Noise Induced Hearing loss & Non-organic Hearing loss

With many thanks to Dr. Priya sing
Noise Induced Hearing Loss
Noise Induced Hearing Loss (NIHL)

• Noise
  > Noise can be any unwanted sounds.

  > It’s an intense sound that is capable of damaging the inner ear; damage can be temporary or permanent.
• Noise measured in:
  - dB (A) >> average weighted
  - dB (C)>> peak, explosive noise

• Harmful effects of noise depend on energy content of noise transmitted to the ear (level, frequency and duration of exposure) in dB (A)

  - This is for steady state noise but not impulse noise
Temporary Threshold shift (TTS)

• It’s experienced after noise exposure

• If there is recovery after few hours, TTS arises

• Recovery usually 16-48 hours post exposure

• Should not be ignored or disregarded as it can lead to permanent loss

• Completely preventable
Acoustic trauma

• Sudden, permanent hearing loss brought about by a single exposure to an intense sound

• Sound could be impulse or impact in excess of 130-140 dB

• Inner ear structures are severely damaged

• May be accompanied by Tinnitus, which may subside over time or persist forever

• It may be unilateral or bilateral
permanent Threshold Shift (PTS)

- It’s **gradual loss** that caused by **continuous exposure to noise**

- It can cause damage to structure of hair cells and hearing loss accompanied by Tinnitus

- Effects seen many years after onset of noise exposure, combined with age
• Can be immediate following a sudden, intensity loud exposure e.g. explosion or gunshot

• Currently incurable but entirely preventable!!
Characteristics of NIHL

• Always Sensory-neural (SNHL)

• Often bilateral and symmetrical

• Does not usually produce a profound loss

• Once the noise exposure stops, it usually does not deteriorate
• Rate of loss decreases as thresholds increases

• Most severe at 4 KHz

• Continuous noise more damaging than intermittent noise
Audiogram for NIHL
## Limits of exposure time

<table>
<thead>
<tr>
<th>Level of noise in dB(A)</th>
<th>Maximum daily exposure time</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>8 hours</td>
</tr>
<tr>
<td>91</td>
<td>2 hours</td>
</tr>
<tr>
<td>97</td>
<td>30 minutes</td>
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<tr>
<td>103</td>
<td>7 minutes</td>
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Effects of noise in people

- Interference with communication
- Annoyance
- Job difficulties
- Possible effects on health; stress, blood pressure
- Increased risk at work
Etiology with respect to exposure

1. Work noise variables and individual personal protective equipment (PPE) effectiveness

2. Leisure time and military service

3. Exposure to ototoxic solvents and drugs
1. Work Noise and PPE

- **Impulse noise**
  - Consists of single bursts with duration < 1 s and peak levels 15 dB higher than background noise
  - Different from steady state noise with respect to time domain properties. It contains rapid pressure transients that do not always give a fully audible response but can reach sensory hair cells in IE.
  - Based on the RR of peaks of sound pressures
In industry, impulses are irregular, seldom, identical or repetitive.

Many machines produce impulses at the same time, workers are not stable as they move around (different distances from the noise).

Exposure is random and mixed (steady state and impulses).

NIHL is higher in occupations where there is exposure to impulse noise.
• **Steady state noise:**
  - A continuous noise that does not vary by more than 5 dB overtime, either gradually or rapidly.
  - E.g. workers who are operation machines that work constantly

• **Fluctuating noise:**
  - It is also continuous but varies by more than 5 dB overtime, gradually or rapidly.
E.g. workers who move around with work environment

- **Intermittent noise:**
  - Non hazardous noise mixed with hazardous noise.

- E.g. workers using hand tools, turning equipment on and off. Also leisure noise
Hearing protection

• Must meet minimum requirements

• Effect of usage rate. E.g. if a 30 dB PPE used for only 4 out of 8 hours a day, effectiveness is < 3 dB

• Best PPE: one used 100% of the time

• Therefore, PPE must be comfortable and lightweight
• Choice of type of PPE based on:
  ✓ Personal needs and
  ✓ Noise exposure

• Education and training should be provided on PPE use and maintenance

• Education on effect of noise and risks should be also provided

• Use personal audiometric data
Use of PPE pitfalls

• Awareness of dual protection; when daily exposure is > 110 dB

• Over protection; protection should not be reduced to below 70 dB

• Poor fitting

• Wrong choice, inadequate attenuation

• Consider eyeglasses
2. Military and leisure noise exposure

• Military

✓ Exposures to rifle and bazooka noise damages hearing of conscripts

✓ A single shot at 140 dB or greater can have measurable effect

✓ Heavy bazooka = 184 dB

✓ Military noise causes HL in 10% of conscripts, mainly due to shooting with blanks in forest practices without PPE
Leisure time noise

✓ Music is the most frequent hazard

✓ At concert in general there is 100 dB (A)

✓ Rock music highest must exposure rate

✓ Classical music has lower levels but still a risk

✓ Role of music in NIHL still not well understood, and PEE use is low among musicians
3. Other exposure: drugs and solvents

• **Smoking**
  ➢ Can aggravate NIHL (Starck et al, 1999)

**Analgesics**

• Use of salicylates known to affect hearing and acute noise exposure increases the HL induced by salicylates
Organic solvents

- Have Synergistic damaging effect on hearing in combination with noise

- E.g. in papermill, workers had significant NIHL even though noise levels were lower when compared to workers in a noisier section

Toluene and noise

- Risk increased by 11 times

Solvents:

- effects depend on solvent concentration
Individual risk factors

- Depends on biological factors

  - Cardiovascular, e.g. high cholesterol- OHCs (lateral wall)

  - Hypertension, at 4 KHz or is the noise causing hypertension

  - Smoking and hypertension increases NIHL
• VWF (Von Willebrand) syndrome, causes 10 dB greater HL than if the syndrome is not present

❖ Genetic

• No enough knowledge about the correlation with NIHL
Audiological Measurements

Audiometry:

- Clinical Vs screening
- 1dB Vs 5 dB steps
- 10 dB shift clinically Vs 15 dB shift screening is significant
Background noise

Attention and knowledge of test part of subject and tester

For employees in noisy environment, first test should be carried out during the first 6 months of employment

Follow up should be scheduled no longer than 15 months apart
OAEs:

- Not much done on this and NIHL but potential to be a good tool

HF audiometery:

- May good detector for early NIHL
Audiologist roles

• Prevention

• Education

• Training

• Hearing conservation programs (HCPs)

• Hearing surveillance; early detection, prevention, and evaluation of control measures

• PPE
NIHL in children

• Increasing number of children exposed to louder sounds at younger ages, may increase risk for NIHL developing earlier

• All factors as with adults need consideration: type of noise, duration, intensity..etc

• CDs and MP3 should not be ignored
Effects:

- Communication difficulties
- Isolation
- Stress
- Frustration
- Behavioral problems

- Education and hearing conservation programs should be considered

- More epidemiological studies and research needed
Non- Organic Hearing Loss
Non-organic hearing loss

- Terminology
  - Pseudohypercusis
  - Malingering
  - Functional hearing loss
  - Psychogenic
  - Hysterical deafness
  - Spurious hearing loss
More scientific definition

“When a patient presents with intra-test and or inter-test discrepancies during audiologic assessments that can not be accounted for by any known organic causes”

Chaikin & Ventry, 1963

• As an audiologist we have no procedure for determining whether there is conscious or unconscious basis for the NOHL and should not specify its basis
• Therefore, preferred terms, pseudohypercusis, NOHL and functional preferred

• **Malingering**: is the conscious exaggeration- can only be diagnosed as such if patient confesses
Reasons for NOHL

1. Patient does not understand the test procedure

2. Patient is poorly motivated

3. Patient is physically or emotionally incapable of responding appropriately

4. Patient is distracted
5. Patient is trying to conceal another problem

6. Personal/ financial gain

7. Psychogenic/ unconscious
Important points to remember

• Can not be categorized neatly into conscious or unconscious

• Can be a mixture of both

• May be an element of organic pathology

• Organic causes of hearing loss far more prevalent than non-organic causes, so be sure as possible as you can before proceeding as this has a huge impact on inappropriate intervention
Prevalence and other factors

In children

- Study in 60’s concurred that there is 1-5% prevalence in centers

- Girls more than boys (controversial and varied evidence)

- Peaks between ages of 10-12 (Andaz et al, 1995, Bowdler and Rogers, 1989)
- May report other functional problems, e.g. vision

- Often connected to other social or academic problems
In adults

- Most believed to be
  - Volitional
  - Industrial (Harris, 1979) and military populations (Gold et al 1991)
  - Possibly of conversion deafness (Goldstein, 1966), controversial again - psychological conflict or need
Indicators for NOHL

Before formal testing:

- Referral source, e.g. lawyer
- Income affected, e.g. Veterans, Experts
- Case history taking, exaggerated body language and contradictory statements of difficulty
- Communication competency in clinical sitting
Behavioral Signs

- Exaggerated efforts to lip read with continuous visual fixation on the face
- Exaggerated attempts to hear
- Complains of not hearing and asking for written communication
- Unfamiliarity with HAs operations
- Using hearing aids with dead battery

- Apparent anxiety and nervousness

- Huge discrepancy between case history information and their voice and speech quality
During test time:

- Frequent inconsistent responses
- Many false negatives with few or no false positives
- Extremely slow and deliberate responses

Shadow curve:

- when there is a true unilateral loss, unmasked, absence of shadow curve indicative of NOHL
Auidometric configuration:
• Flat audiogram or saucer shape audiogram suggested but nothing specific agreed

Test re-test reliability:
• Lack of consistency ( -5 to +10 acceptable)

➢ Beware of central pathologies and tinnitus patients as their lack of consistency likely due to factors other than NOHL
Audiogram with shadow curve versus audiogram with absent shadow curve
More indicators

- Poorer BC thresholds of > 20 dB or more
- Poor correlation between PTA and SRT, SRT being significantly better. If SRT-PTA is greater than 10-12 dB
- Speech Recognition scores were higher at lower sensation level in comparison to normal subjects
- False alarming, failure to respond during quiet periods between tonal presentations
Special test for pseudohyperacusis

1. Behavioral and qualitative measures

- Acoustic immittance testing
- Ascending-descending method
- Stenger and modified stenger test
- Low level PB words
- Pulse count
- Yes- No test
2. **Quantitative tests**

- Auditory Evoked potentials (AEPs)
- Otoacoustic Emissions (OAEs)
- Pure tone Delayed Auditory feedback
Acoustic Imittance Measurements

• Acoustic Reflex Threshold is of greater diagnostic value in NOHL, it’s an easy objective test

- **Normally**: ART ≥ 60 dB above PTT
- **Cochlear lesion**: ART ≤ 60 dB
- **NOHL**: ART ≤ 5-10 dB above PTT
SPAR (Sensitivity Prediction from the Acoustic Reflex) by Jerger in 1974

- It's a test for threshold estimation
- It is based on the fact that the ART is lower when a broad-band signal/noise is compared to Pure tone

- Normally: BBN ART = ≤ 25 dB of PT ART
- Mild-moderate SNHL = ≤ 10-20 dB difference
- Moderate-severe SNHL = < 10 dB difference

SPAR compares BBN ART with PT ART at 0.5, 1 & 2 KHz
Ascending Descending Method

- Use both ascending and descending method to establish threshold as opposed to just descending method

- Remove patient’s benchmark for reference

- In normal hearers, there should be no threshold difference between either method
• In NOHL, thresholds could be 20-30 dB better for the ascending tones than descending ones (Harris, 1958)
Stenger test

• Concept:

- When auditory stimuli are presented to both ears simultaneously with one stimulus being louder than the other, only the louder stimulus is perceived

- E.g. 50 dB to one ear and 15 dB to the other ear of normal hearing patient will be perceived as a monaural sound, one ear only
• Pure tone or speech can be used as stimuli and this known as stenger phenomenon

• It’s good for **unilateral hearing loss**

• **Present 2 tones simultaneously:**
  
  ➢ 10 dB below PPT in the ear with hearing loss
  ➢ 10 dB above PTT in the good ear
• Results:

- **Positive stenger**: patient does not respond to the hearing sound as he can hear it in the poorer ear, faked hearing loss

- **Negative stenger**: patient reports hearing in good ear, true hearing loss in the poorer ear
Minimum Contralateral Interference Levels (MCILs)

• It’s a test for threshold estimation

• Can be done using spondees

• Following stenger test

• Once you have positive stinger, present tone to good ear at 10 dB SL, patient will respond
• Now present to bad ear at 0 dBHL, with continuous presentation to good ear

• Raise by 5 dB in poor ear and keep increasing in 5 dB steps till the patient does not respond (all while the tone is constant in good ear)

• This level = MCIL (stenger effect has occurred)

• True threshold for poor ear calculated by subtracting 10 to 20 dB less than the MCIL (katz, 6th edition)
The End of the course