





# Noise Induced Hearing Loss




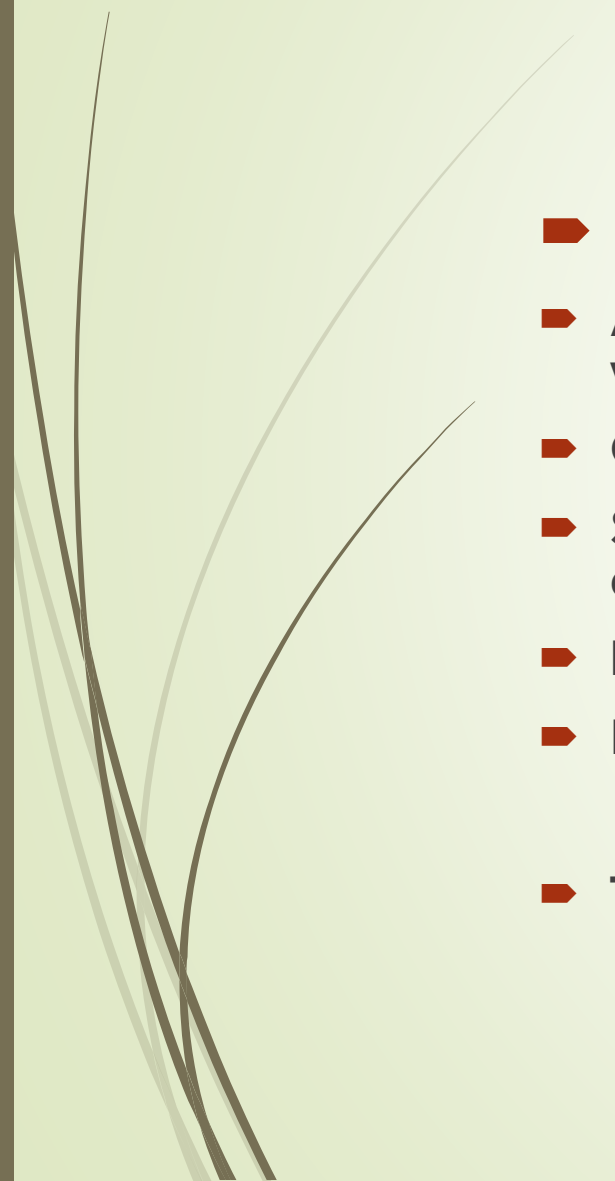
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- The normal human ear can detect sounds across the frequency range from approximately 20–20,000 Hz. The most important range for human speech communication is between 500 and 3000 Hz.

# Occupational Hearing Loss

- Noise-induced hearing loss:
  - Chronic NIHL
    - Chronic noise exposure
    - Always SNHL
  - Acoustic trauma
    - Sudden very loud noise exposure
    - SNHL, CHL or mixed
- Chemical-induced hearing loss:
  - Toluene
  - Styrene
  - Xylene
  - Heavy metals
- Traumatic hearing loss
  - Welding
  - CHL

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- Occupational hearing loss may be partial or (rarely) total, unilateral or bilateral, and conductive, sensorineural, or mixed (conductive and sensorineural)



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- **Noise** : the most common industrial hazard
  - Approximately 22 million U.S. workers exposed to hazardous noise levels at work, and an additional 9 million exposed to ototoxic chemicals
  - Of the 28 million with hearing loss in USA about 1/3 due in part to noise
  - \$242 million is spent annually on worker's compensation for hearing loss disability
  - In the 50% of US workplaces the noise level is between 85 and 95 db
  - NIHL compromise 30% adult hearing loss
    - The second form of acquired hearing loss after presbycusis
  - The most common preventable cause of SNHL



## Introduction

Noise-induced hearing loss is the most common permanent and preventable occupational injury in the world.

*World Health Organization*

## NIHL & Compensation

### Worker's Compensation

In many countries, excessive noise is the **biggest compensable occupational hazard**. Cost of NIHL to developed countries ranges from **0.2 to 2% of its GDP**. NIHL is **on the rise** globally. (Source: WHO)

# Noise Threshold Values (continuous noise)

- 3 dB exchange rate( NIOSH & ACGIH):

*Table 2 Noise Levels and Maximum Exposure Times.*

Constant Noise Levels	Maximum Exposure Time
85 dBA	8 hours
88	4 hours
91	2 hours
94	1 hours
97	30 mins
100	15 mins
103	8 mins
106	4 mins





## Noise-induced Hearing Loss

- Chronic NIHL
- Acoustic trauma

Target Organ:  
Outer Hair Cells in Cochlea





# NOISE-INDUCED HEARING LOSS

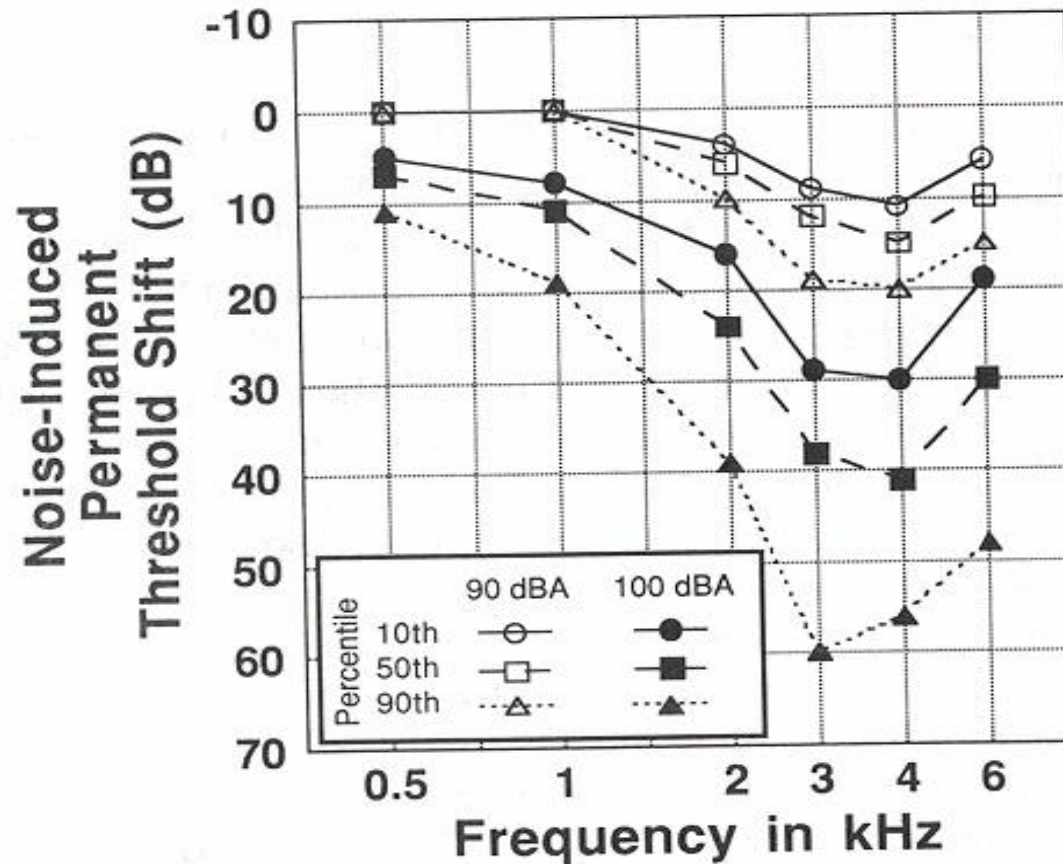
Risk of permanent hearing impairment is related to the **duration** and **intensity** of exposure as well as **genetic susceptibility** to noise trauma.

prolonged exposure to sounds louder than 85 dBA is potentially injurious.

most severe around 4000 Hz, with extension toward the "speech frequencies" (500-3000 Hz) occurring only after prolonged or severe exposure.

# Susceptibility

- 5% of individuals exposed to 80dBA noise levels develop a significant hearing loss.
- 15-25% for 90dBA exposure
- Why?





# Age


No clear-cut differences exist between young and older individuals in their susceptibility to NIHL







# Sex

- **More males than females are reported to have NIHL. However, whether this is a consequence of greater sensitivity to NIHL in the workplace or whether it represents a higher level of exposure to non occupational noise is unclear.**
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- Hearing loss due to other etiologies
- Smoking
- Co- exposure to vibration
- Past hx of acoustic trauma
- DM
- Genetic factors
- Hyper lipidemia
- ASA
- Aminoglycosides
- Co-exposure to solvents or CO



# Non auditory effects

- Poor communication
- Sleep disorders
- HTN
- Tachycardia
- Psychological effects
- Diminished productivity
- Hyperlipidemia
- Accidents
- absenteeism



# Sleep disorders

- Due to bed time exposure
- Intermittent noise more than continuous
- In most cases accommodation occurs
- Changes:
  - ❑ Difficulty with going asleep
  - ❑ Repetitive awaking
  - ❑ Change in REM phase
  - ❑ Use of sedatives

## Psychological changes

- **Neurosis & Irritability & dispute and Assault (>80 dBA)**
- **Noise is not as a etiology but aggravating factor**



# Physiologic changes

- Activation of autonomic system after noise exposure
- Directly depend on severity, frequency, age, circadian rhythm and individual susceptibility.
- Threshold; 50 – 70 dBA
- No accommodation
- May lead to chronic problems (HTN or IHD)

## Symptoms


- علائم کاهش شنوایی در فرکانس های بالا:
- اولین علائم:
- مشکل در درک و فهم گفتار دیگران
- مشکل در تمایز دقیق برخی کلمات هم صدا ( Bait, Bet و Lock, Luck ) (زانو، زائو)
- مشکل در درک صداهای زیر و پرفرکانس مثل صدای پرندگان، خانم ها و کودکان
- گاهی: Tinnitus

# Signs

- No specific physical sign



*"It could be one of those things that crawl into your ear and lay eggs."*

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- Persons with NIHL typically complain of being able to “hear but not understand speech”
  - The difficulties in speech understanding can lead to :
    - Fatigue
    - Anxiety
    - Stress
    - Reduced quality of life
    - In progressive hearing loss :social withdrawal and isolation  
depression
    - increased risk of accident
  - **Conversation on the telephone is generally unimpaired because telephones do not use frequencies above 3000 Hz.**

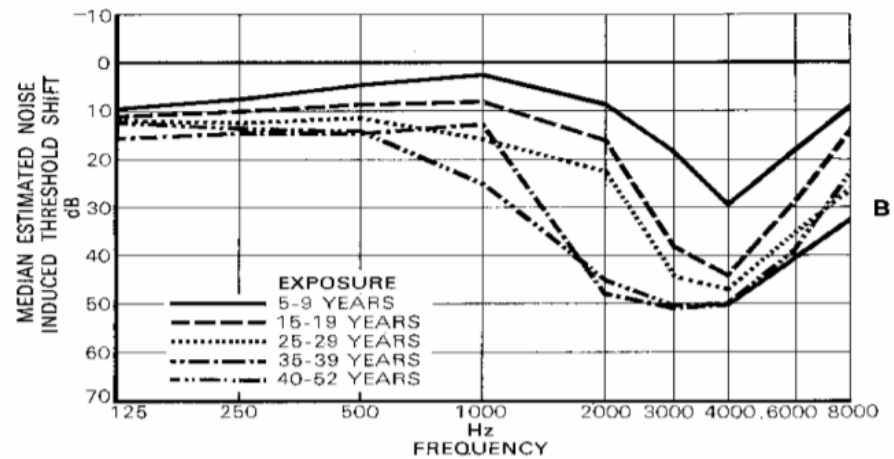
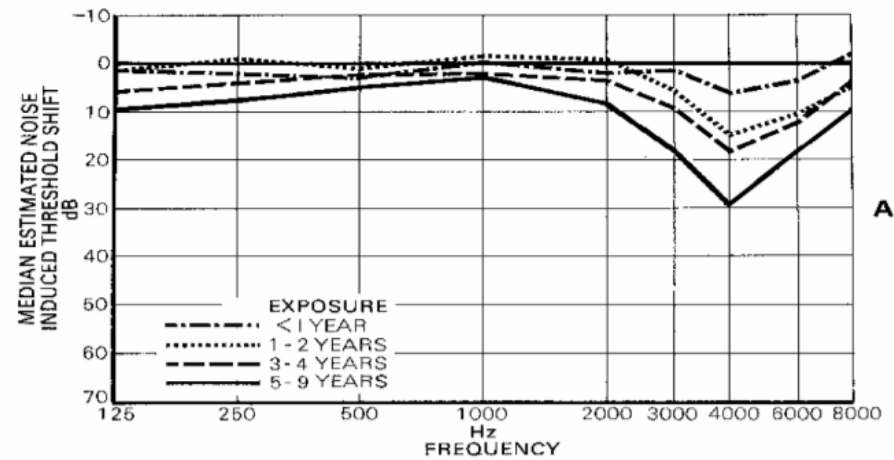
# Chronic NIHL

## ○ Defining Characteristics

- Always sensorineural
- Nearly always bilateral and symmetric
- Does not produce a profound hearing loss
- Will not progress once noise exposure discontinued
- Rate of loss decreases as threshold increases
- Most severe loss at the 4kHz frequency
  - 3-6kHz losses are greater than 500Hz-2kHz
- Maximum loss seen after 10-15 years of exposure
- Continuous noise is more damaging than intermittent noise
- Maximum change is 75 dB in high and 40dB in low frequencies

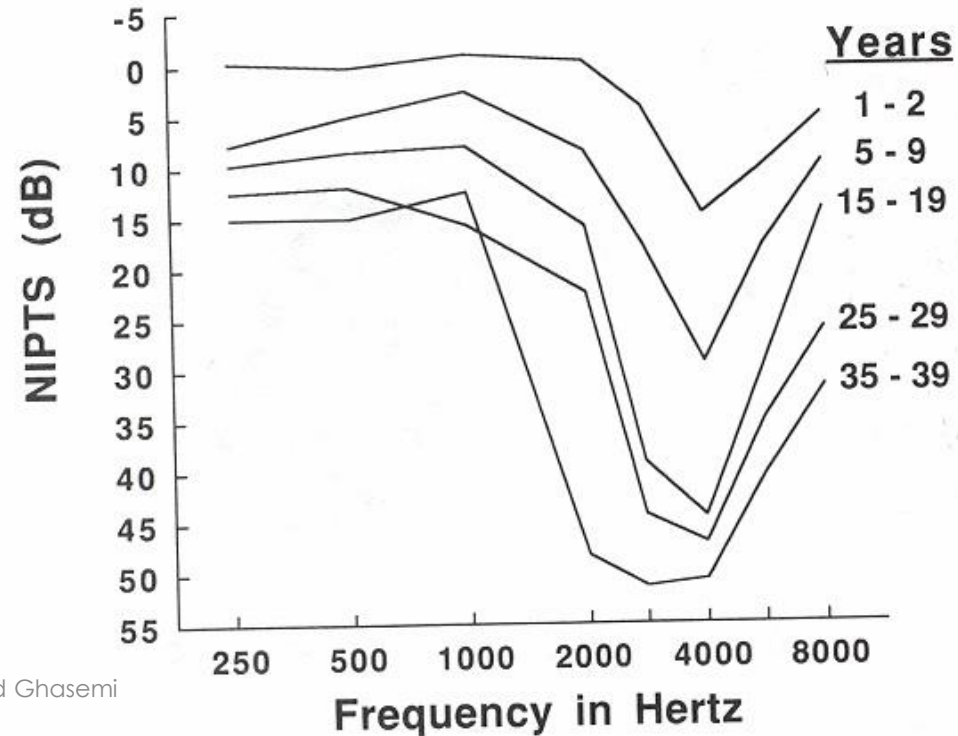


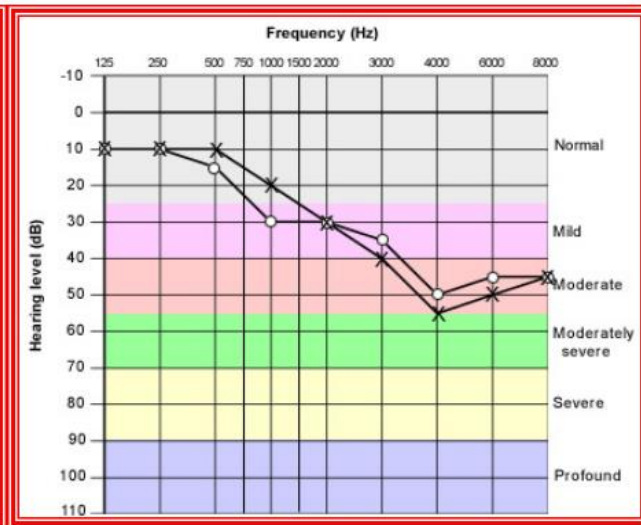
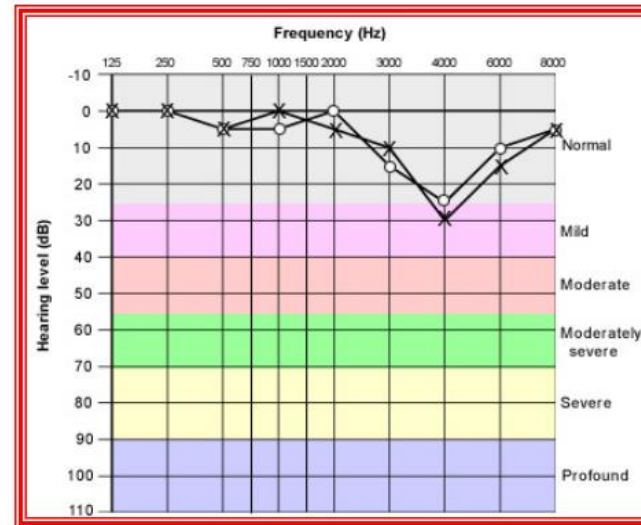
Figure 3: Audiograms showing onset and progression of noise-induced hearing loss 'notch' appears in the 3-6kHz region, then the notch broadens over time with continued exposure (From Burns, 1968, ).

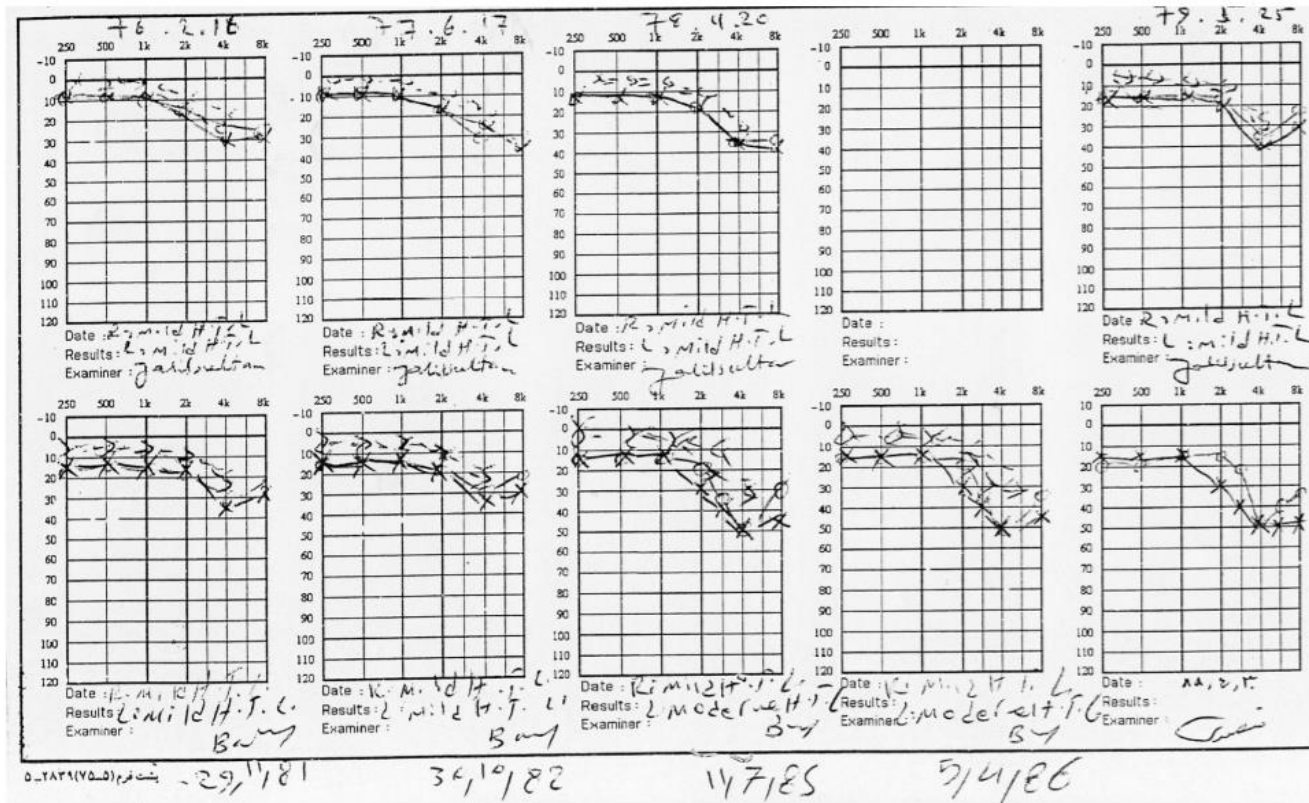


# Chronic NIHL

## ➤ Defining Characteristics









# Diagnosis of NIHL

- Greatest value in diagnosis:
  - History
  - Noise exposure assessment (intensity & duration)
  - Rule out other disorders
  - Serial audiograms



# criteria for the diagnosis of ONIHL

- ONIHL is always a neurosensory loss.
- ONIHL is almost always bilateral.
- High-frequency losses rarely exceed 75 dB, and low-frequency losses rarely exceed 40 dB.
- Hearing loss does not progress after noise exposure is discontinued.
- As hearing loss progresses, the rate of hearing loss decreases.
- Loss is always greater at the frequencies 3000-6000 Hz than at 500-2000 Hz. Loss is usually greatest at 4000 Hz. The 4000-Hz notch is often preserved even in advanced stages.
- In stable exposure conditions, losses at 3000, 4000, and 6000 Hz usually reach a maximum level in 10-15 years.

## exposure

- A minimum 5 years exposure to 90 dB (8 hours per day)
- 2.5 years for 93 dB
- **NIL index:**
  - 100 for non susceptible
  - 90 for susceptible

# Differential Diagnosis





# Presbycusis

- The clinical presentation of presbycusis varies from patient to patient and is a result of the various combinations of cochlear and neural changes that have occurred.
- Patients typically may have more difficulty understanding rapidly spoken language, vocabulary that is less familiar or more complex, and speech within a noisy, distracting environment. In addition, localizing sound is increasingly difficult as the disease progresses.
- speech discrimination score may be normal unless tested in the presence of background noise.
- Often, there is a curvature to the audiogram that is convex upward.

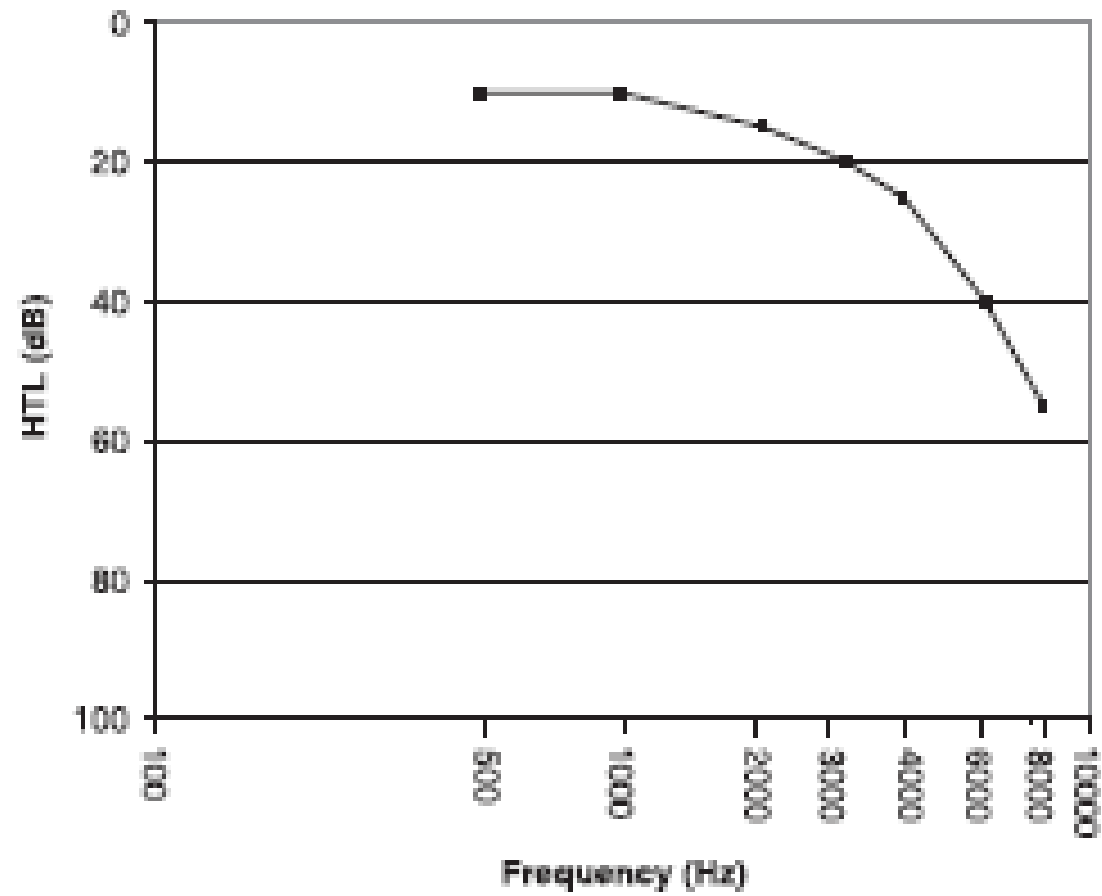


Figure 1. The hearing level and frequency relationship.


# Ototoxic drugs

- Ototoxicity is typically associated with **bilateral high-frequency SN** hearing loss and tinnitus. Hearing loss can be temporary but **is usually irreversible** with most agents. Generally, antibiotic-induced ototoxicity is **bilaterally** symmetrical, but it can be asymmetrical. The **usual time of onset is often unpredictable**, and marked hearing loss can occur even after a single dose. Additionally, hearing loss may not manifest until several weeks or months after completion of antibiotic or antineoplastic therapy.
- Vestibular injury is also a notable adverse effect of aminoglycoside antibiotics and may appear early on with positional nystagmus. If severe, vestibular toxicity can lead to dysequilibrium and oscillopsia.





# Chemicals

- The findings suggest that chemicals such as solvents, pesticides and metals have both oto-and neuro-toxic properties.
  - Studies conducted in animals have demonstrated that the outer hair cells are affected by solvents and if the exposure continues the damage is spread to the middle and inner row of outer hair cells. A concomitant agent in many industries is noise exposure.
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# Asphyxiants

- The **CO intoxication** results in hearing impairment, dizziness and headache. Dizziness and headache were also noted in the prolonged intoxication with **HCN and SO<sub>2</sub>**. These gases are common air pollutants; thus, HCN and SO<sub>2</sub> exposures affect the majority of individuals. CO and HCN potentiate damaging effect of noise to hearing in animals.
- The effects of combined exposure to noise and asphyxiants in human are not fully recognized.



# Vibration

- Vibration-induced hearing loss may be developed in patients after temporal bone surgery or in subjects working with vibrating tools. In such cases, co-exposure to noise and vibration can increase hearing threshold shift compared to noise-only exposure.
  - Recent studies concerning association of body vibration with sound trauma brought contradictory and inconclusive results
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## Non-classic Audiograms in NIHL

- Unilateral or asymmetric
- 3 khz or 6 khz notch
- Bulge-type audiogram



# Unilateral or Asymmetric

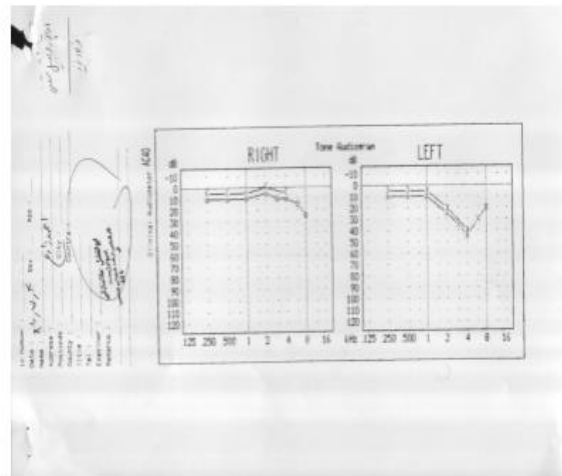
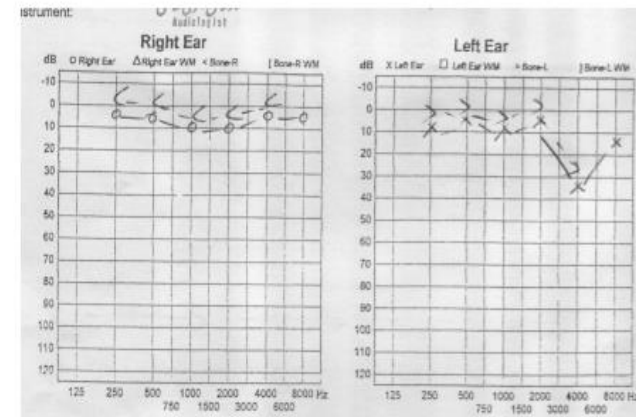
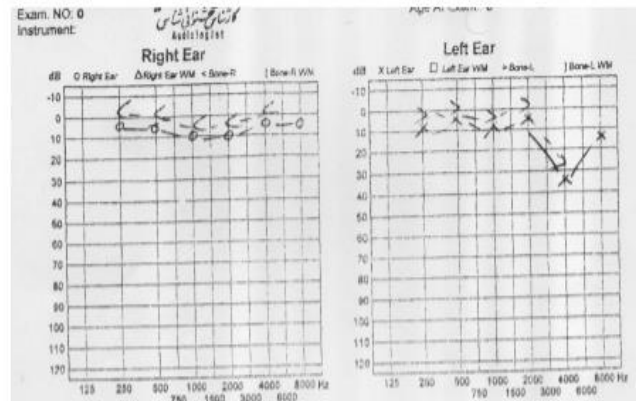
- Unequal or unilateral exposure to noise source
- Truck drivers, tractor drivers,
- Unequal fitting of hearing protective devices
- Anatomic difference between ear canals
- Preexisting unilateral or asymmetrical notch

**Maximal asymmetry in pure NIHL is 15 dB between left and right ear at 3 or 4 or 6 khz.**

**In more asymmetry other causes or preexisting hearing loss must be ruled out**

# Unilateral NIHL

( crane operators with left-sided noise source)









## ➡ Acoustic trauma

- ➡ sudden loss of hearing caused by an intense single incident noise blast or explosion
- ➡ Most cases of acoustic trauma are caused by impulses from explosions such as bombs, blasts and gunfire
- ➡ Air bag-induced otologic pathologies including sensorineural hearing, conductive hearing loss, mixed hearing loss, tinnitus and disequilibrium
- ➡ Damaged both in the middle ear and cochlea
- ➡ Tympanic membrane rupture, the middle ear ossicles may become dislocated causing a conductive hearing loss

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- **Sensorineural hearing loss: often occur due to direct mechanical injury to the sensory cells of the cochlea or fistulas between the inner and middle ear**
  - **Hearing loss that are more severe than seen with NIHL especially in the low and middle frequencies**
  - **In immediate hearing loss: vertigo, tinnitus ,and pain**
  - **The injury may be unilateral or bilateral ,depending upon the direction of the blast**
  - **Sensorineural hearing loss from acoustic trauma may exhibit some recovery from initial levels**
  - **Patients need to be followed for 4 to 6 month to determine if the hearing loss is permanent**



## NONORGANIC HEARING LOSS

- Functional hearing loss for purposes of secondary gain is quite frequent.
- Poor correlation between the SRT and the average of the air conduction thresholds at 500, 1000, and 2000 Hz is the most common indication of functionality .
- Test-retest variability is also suggestive.
- In cases of suspected unilateral functional hearing loss, the Stenger test is useful .

## Diagnostic Work-up

- History taking (medical):

- سابقه مواجهه با شلیک یا انفجار
- سابقه حضور در جبهه
- سابقه ترومای سر
- سابقه اوریون، مننژیت
- سابقه مصرف اتوتوکسیک

- History taking ( occupational ):

- عنوان شغل فعلی و مشاغل قبلی
- مدت اشتغال در هر یک از آنها
- متوسط ساعات کار روزانه
- اضافه کاری و شغل دوم
- استفاده از وسایل حفاظت شنوایی
- نحوه استفاده از آنها ( مدت و روش استفاده)
- مواجهه با اصوات غیرمجاز در خارج از کار

## Diagnostic Work-up

- Exposure evaluation:

- کسب اطلاع از مستندات اندازه گیری صوت در واحد یا ایستگاه کار شاغل
- اندازه گیری مستقیم صوت در واحد یا ایستگاه کاری شاغل
- اندازه گیری مستقیم صوت با روش personal dosimetry
- توجه به ساعات کار روزانه و ساعات مواجهه با اصوات غیرمجاز



## Diagnostic Work-up

- Evaluation of previous audiogram if accessible:
  - Employment entrance audiogram
  - Periodic audiogram





## Treatment and Management

- No specific treatment is currently available
- Hearing aid if indicated

## Follow-up Schedule

- Periodic audiometry every six month
- Comparison of HTLs changes between audiograms

# Prevention

## (Hearing Conservation Programs)

- پایش میزان صدا در بخش‌های مختلف محیط کار با روش‌های استاندارد
- آموزش و انگیزش (کارگران - کارفرما - سوپروایزرها)
- اجرای کنترل‌های مهندسی و اداری در محل‌های مورد نیاز
- استفاده از وسایل حفاظت شنوایی مناسب
- انجام آزمون‌های شنوایی دوره‌ای (ادیومتری) در افراد پرخطر
- پایش سالانه نتایج برنامه و بازنگری آن با استفاده از روش‌های استاندارد

جدول ۱-۳: اجزاء اصلی و ترتیبی برنامه‌های حفاظت شنوایی در محیط کار

# Removal From Noise

- فاکتورهای تاثیر گذار بر قطع مواجهه فرد از صدای غیرمجاز:

- - مواجهه با صدای غیر مجاز در محیط کار فرد وجود دارد؟

- - نوع کاهش شنوایی چیست؟ ( SN یا CHL )

- - گرفتاری عصب شنوایی وجود دارد؟

- - افت شنوایی در فرکانس های گفتاری وجود دارد؟

- - سیر پیشرفت کاهش شنوایی چگونه است؟