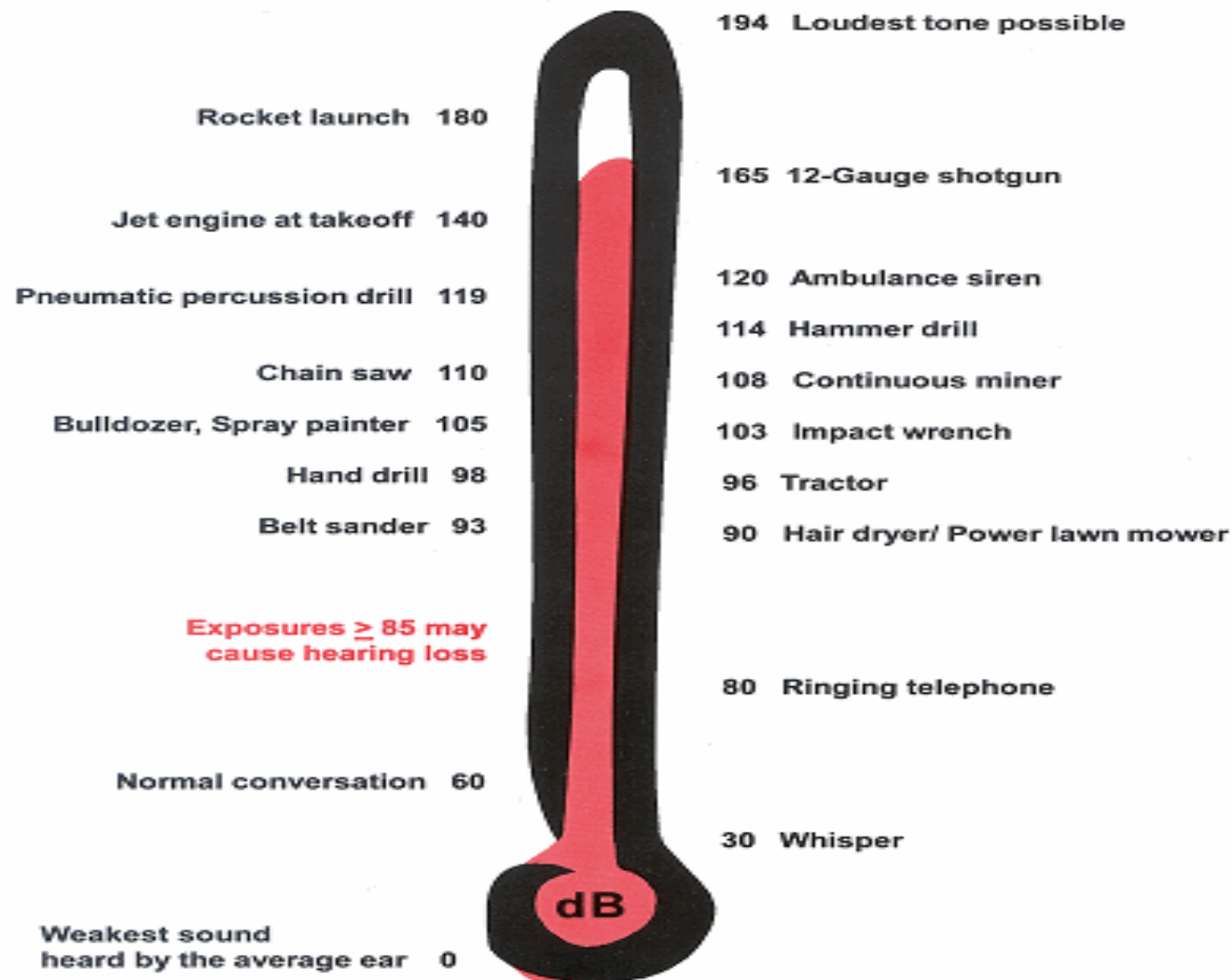
Sound Versus Noise



- **Sound is a pressure change detectable by the human ear**
 - The pitch ranges between 20 to 20,000 Hz.
 - The volume ranges between 0 to 140 dB
- **Noise is a type of sound.**
 - Is composed of many pure tone frequency that interact with one another to yield a sound with a complex mixture of loudness & pitch.
 - It is generally described as undesirable or unwanted sound.



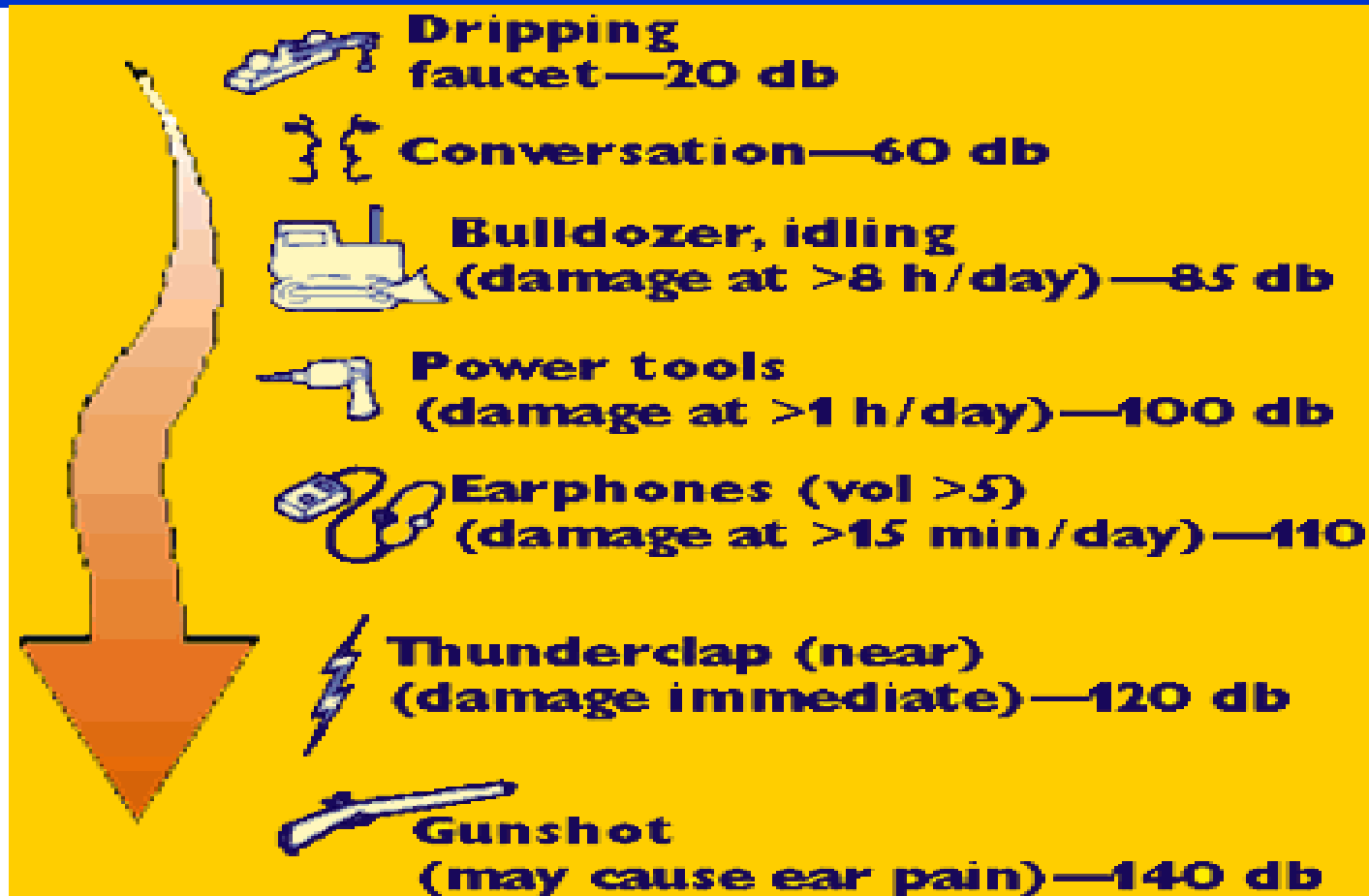
General Estimates of Work-Related Noises



For more information on occupational hearing loss or other work-related injuries or illnesses contact the National Institute for Occupational Safety and Health (NIOSH) at

1-800-35-NIOSH or <http://www.cdc.gov/niosh>

Common Sounds may be louder than you think...



Non-Auditory Effects of Noise

- Cardiovascular effect
- Nervous effect
- Interferes with speech and concentration
- Psychological effects (causes annoyance, stress, and fatigue)
- Reduces work efficiency
- Lowers morale
- Masks warning sound
- Reproductive effects??



Occupational Hearing Loss

- **Noise-Induced Hearing Loss or Noise-Induced Permanent Threshold Shift (NIPTS)**
 - Permanent sensor neural condition
 - Cannot be treated or corrected medically
 - Initially effects high frequencies
 - Progresses to lower frequencies
 - Preventable



Hearing Loss

•Temporary Hearing Loss

- results from short term exposure to noise
- hearing returns when away from the noise

•Permanent Hearing Loss

- results from exposure to a moderate or high level of noise over a long period of time
- hearing loss is PERMANENT



Acute acoustic trauma

- Brief exposure to extremely loud noise (120-140 dB) or due to blast injuries
- Conductive, sensorineural or mixed
- Temporary or permanent
- Vertigo, tinnitus and pain
- Unilateral or bilateral
- Follow-up for 4-6 months

Etiology and pathogenesis of NIHL

- All structures of the organ of corti can be affected, but the most injury is to stereocilia of inner and outer hair cells.

ACGIH & NIOSH

- Noise greater than 85dBA(8h in a day & over 40h in a week can induced NIHL.
- Predisposing factors: SNHL, auto toxic drugs, uncontrolled diabetes, hyperlipidemia, heavy smoker,CO, solvents, heavy metals, heat & vibration



Clinical & Audiometric sings:

- Tinnitus
- TTS
- PTS
- ❖ Audiometric notch(10 dB)
 - ✓ no notch(less than 15)
 - ✓ Small notch(15- 34)
 - ✓ Large notch(≥ 35)

Early signs of hearing loss

- Difficulty in understanding spoken words in a noisy environment.
- Need to be near or look at the person speaking.
- Familiar sounds are muffled.
- Complaints that people not speak clearly.
- Ringing noises in the ear.
- Tinnitus.

Threshold Shifts

- Temporary Threshold Shifts (TTS)
 - Hearing returns to normal after noise exposure
- Permanent Threshold Shifts (PTS)
 - Repeated noise exposure without a return to normal
- Standard Threshold Shifts (STS)
 - ≥ 10 dB average loss in 2000, 3000, or 4000 Hz in either ear

Diagnosis of NIHL

- Exposure to noise(≥ 100 dB in normal person & ≥ 90 dB in susceptible) in 5 years.
- Audiogram findings
- R/O of others cause of hearing loss

Audiometry in NIHL

- NIHL is sensorineural hearing loss.
- NIHL is usually symmetrical.
- NIHL is usually high frequency hearing loss.
- Early change in NIHL are indicated at the 3000-4000 Hz long before they are noticed by an individual.(notch)
- PTS & TTS.

Results of PTA

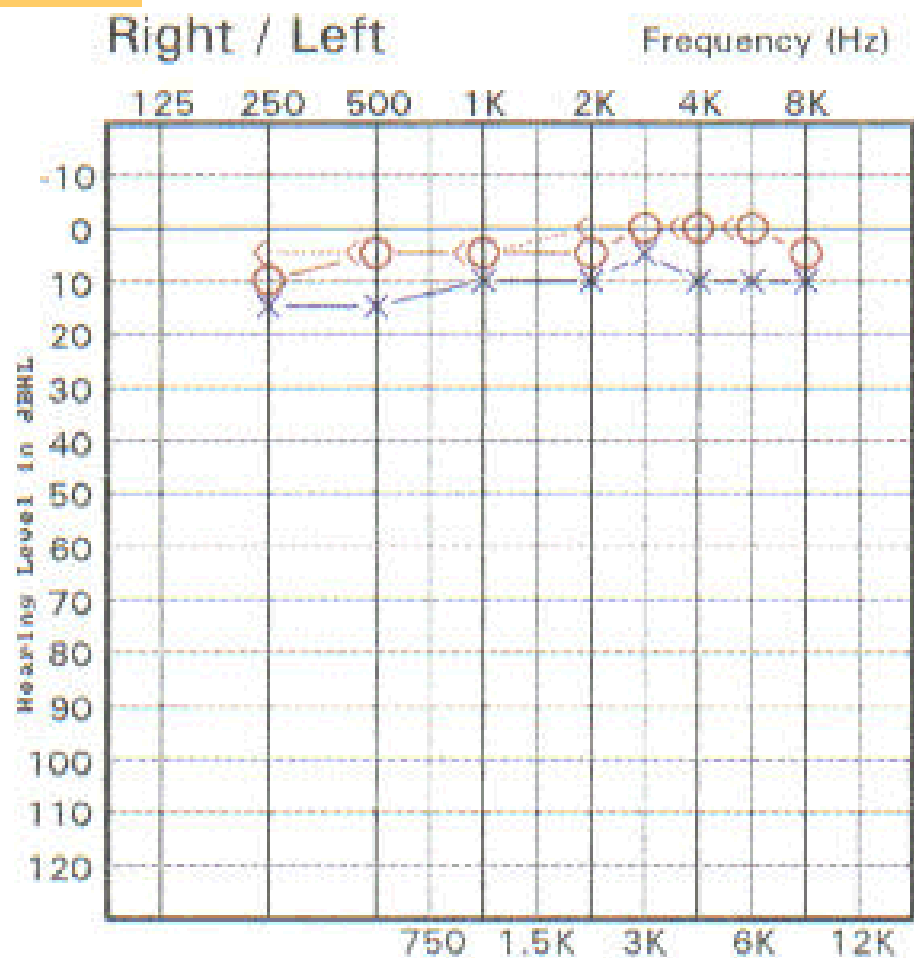
- ***Normal*** (BC threshold less than 15 dB or Air-Bone gap of 10 dB or less).
- ***Conductive hearing loss*** (Air-Bone gap more than 10 dB).
- ***Sensorineural hearing loss*** (hearing threshold more than 20 dB, with no Air-Bone gap).
- ***Mixed hearing loss*** (hearing threshold more than 20 dB with Air-Bone gap).

Pure Tone Audiometry

- Most common test
- Threshold of hearing in different frequencies
- Comparing hearing threshold with zero reference level
- Two kinds:
 - Air conduction assesses entire system
 - Bone conduction assesses cochlea onwards
 - BC with and without masking
- A graph showing HTL as a function of frequency
- Frequencies: 125, 500, 1000, 2000, 4000, 8000Hz and 3000, 6000 Hz

Standard signs in audiometry

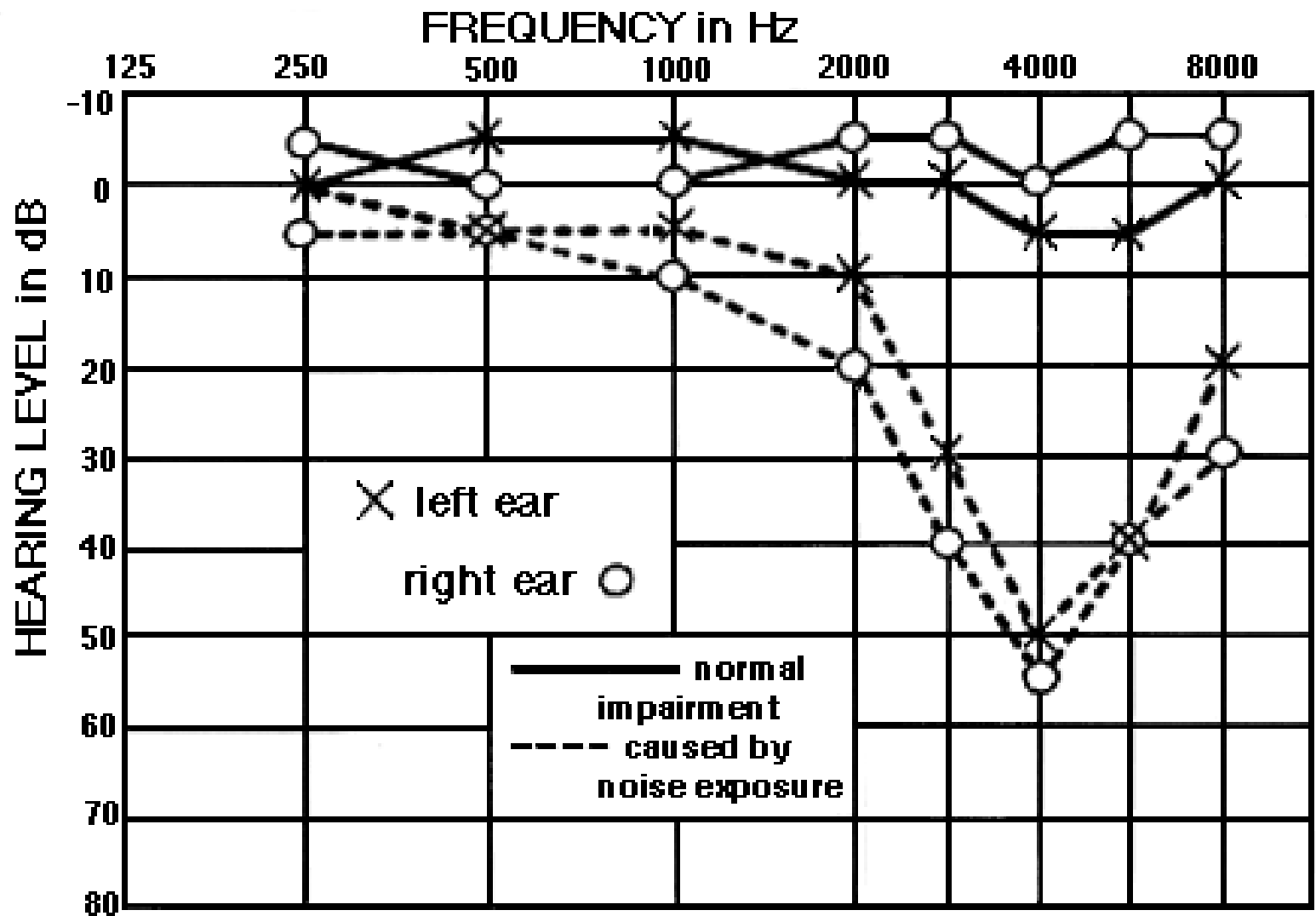
- O---O: right AC
- ×---×: left AC
- <---<: right BC
- >--->: left BC
- [----[: right BC with masking
-]----] : left BC with masking



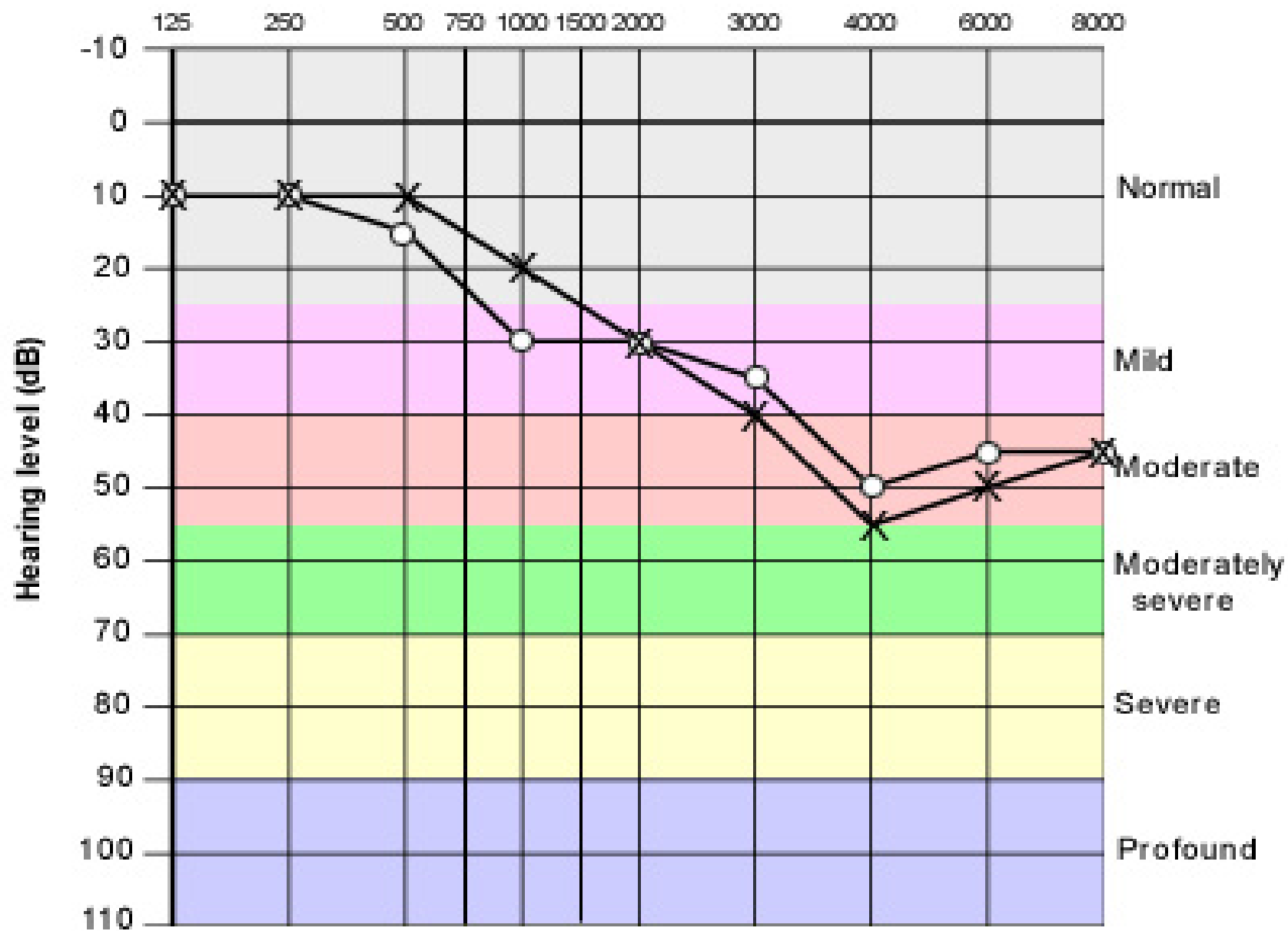
Audiogram
Symbol Key

	right	left
AC unmasked	○	×
AC masked	△	□
BC unmasked	<	>
BC masked	◻	◻
BC forehead masked	┐	┐
BOTH		
BC forehead unmasked		∨
Sound Field	\$	\$
Examples of NR		
	○ △ ◻	×

Audiogram



Frequency (Hz)



Principles of Hearing Evaluation

- Normal hearing
 - Hearing by AC=BC and both are within normal limits
- Conductive hearing loss
 - Hearing by AC is poorer than hearing by BC and BC is within normal limits
- Sensorineural hearing loss
 - Hearing by AC=BC and both are impaired to the same degree
- Mixed hearing loss
 - Hearing by AC is poorer than hearing by BC and both are impaired

- Normal threshold: -0.5 – 25 dB
- Mild Hearing Loss: 25 - 40 dB HL
 - Difficulty with soft speech
- Moderate Hearing Loss: 40 - 55 dB HL
 - Difficulty with normal speech
- Moderately Severe Hearing Loss: 55 - 70 dB HL
 - Difficulty with loud speech
- Severe Hearing Loss: 70 - 90 dB HL
 - Can only understand shouting
- Profound Hearing Loss: > 90 dB HL
 - Cannot understand even amplified speech

Symptoms of Hearing Loss

- Do you ask people to speak louder so that you can hear?
- Do you have to turn the TV or Radio so loud that others complain?
- Do you hear annoying noise when you are in a silent room?



Differential Diagnosis of HL

- Infections of the ear.
- Obstruction or injury by physical agents (wax, foreign bodies, trauma, barotraumas).
- Noise.
- Presbycusis.
- Hereditary hearing impairment.
- Metabolic disorders (diabetes, renal failure, ...).
- Infectious diseases.
- Sudden SNHL (one sided).
- CNS diseases (C.P angle tumor).
- Meniere's disease.
- Toxic agents (drugs, chemical agents).
- Non-organic hearing loss.



Treatment

- There is no medical or surgical treatment.
- Hearing amplification is reserved for those patients with socially impaired hearing.
- But usually hearing aids are not useful in NIHL.

Prognosis

- NIHL will stabilize if the patient is removed from the noisy environment.
- If not hearing deteriorate and result total deafness.

Noise Limit

- No employee shall be exposed above the permissible exposure level (PEL).
- PEL = 90 dBA for a 8-hour time-weighted average (TWA)
- Feasible administrative or engineering controls are required.
- Hearing protection is required to protect the employee to the PEL.

permissible exposure level (PEL).

- Duration per day, hours | Sound level dBA slow response

• 8.....	90
• 6.....	92
• 4.....	95
• 3.....	97
• 2.....	100
• 1 1/2	102
• 1.....	105
• 1/2	110
• 1/4 or less.....	115



"If I was wearing my 'what' ?!"

Noise Action Limit

- Action Level (AL) = 85 dBA for a 8-hour TWA
 - Determined without regard to hearing protector attenuation
- Hearing Conservation Program (HCP) required
- Hearing protection devices must be available

H.C.P(HEARING CONSERVATION PROGRAM)



Components of a Hearing Conservation Program(HCP)

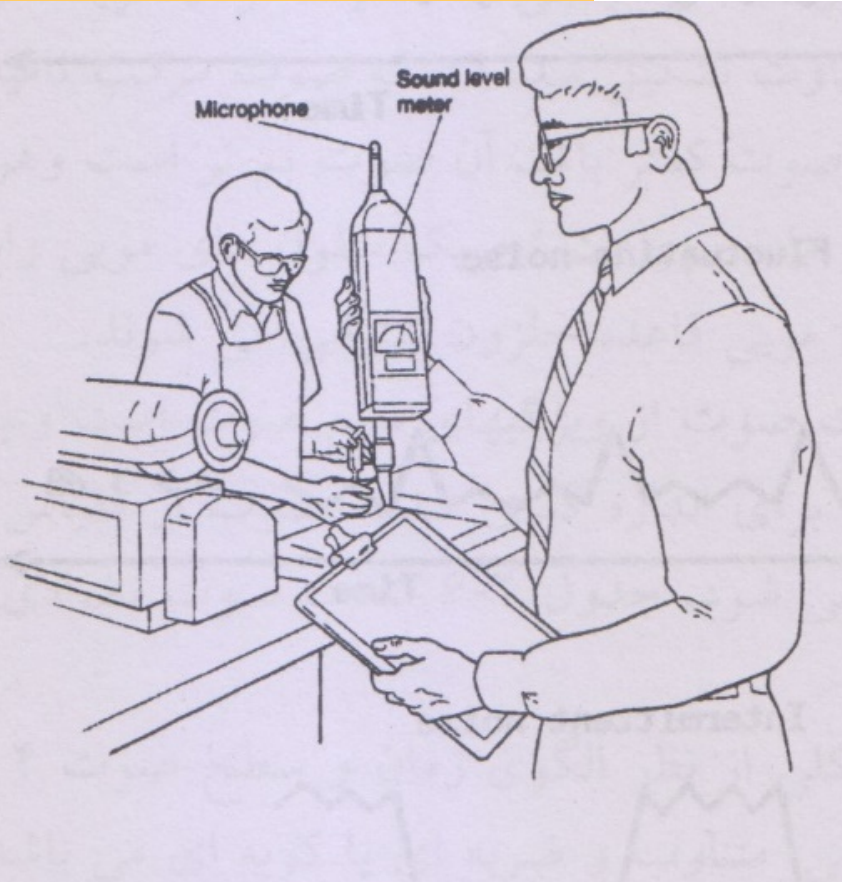
- Assessment and monitoring of workplace noise and noise exposure
- Engineering control of workplace noise and noise exposure
- administrative controls
- Employee education and training
- Hearing Protection devices
- Measurement of hearing

Training

- Must be annual
- Must include:
 - Effects of noise on hearing
 - Purpose of hearing protectors
 - Instruction in hearing protector selection, fitting, use and care
 - Purpose of audiometric test and explanation of the procedures and results

Sound survey

- Preliminary survey(Walk- through)
- Basic
- Detailed(noise dosimeter)
- Engineering sound survey



Hearing Protectors

- Shall be available to “**action level**” employees
- Shall be required for those employees:
 - Exposed at or above 90 dBA
 - Exposed at or above 85 dBA (without an audiometric baseline)
 - Who have an STS





Selection of Hearing Protection Devices

- Hearing protection devices are selected according to:
 - Employee comfort
 - Level of noise exposure
 - NRR of device(earmuff> foam earplug> earplug> canal cap)
 - Type of work being performed
 - Environmental conditions

Employee may select hearing protection from a variety of suitable hearing protectors provided by employer.

Types of Hearing Protection Devices

- Ear muffs
- *Earplugs*
- Ear canal cap
- Dual protection(>100dB continues sound or >160dB peak exposure)





Fit, Use, and Care of Hearing Protection Devices

- Employer must ensure proper initial fitting
- Employer must supervise the correct use of hearing protectors
- Hearing protectors must be replaced as necessary at no cost to employee
- Hearing protection devices must be cleaned and stored according to the manufacturer's specification\

Audiometry HCP

- Audiometry is vital to the total HCP.
- By audiometry we gauge the effectiveness of noise reduction and engineering controls.
- Audiometry is, at present, the best way to detect individual's susceptibility to noise.

Speech Audiometry (SRT)

- Standardized lists of two equally syllables words (for example: baseball, birthday, ...) presented to person.
- Lowest level at which the subject can repeat approximately 50% of the words is the threshold of SRT.

Importance of SRT

- Validate of the PTA results.
- If the threshold of SRT is 15 dB or more better than the PTA, there is strong evidence to suggest a functional hearing loss.
- A SRT that is significantly poorer than the PTA may suggest hearing loss due to retro-cochlear pathology.

Speech audiometry (cont.)

- SDS (speech discrimination score)
- Phonetically balanced one-syllable words
- Intensity: SRT + 25-40 dB
- Percentage of words correctly repeated
- Normal: 88-100%

During examination

- **Ask worker to Recognize Hearing Loss**





Ask worker to Recognize Hearing Loss (1)

- 👂 Do you have a problem hearing over the telephone?
[Yes] [No]
- ✂ Do you have trouble following the conversation when two or more people are talking at the same time? [Yes] [No]
- ⊠ Do people complain that you turn the TV volume up too high?
[Yes] [No]
- ⌘ Do you have to strain to understand conversation?
[Yes] [No]
- 👂 Do you have trouble hearing in a noisy background?
[Yes] [No]

(Continued on the next slide)



Ask worker to Recognize Hearing Loss (2)

- ⌘ **Do you find yourself asking people to repeat themselves?**
[Yes] [No]
- ⌘ **Do many people you talk to seem to mumble (or not speak clearly)?**
[Yes] [No]
- ⌘ **Do you misunderstand what others are saying and respond inappropriately?** [Yes] [No]
- ⌘ **Do you have trouble understanding the speech of women and children?** [Yes] [No]
- ⌘ **Do people get annoyed because you misunderstand what they say?** [Yes] [No]



Ask worker to Recognize Hearing Loss (3)

- If you have been answered "**yes**" to three or more of these questions, it is suggested to prescribe further hearing evaluation especially about job exposure.

NIHL عوامل مستعد کننده

دیابت

سیگار

اکوستیک تروما

هیپر لیپیدمی

مصرف دارو

عوامل ژنتیکی

مواد شیمیایی