Audiology Pure-Tone Testing

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Overview

Pure-tone audiometry is a behavioral test used to measure hearing sensitivity. This measure involves the peripheral and central auditory systems. Pure-tone thresholds (PTTs) indicate the softest sound audible to an individual at least 50% of the time. Hearing sensitivity is plotted on an audiogram, which is a graph displaying intensity as a function of frequency.

Degrees of hearing loss

• Normal hearing (0-25 dB): At this level, hearing is within normal limits.
• Mild hearing loss (26-40 dB): Mild hearing loss may cause inattention, difficulty suppressing background noise, and increased listening efforts. Patients with this degree of loss may not hear soft speech. Children may be fatigued after listening for long periods.
• Moderate hearing loss (41-55 dB): Moderate hearing loss may affect language development, syntax and articulation, interaction with peers, and self-esteem. Patients with this degree of loss have trouble hearing some conversational speech.
• Moderate-severe hearing loss (56-70 dB): Moderate-severe hearing loss may cause difficulty with speech and decreased speech intelligibility. Patients with this degree of loss do not hear most conversational-level speech.
• Severe hearing loss (71-90 dB): Severe hearing loss may affect voice quality.
• Profound hearing loss (>90 dB): With profound hearing loss (deafness), speech and language deteriorate.

Types of hearing loss

• Conductive

  ◦ Conductive hearing loss has normal bone-conduction thresholds, but air-conduction thresholds are poorer than normal by at least 10 dB.
  ◦ Conductive hearing loss is secondary to an outer ear or middle ear abnormality, which can include abnormalities of the tympanic membrane. The abnormality reduces the effective intensity of the air-conducted signal reaching the cochlea, but it does not affect the bone-conducted signal that does not pass through the outer or middle ear.
  ◦ Examples of abnormalities include occlusion of the external auditory canal by cerumen or a mass, middle ear infection and/or fluid, perforation of the tympanic membrane, or ossicular abnormalities. Pure-tone air-conduction thresholds are poorer than bone-conduction thresholds by more than 10 dB (see image below).

Audiogram depicting a mild rising conductive hearing loss in the left ear. Note the significant air-bone gaps.

• Sensorineural
  ◦ Sensorineural hearing loss has bone- and air-conduction thresholds within 10 dB of each other, and thresholds are higher than 25 dB HL. See image below.

Audiogram depicting a high-frequency sloping sensorineural hearing loss in the left ear.

  ◦ Sensorineural hearing loss is secondary to cochlear abnormalities and/or an abnormality of the auditory nerve or central auditory pathways. Because, in this type of hearing loss, the outer ear and middle ear do not reduce the signal intensity of the air-conducted signal, both air- and bone-conducted signals are effective in stimulating the cochlea. Pure-tone air- and bone-conduction thresholds are within 10 dB.
  ◦ Examples included presbycusis, noise-induced hearing loss, Ménière disease, and retrocochlear lesions such as vestibular schwannoma.

• Mixed
  ◦ Mixed hearing loss has conductive and sensorineural components.
  ◦ This type of hearing loss has sensorineural and conductive components. Pure-tone air-conduction thresholds are poorer than bone-conduction thresholds by more than 10 dB, and bone-conduction thresholds are less than 25 dB (see image below).

Audiogram depicting a mixed sloping hearing loss in the left ear.

Terminology

• Audiogram
  ◦ The audiogram is a chart of hearing sensitivity with frequency charted on the abscissa and intensity on the ordinate (see images shown above). Intensity is the level of sound power measured in decibels; loudness is the perceptual correlate of intensity.
  ◦ For threshold testing intensity, decibels are measured in hearing level (HL), which is based on the standardized average of individuals with normal hearing sensitivity. HL is not equivalent to sound pressure level (SPL), but the American National Standards Institute (ANSI) has defined a relationship between SPL and HL for each audiometric frequency from 250-8000 Hz.

• Frequency
  ◦ Frequency is cycles per unit of time. Pitch is the perceptual correlate of frequency. Frequency is measured in hertz, which are cycles per second.
  ◦ Usually frequencies of 250-8000 Hz are used in testing because this range represents most of the speech spectrum, although the human ear can detect frequencies from 20-20,000 Hz. Some children can detect even higher frequencies.

• Pure-tone average
Pure-tone average (PTA) is the average of hearing sensitivity at 500, 1000, and 2000. This average should approximate the speech reception threshold (SRT), within 5 dB, and the speech detection threshold (SDT), within 6-8 dB.

If the SRT is significantly better than the PTA, the possibility of pseudohypoacusis should be considered. If the PTA is significantly better than the SRT, the possibility of central involvement should be considered.

- **Speech reception threshold**
  - The SRT is the softest intensity spondee words that an individual can repeat at least 50% of the time.
  - Spondees are bisyllabic words equally emphasizing both syllables. In some cases (eg, patients with poor word recognition), a limited set of words may be used.

- **Speech detection threshold**
  - The speech detection threshold (SDT), also termed the speech awareness threshold (SAT), is the lowest intensity speech stimulus that an individual can detect at least 50% of the time.

- **Word recognition**
  - Word recognition (formerly called speech discrimination) is the ability to repeat correctly an open set of monosyllabic words at suprathreshold intensity. Word lists are phonetically balanced (PB), meaning that the speech sounds used occur with the same frequency as in the whole language.
  - The score represents the percent of words correct for most word recognition tests.

**Common audiogram/audiologic assessment abbreviations**

- CNT - Could not test
- DNT - Did not test
- HA - Hearing aid
- HAE - Hearing aid evaluation
- NR - No response
- SNHL - Sensorineural hearing loss
- WNL - Within normal limits
- AU - Both sides (ears)
- AS - Left
- AD - Right
- VT - Vibrotactile response
- RTC - Return to clinic
- PRN - As needed
- BC - Bone conduction
- AC - Air conduction
- PTA - Pure-tone average
- UCL - Uncomfortable loudness level
- MCL - Most comfortable loudness level
- HFA - High frequency average
- HL - Hearing level
- SPL - Sound pressure level
- SRT - Speech reception threshold
- SAT - Speech awareness threshold

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