AUDIOLOGY OVERVIEW

Resident’s Lecture
TOPICS

- Overview
- Middle Ear: Tympanograms
- Inner Ear (Cochlea): Otoacoustic Emissions
- Inner Ear (CN VIII): ABR/BAER
- Hearing loss: Conductive vs Sensorineural
- When to order and what to order
Overview - Anatomy

1. Eardrum
2. Malleus
3. Incus
4. Stapes
5. Semicircular canals
6. Auditory nerve
7. Facial Nerve
8. Vestibular nerve
9. Cochlea
10. Eustachian tube
Normal Auditory Function

1. Outer Ear
   The visible outer portion and ear canal funnels sound inward.

2. Middle Ear
   The eardrum and three tiny bones vibrate from sound waves.

3. Inner Ear
   The fluid-filled cochlea contains thousands of tiny sound receptors called hair cells. The hair cells sway with sound waves in the fluid filled space.

4. Hearing Nerve
   Thousands of little nerve pathways transmit sound information from the hair cells up to the hearing center of the brain.
Middle Ear: Tympanometry
Tympanograms

- Measurement of eardrum mobility and middle ear pressure

- Most common types:
  - A – Normal
  - C – “Middle ear congestion”
  - B - Fluid
    - B – high volume, patent PE tube or perforation

- Test hints
Tympanometric Measurement

- Equipment
  - ear canal probe with speaker (receiver), microphone and pressure pump

- Protocol
  - acoustical impedance or admittance is measured in the plane of the probe at positive and negative ear canal pressure
# Tympanogram Types

<table>
<thead>
<tr>
<th>Type A</th>
<th>Type C</th>
<th>Type B</th>
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<tbody>
<tr>
<td><img src="graph1.png" alt="Graph" /></td>
<td><img src="graph2.png" alt="Graph" /></td>
<td><img src="graph3.png" alt="Graph" /></td>
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<tr>
<td>Eardrum Movement</td>
<td>Eardrum Movement</td>
<td>Eardrum Movement</td>
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<tr>
<td>-400 to +200</td>
<td>-400 to +200</td>
<td>-400 to +200</td>
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</tbody>
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- **Type A**
  - Pressure between +100 and -100
  - No hearing loss

- **Type C**
  - Pressure between -150 and -400
  - Conductive hearing loss at low and high frequencies
  - Consistent with Eustachian Tube dysfunction

- **Type B**
  - No measurable pressure
  - Conductive hearing loss at all frequencies
  - Consistent with fluid in the middle ear
Type A tympanogram

Indicative of normal middle ear function
Type C tympanogram

Indicative of negative middle ear pressure

Onset or offset of middle ear dysfunction

May or may not cause conductive hearing loss
Type B tympanogram

Indicative of middle ear dysfunction

- ME effusion
- PE tube or perforation
- Occluded ear canal (wax/foreign body)
Testing Hints

- With portable tympanometer – Never accept an initial Type B – redo.

- Use probe tip larger than ear canal.

- Pull up on ear to straighten canal.

- Never test a draining ear.

- Check ear canal prior to testing.
Inner Ear: OAE
Hair Cell Function

Hair cells

Auditory Nerve
Tonotopic Organization of Cochlea
Otoacoustic Emissions

- Otoacoustic emissions result from the activity of the outer hair cells in the cochlea.

- "Yes or No" response – does not provide any information regarding degree or nature of possible hearing loss.
OAEs: Clinical Application

- Newborn hearing screenings
- Diagnostic hearing evaluations
- Ototoxicity monitoring
- Noise exposure (damage) monitoring
- DDx: sensory vs. neural hearing loss
What an OAE looks like
Inner Ear: ABR/BAER
Auditory Pathway
ABR (BAER)

- Test of synchrony of the auditory pathway through the brainstem.

- Provides means of assessing hearing sensitivity in individuals who cannot be tested by other means.

- Provides information about retrocochlear function.
ABR Response for Clicks

Normal Auditory Brainstem Response

Wave I: Action potential, auditory nerve
Wave II: Cochlear nucleus
Wave III: Superior olive
Wave IV, V: Inferior colliculus
Wave VI, VII: Unclear
Clinical Utility: ABR

- Screening version is used for newborn hearing screening

- Diagnostic ABR: Infants at high risk for neural hearing loss

- Young children or difficult to test population who are unable to complete accurate “traditional” hearing assessment
Test protocol by high risk factor in NICN

OAE only

- Low birth weight, >1500 grams
- Defects of head and neck
- <72 hr admission
- Ototoxic drugs <3 days
- Maternal drug/alcohol abuse

OAE and ABR

- Hyperbilirubinemia
- Meningitis
- TORCH infections
- Family history of congenital hearing loss
- CMV
- ECMO
Comprehensive Hearing Evaluation

- Tympanometry
- Otoacoustic Emissions
- Behavioral Hearing Test (or ABR)
Understanding an audiogram

- 0 dB (0 "decibels")
- 20 decibels. Between 0 and 20 dB is normal for an adult
- 50 decibels
- 90 dB (90 decibels)

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Hearing levels on an audiogram

Speech Sounds and Some Environmental Sounds

<table>
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<th>Frequency (in hertz)</th>
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<tr>
<td>125</td>
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<tr>
<td>250</td>
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- Breathing
- Whisper
- Watch ticking
- Quiet radio
- Talking
- Vacuum cleaner
- Dog barking
- Phone ringing
- Car horn
- Lawnmower
- Train

Speech Zone
Speech Sounds and the Audiogram

Two things are important to recognize. For the most part:

1. Consonants are higher pitched than vowels (they lie more to the right on the chart).
2. Consonants are spoken more softly than vowels (they lie higher on the chart, in the lower decibel ranges).
Hearing Loss
Conductive Hearing Loss

- Problem with outer ear, ear canal, eardrum or middle ear
- Normal sensory hearing
- Correct problem, hearing returns to normal.

![Graph showing hearing levels across different frequencies](image-url)
Sensorineural Hearing Loss

- Problem in the cochlear or on the nerve pathway.
- Permanent
- Depending on degree, may need intervention (hearing aids or cochlear implant)
Auditory Neuropathy

- Normal cochlear function, abnormal CN VIII function
- Seen in cases of kernicterus, retrocochlear pathology, or unknown etiology
- Treatment Options
ABR Results – Auditory Neuropathy

Response at 1.5 msec is cochlear microphonic.

a. polarity of response flips with polarity of stimulus
b. latency does not shift with stimulus intensity
c. latency does not shift with stimulus rate
QUESTIONS?
Hearing Loss: Treatment Options
Hearing Aids

- Can be fit for any degree of hearing loss
- Used for permanent conductive or sensorineural hearing loss
- First “line of defense” for children with hearing loss
Cochlear Implants

- Used for bilateral profound hearing loss

- Children must complete six month trial period with hearing aids and demonstrate no benefit

- Candidacy Assessments: Speech, MRI, CT, Neuro-Otology

- FDA minimum age = 12 months

- No MRIs following implantation
What to order....
Infant, Failed NBHS

- If no risk factors, repeat OAE

- If risk factors exist, ABR without (if under 5 months) or with anesthesia
Toddler, Speech Delay

- If no confounding developmental delays, Pediatric Hearing Evaluation

- If developmentally delayed or medically complicated, ABR with anesthesia
Older Child, Hearing Concerns

- Pediatric Hearing Evaluation
Audiology:
Department Overview
Special Programs in Audiology

- NICU screening
- Hematology/Oncology Monitoring
- Cochlear implant
- Hearing Aids
- Auditory Processing Evaluations
- Education
- Interoperative Testing
Staff

- Four Staff Audiologists (M.S. or Au.D.)
- One Doctoral Intern
- One Newborn Hearing Screening Technician
- One ASL/Spanish Cochlear Implant Coordinator
- Support Staff