

**Exposure
to**

PHYSICAL HAZARDS

Noise



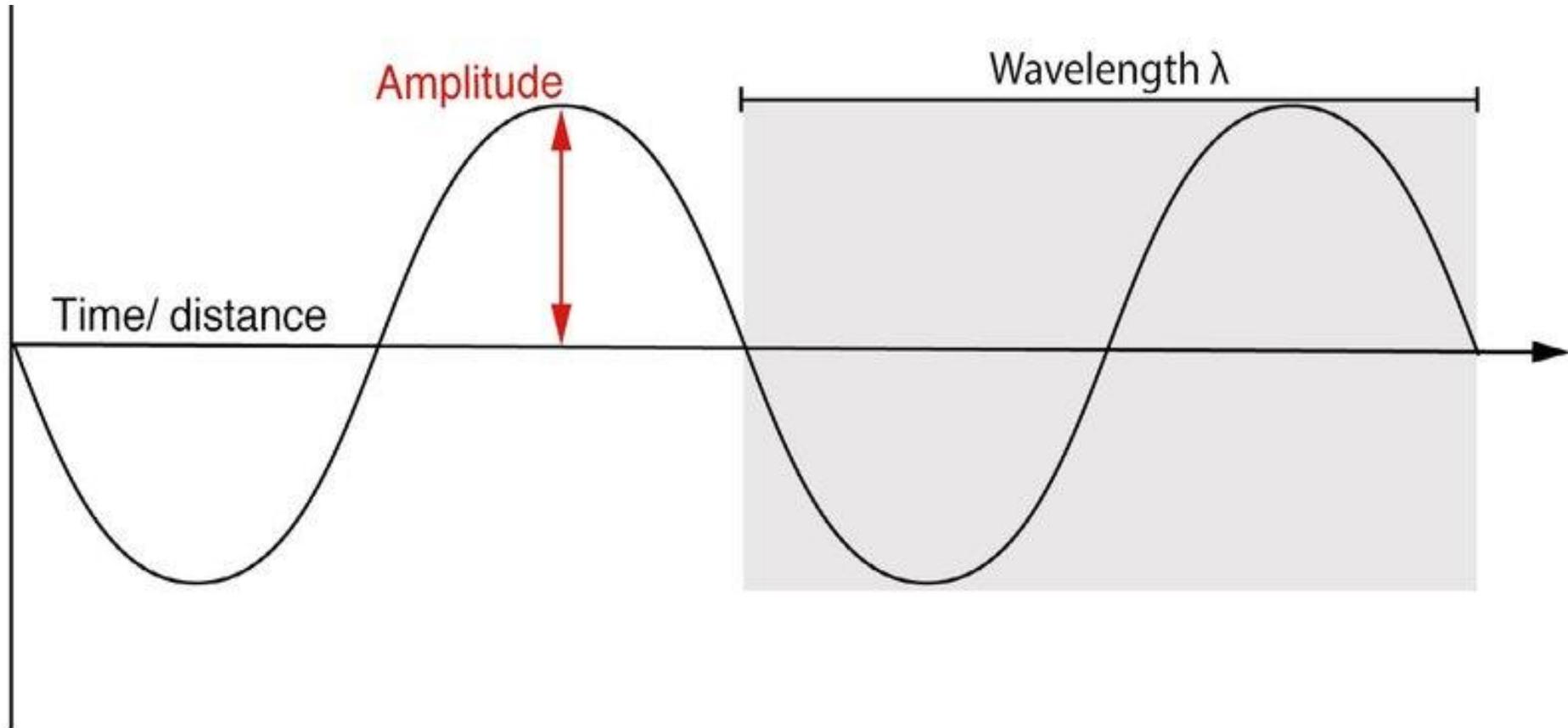
- **Impairment:** تلف any loss or abnormality of psychological, physiological or anatomical **structure or function**.
- **Disability:** عجز any restriction or lack of ability to **perform an activity** in the manner or within the range considered normal for a human being. (resulting from an impairment)
- **Handicap:** اعاقة a disadvantage for a given individual that limits or **prevents the fulfillment of a role that is normal**
- **Impairment** refers to a problem with a structure or organ of the body; **Disability** is a functional limitation with regard to a particular activity; and **Handicap** refers to a disadvantage in filling a role in life relative to a peer group.

Noise الضوضاء

Definition: Noise is any unwanted or undesirable sound.

Auditory field lies between 20-20000 hertz (Hz) or cycles per second. If noise is below the lower level of normal hearing (below 20 Hz) it is called infra sound but if the noise above the upper limit of normal hearing (above 20 kHz) it is called ultrasound.

The Sound Wave



Noise الضوضاء

Exposure to noise occurs in the following occupations:

- Weaving.
- Hammering of metals.
- Military exposure due to explosions and shooting.
- Building and construction.
- Aviation.



Physiology

The biological effect of impulse noise is different from continuous noise in that:

The inner ear in continuous noise is partially protected by the **acoustic reflex triggered by noise > 90 dB**, leading to contraction of the middle ear muscles (the stapedius and tensor tympani) and thus stiffen the conducting system and **make it more resistant to sound entry**.

But in case of impulse noise it is delayed in onset depending on sound intensity for a period of 1/2 - 1 1/2 minutes

High intensity impulse noise (explosions) penetrates the cochlea before the reflex has been neurally activated.

Therefore impact noise > 140 dB may cause immediate and irreversible hearing loss.

General Class of Noise Exposure

There are three general classes into which occupational noise exposure may be grouped.

1. Continuous noise:

Normally defined as broadband sound of approximately constant level to which an employee is exposed for a period of eight hours per day or 40 hours a week.

2. Intermittent noise:

This may be defined as exposure to a given broadband sound pressure level several times during a normal working day

3. Impact (impulse) type noise:

Is a sharp burst of sound. A sophisticated instrumentation is necessary to determine the peak levels for this type of noise.

Effects of noise

A) Auditory effect: HEARING LOSS.

B) Non auditory effects:

The basis of these effects is grounded in the stress response to noise which lead to release of adrenocortical hormones and sympathomimetic mediators.

- 1- The heart rate increased and rise of blood pressure occurs.
- 2- The respiratory rate often increased.
- 3- Noise can affect the performance of psycho-motor tasks and decrease the work efficiency.
- 4- Disturbance of sleep quality and quantity.

The severity of occupational deafness is related to:

- 1- The duration of exposure.
- 2- The intensity of the sound.
- 3- The frequency of sound waves.
- 4- The type of noise either continuous noise or impact noise which is more dangerous.
- 5- Personal susceptibility.
- 6- Individual age.



What is dB and frequency?

dB and frequency are terms to describe sound level and the number of cycles of a sound wave in one second

A decibel meter is a measuring instrument used to assess noise or sound levels by measuring sound pressure. Often referred to as a sound pressure level (SPL) meter, decibel (dB) meter, noise meter or noise dosimeter, a sound level meter uses a microphone to capture sound

Frequency denotes the number of waves passing a point in a second and correlates subjectively with pitch.

Decibel Meter



The human ear can detect sound pressure variations from the finest noise to powerful stimuli (roughly 0 – 120 dB)

The most important range of human speech reception is between 500 – 3000 Hz and because isolated pure tone waves seldom occur in nature, the cochlea have the ability to analyze complex sound waves.

Noise Induced Hearing Loss (NIHL)

- 1) May be **acute** (secondary) to loud impulse noise.
- 2) May be **chronic** due to long term repeated exposure to hazardous noise levels.



Acute Acoustic Trauma (AAT)

Noise level in the range of 140 – 160 dB in **military service** accounted for 45% of cases of AAT and about 1 in 4 have bilateral damage to both middle and inner ear.

Signs and symptoms:

- Hearing loss, pain and tinnitus.
- Tinnitus may be the complaint and not the hearing loss.

On physical examination:

- The ear is usually normal unless the tympanic membrane is ruptured which occur in 30% of cases.
- Damage to the cochlea, vestibular system and ossicles of middle ear may also occur in 30% of cases.

Audiometric testing reflects:

Conductive hearing loss secondary to the **rupture of the tympanic membrane**, disruption of ossicles and mechanical damage to the oval window.

Sensorineural hearing loss from **cochlear hair cell disruption**.

Higher frequency pure tone hearing loss with frequencies between 4000 and 8000 HZ most affected.

When both bone and air conduction are decreased → this indicates Sensorineural hearing loss.

When air conduction loss exceeds bone conduction loss (condition called air bone gap), this indicates conductive loss.

- **Weber test** with the tuning fork over forehead or front of teeth, the sound lateralize toward the ear of conductive loss and away from a Sensorineural one.

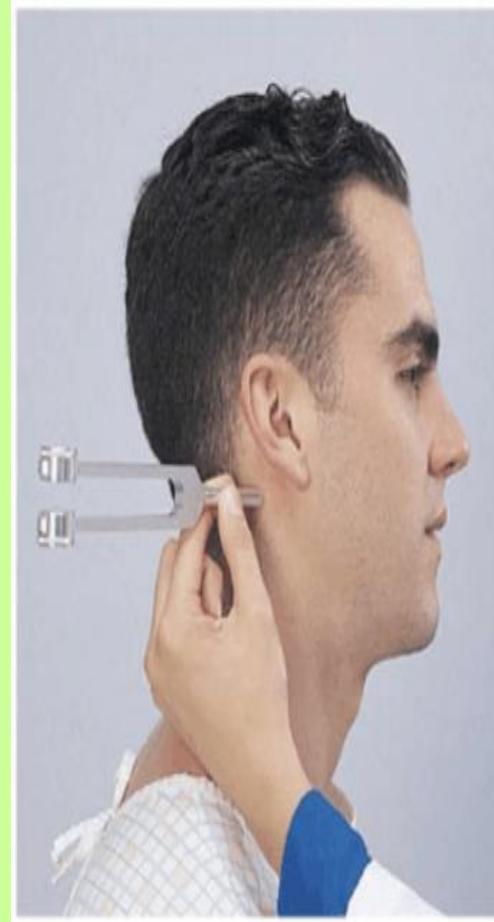
Pure Tone Audiometry

Tuning Fork Test



Rinne's Test

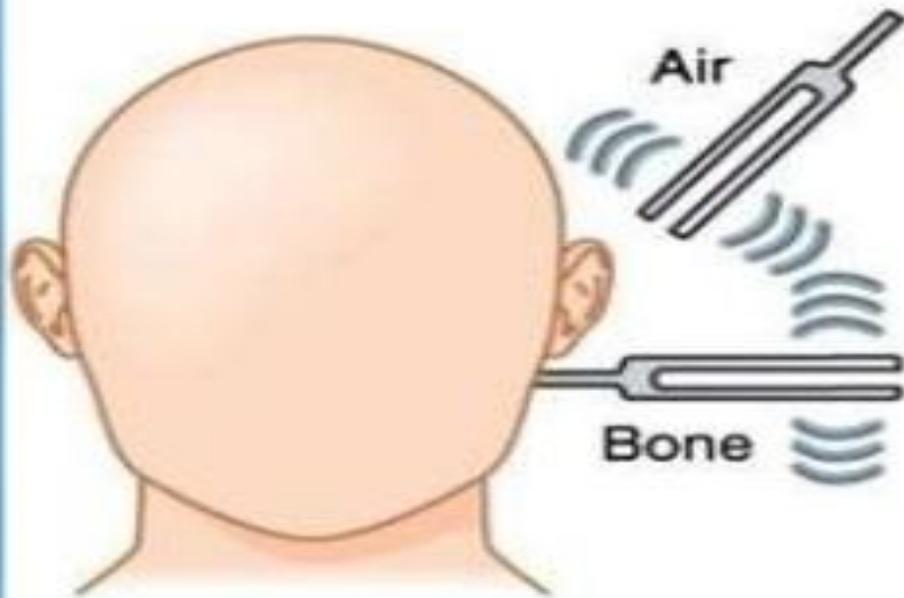
Normally air conduction is better than bone conduction (the fork is put on the mastoid) if bone conduction is better than air conduction, this indicates conductive hearing loss. **(over the mastoid)**



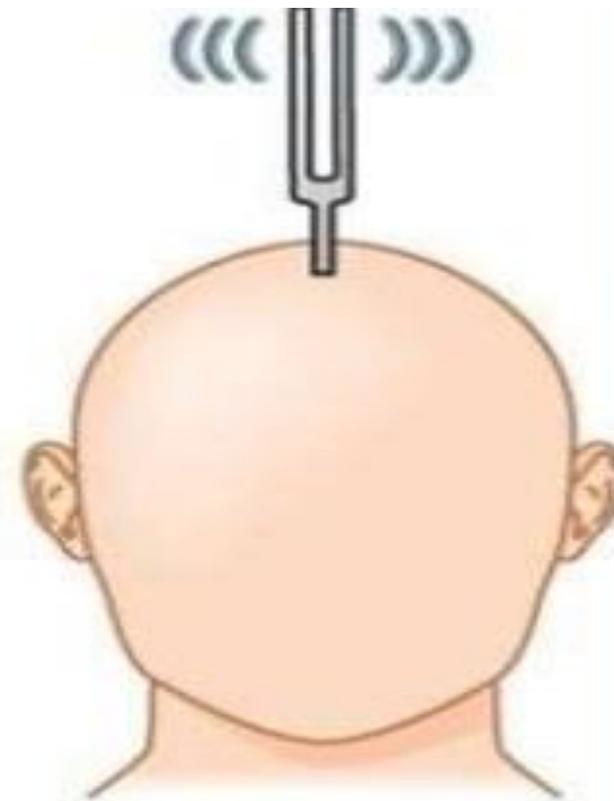
Weber's Test

With the tuning fork (**over forehead**) or front of teeth, the sound lateralize toward the ear of conductive loss and away from a Sensorineural one.





Rinne test



Weber test

Hearing loss	Rinne test (Conduction)	Weber test (Localization)
None	Air > bone	Midline
Sensorineural	Air > bone	Normal ear
Conductive	Bone > air	Affected ear

Complications include:

- Persistent perforation of tympanic membrane.
- Permanent hearing loss.
- **Cholesteatoma** (a skin-lined cyst that begins at the margin of the eardrum and invades the middle ear and mastoid)



Chronic Noise Induced Hearing Loss

Prolonged exposure to noise primarily damages the inner ear; especially the hair cells of the organ of corti, cochlear blood vessels, the striavascularis, the nerve endings associated with the hair cells are also damaged.

Initially the basal turn of the cochlea are affected (the area responsible for perception of higher frequency sound).

Eventually disruption of the medial and apical areas occurs as well.

Pathogenesis of NIHL:

1. Repeated exposure to loud noise > 85 dB the following changes occur:
2. Cochlear cell bodies swell and ultimately hair cells are destroyed.
3. Capillary vasoconstriction in response to loud noise which causes disruption of blood supply to the basilar membrane and diminished O₂ tension and local hypoxia in the cochlea.
4. Edema and swelling of the afferent nerve endings below the inner hair cells.
5. Eventually the organ of corti breaks down with separation of segment of sensory cells from the basilar membrane leading to elimination of the sensory structure and replacement by a single flat cell layer.
6. In fact these effects are due to **combination of mechanical, metabolic and vascular effects of the loud noise.**

Signs and Symptoms

People who suffer from Sensorineural hearing loss however do not usually recognize early changes on their ability to hear.

1. Early complaint of NIHL is difficulty in comprehending speech, especially in competing background noise which is usually of low frequency, **Since the maximum effect of NIHL occur in the high frequency sound perceived by basal turn of the cochlea (around 4000 HZ)**, they hear vowel sound, better than consonant high pitched sound.

Consonants such as “s,” “h,” and “f.

2. NIHL is frequently accompanied by **vertigo and tinnitus** which become most bothersome in absent of ambient sound causing inability to sleep at night or concentrate in a quiet room.

Hearing Impairment

Temporary threshold shift (TTS):

- Denotes slight and temporary decrease in hearing sensitivity due to **reversible injury to the hair cells**.

Permanent threshold shift (PTT):

- Permanent damage to the hair cell either due to **brief exposure to high intensity sound** or due to **cumulative effect of long term exposure to noise**.

In evaluating a hearing impaired person pure tone audiometric testing is important.

During the test, tone levels are increased in volume until the person recognizes the sound. The dB reading at this time is recorded and represent hearing threshold at that frequency.

Threshold levels above 25 dB are abnormal

Hearing handicaps are usually noticed when the threshold hearing level in important speech frequencies

(500 – 3000 Hz) average > 25dB

Hearing impairment is considered when either of the following 2 factors are present:

- 40 dB loss in both ears at either 1000 or 2000 Hz.
- 40dB loss in one ear at both 1000 and 2000 Hz frequencies.

Hearing conservation programs (HCP)

They are required where workers are exposed to levels $> 85\text{dB}$.

The fundamentals of the HCP include:

1. - Noise level assessment.
2. - Noise control measures.
3. - Audiometric monitoring.
4. - Hearing protection devices.
5. - Education and training.

1 Noise level assessment and noise control measures

Ambient noise levels are assessed by sound level meter or noise dosimeter.

- Time weighted average (TWA) 8 dB is the permissible daily exposure to noise which is **90 dB** with an exchange rate of 5 dB for every doubling or halving of the exposure time
 - (e.g. workers would be permitted only 4 hour exposure to noise at 95 dB and 2 hours only at 100 dB).

1 Noise level assessment and noise control measures

At work setting where noise exposure is **> 90 dB**, engineering controls (such as machinery design, enclosures and noise control products such as sound absorbents should be attempted).

Also administrative procedures such as rotating worker and mandatory use of hearing protective devices are needed.

2 Audiometric Monitoring

Periodic audiometric monitoring is a notable example of an effective screening test that reduces the risk of occupational illness because workers with early occupational loss evidenced by audiometry don't complain of hearing difficulties.

3 Hearing Protective Device

There are 3 types: insert, semi-insert, muffs

- Most devices provide 15-30 dB attenuation to noise. When insert plugs are combined with ear muffs an addition of 15-30 dB protection is added.



4 Education & Training Programs

Is for both managers & employees (especially those with risk factors) should include nature and consequences of NIHL and of importance of proper use of hearing protection and participation on audiometric monitoring.