




Introduction to Audiology and Hearing Loss for Non-Audiologists


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Today's Presenters



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Disclaimer

Terry Foust is a salaried staff employee at Intermountain Healthcare and a consultant with the Early Childhood Hearing Outreach (ECHO) Initiative and National Center for Hearing Assessment and Management (NCHAM) at Utah State University

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Introduction to Audiology and Hearing Loss for Non-Audiologists

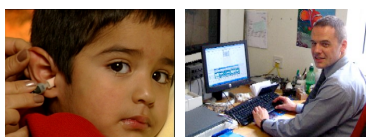
Learning Objectives

- Describe the important aspects of hearing and hearing loss
- Explain how hearing loss is assessed and diagnosed
- Outline the types of treatment and intervention for hearing loss
- Describe the impact of hearing loss on early development
- Explain how audiologists monitor and manage hearing loss

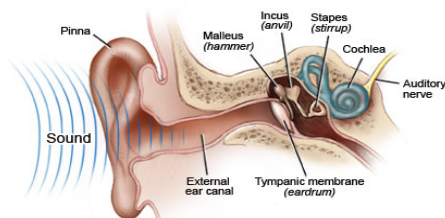
What are Audiologists?

Specialists in Hearing and Balance

- Prevention of hearing loss
- Identification and assessment of hearing and balance problems
- Rehabilitation of persons with hearing and balance disorders



Ear

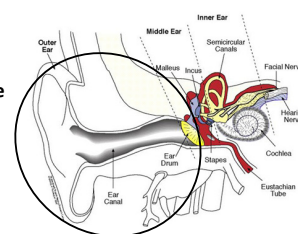


Parts of the Auditory System

- Outer Ear
- Middle Ear
- Inner Ear
- Central Auditory Nervous System

Outer Ear

- Pinna
- External Auditory Canal (Ear Canal)
- Tympanic Membrane (Ear Drum)

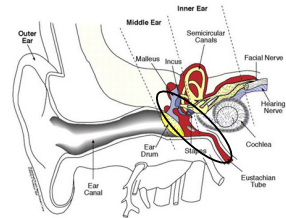


Tympanic Membrane (Ear Drum)



Middle Ear

Ossicles (bones)
Eustachian Tube

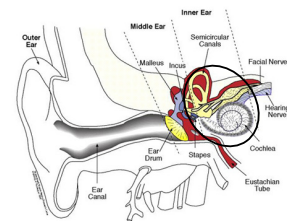


Middle Ear Ossicles (bones)



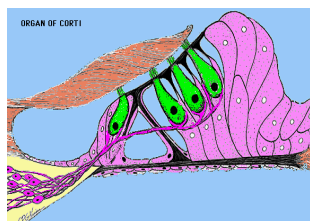
Inner Ear

- Cochlea
- Organ of Corti
- Hair Cells



Organ Of Corti

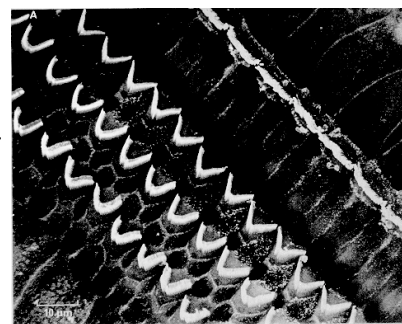
- End organ of hearing
- Fluid movement causes bending of nerve endings
- Nerve impulses (electrical energy) are generated and sent to the brain



(From Augustana College, "Virtual Tour of the Ear")

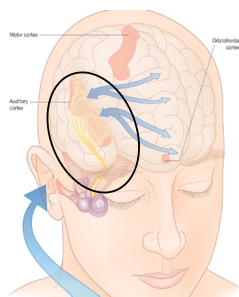
Hair Cells

- Frequency-specific
- 3 rows of Outer Hair Cells
- 1 row of Inner Hair Cells



Auditory Nerve and Central Auditory System

Auditory Nerve through the Brainstem to the Auditory Cortex



Types of Hearing Loss

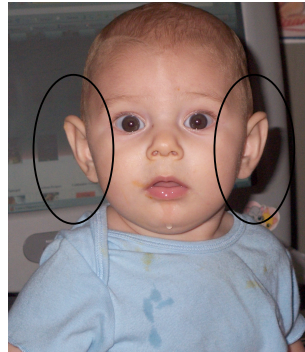
Unilateral = one ear
Bilateral = two ears

-
- Conductive = Outer and/or Middle Ear
 - Sensorineural = Inner Ear/Auditory Nerve
 - Mixed = Outer and/or Middle and Inner Ear
 - Auditory Neuropathy Spectrum Disorder and Central Auditory Processing Disorder = Auditory Nerve and Central Auditory System

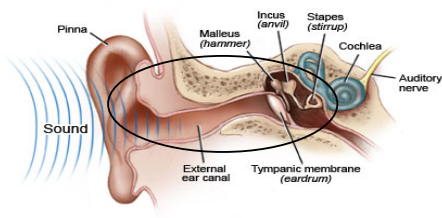
Permanent Congenital Hearing Loss: CDC HSFS, 2013
Unilateral Hearing Loss – 40%



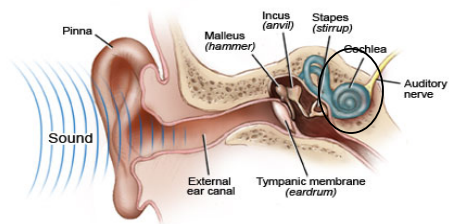
Permanent Congenital Hearing Loss: CDC HSFS, 2013
Bilateral Hearing Loss – 60%

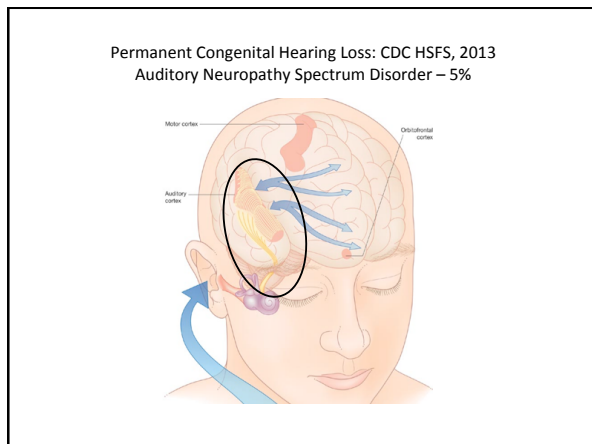
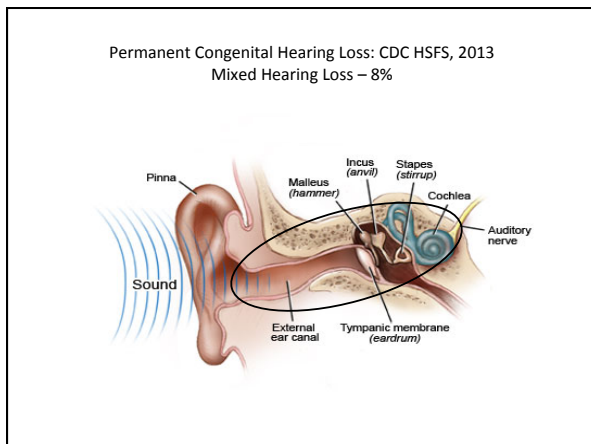


Permanent Congenital Hearing Loss: CDC HSFS, 2013
Conductive Hearing Loss – 14%



Permanent Congenital Hearing Loss: CDC HSFS, 2013
Sensorineural Hearing Loss – 62%





Prevalence of Hearing Loss

CDC EHDI Survey (2013)

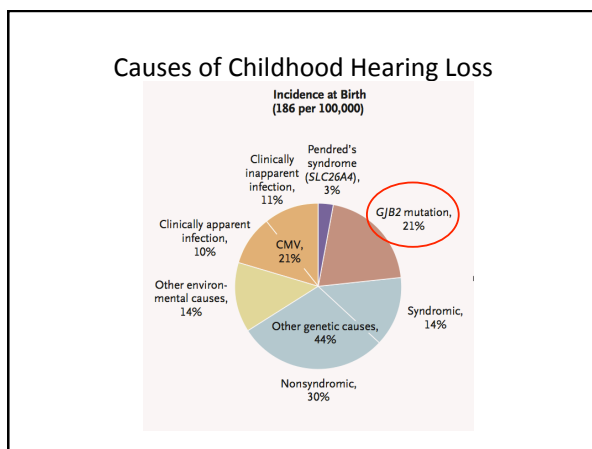
1.5 per thousand – congenital permanent hearing loss BUT

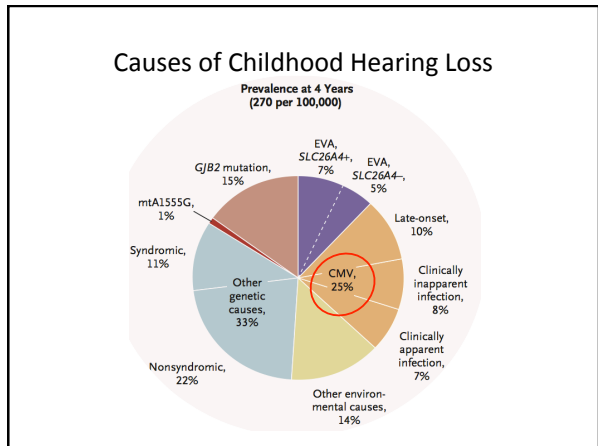
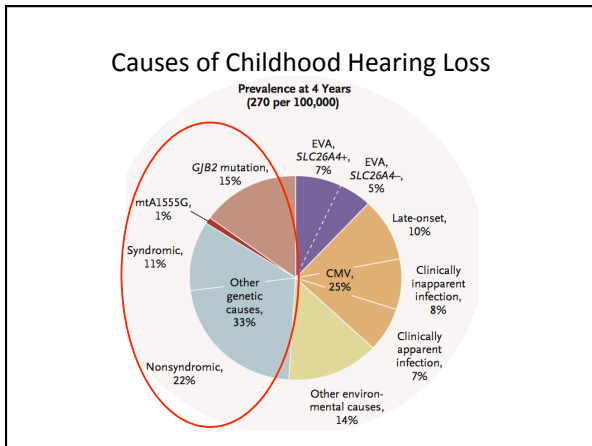
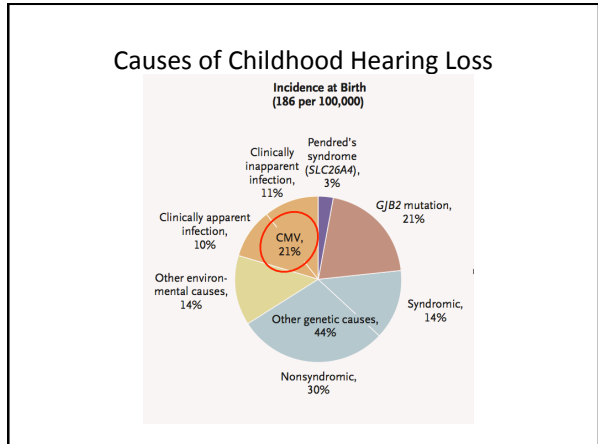
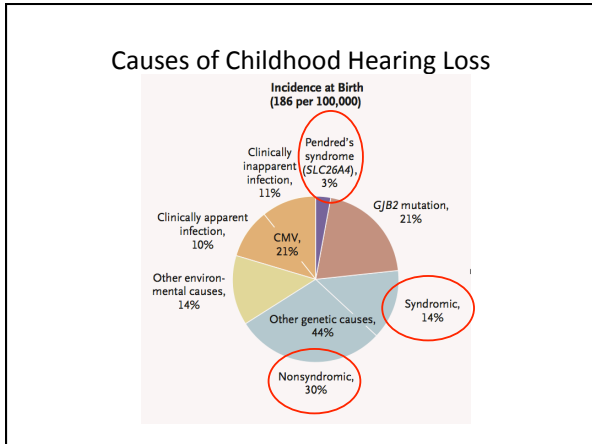
32% not passing newborn screening have incomplete evaluation reporting (4% - 87%)

ECHO

Eiserman, et al, 2008 (EHS): **1.5 per thousand - previously unidentified PHL**

Foust, et al, 2013 (health clinics): **3.5 per thousand - previously unidentified PHL**







Screening and Diagnostics

JCIH Newborn Hearing Screening Guidelines

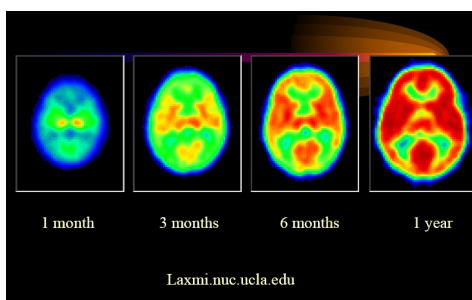
1-3-6 Model

By 1 month
Screen hearing

By 3 months:
Evaluate hearing and complete diagnostic audiology and otolaryngology examinations
Fit hearing aids if necessary

By 6 months:
Enroll in Early Intervention Services

Why is it important?



Hearing Tests

- Determine how significant the hearing loss is (mild, moderate, severe, profound)
- Determine the kind (type) of hearing loss (conductive, sensorineural)
- Determine the configuration (is hearing better at some frequencies or pitches or worse in others)
- Used to make decisions on treatment and intervention

Four Main Tests

- Tympanometry
 - Tympanometry tests how the eardrum and middle ear are working.
- Otoacoustic emissions- OAE
 - OAE tests how the the inner ear or cochlea is working
- Auditory Evoked responses- ABR
 - ABR tests the hearing nerve and auditory pathways of the brain in response to sound.
 - It measures to the quietest level of sound that the child's auditory system can respond to
- Behavioral
 - Using age specific techniques to observe the child's response to sound

Objective Test

- Requires no behavioral response
- Determine status of auditory system
- Middle ear function
- Inner Ear Function
- Function of central pathways in the brainstem and cortex

Tympanometry

Measured at the plane of the ear drum or Tympanic Membrane

Record how much acoustic energy is transferred into the middle ear

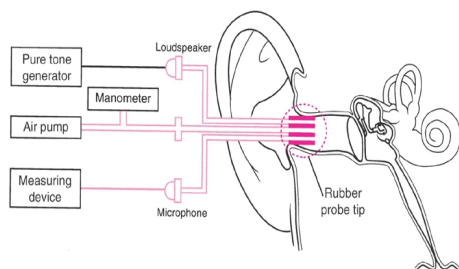
Determine the condition of the middle ear from this measurement

- hole or perforation of the eardrum
- fluid behind the ear drum
- air pressure behind the ear drum
- normal ear drum movement

Equipment for middle ear measurements

- Probe for seal in ear canal
- Speaker to generate tone sound wave
- Microphone to measure reflected sound in the ear canal
- Air pump to deliver positive and negative pressure to the sealed ear canal
- Earphone for other ear for reflex measures

Tympanometry



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OAE Overview

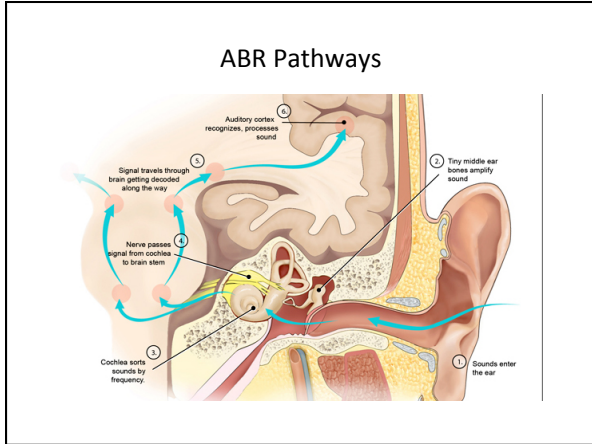
- Sound stimulus goes into the ear canal
- *If* the eardrum and middle ear system is healthy AND the Inner Ear is normal
- *Then* a response (echo) from the movement of the outer hair cells can be measured
- Babies are the easiest to test when they are:
 - Younger
 - Quiet or distracted

Auditory Evoked Potentials

- Labeled based on origin of response in system further “up” the system, the longer the latency
- ABR- auditory BRAINSTEM response 10 - 15 msec
- AMLR- auditory middle latency 15 - 60 msec
- ALR- auditory late response 75 - 200 msec
- ERP- Event related potentials 220 - 389 msec

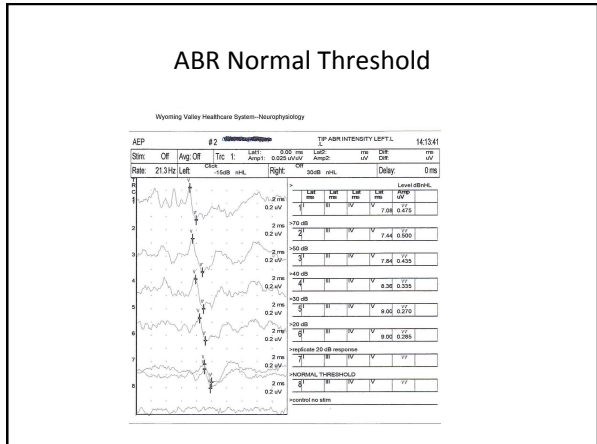
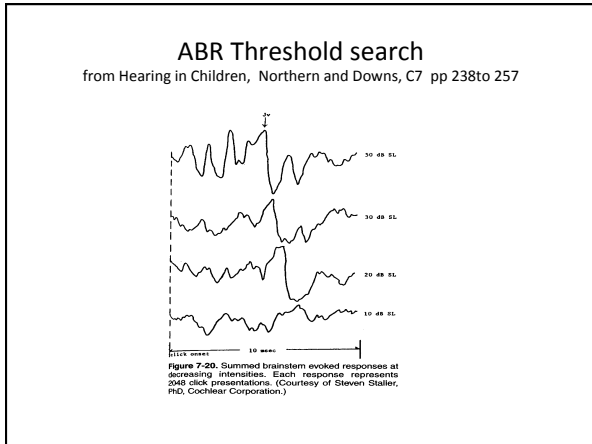
Auditory Evoked Potentials

- ABR- auditory brainstem response occurs in the first 10-15 msec after a sound enters the ear
- “Waves” generated by synchronous nerve firing-volley
 - Waves I and II VIII nerve
 - Wave III Superior Olivary Nucleus level of pons
 - Wave IV Lateral Lemniscus pons
 - Wave V Inferior Colliculus level of mid-brain

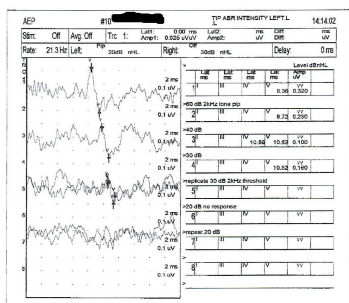


ABR

- Evaluate nerve conduction delays- timing
- Estimate hearing threshold
 - Electro-physiologic response 10-20 dB above behavioral threshold



ABR Threshold Mild hearing loss



Why use ABR?

- ABR not affected by patient state or anesthesia- brainstem level response
- Natural sleep or sedation to estimate threshold in infants and children
- Later waves from higher centers
response affected by alertness/state
- Sedation or some medications will suppress the middle and late responses

Behavioral Tests



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Hearing Screening Protocols

- Separate protocols for Well-Baby Nursery and NICU

Newborn Hearing Screening – Well Baby

Physiologic ('objective') measure (pass/fail interpretative criteria available; evidence-based; automated):

- Auditory Brainstem Response (ABR) automated technology
- Otoacoustic Emissions (OAE) automated technology
- 2-technology screen: Screen first OAE; if OAE fails receive ABR. If Pass ABR = Pass Screening (NIH 1993)



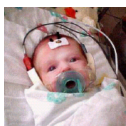
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- Limit number of repeated inpatient tests (increases probability of 'passing' by chance alone)
- In absence of national calibration standards or uniform performance standard, "*audiologists must obtain normative data for the instruments and protocols they use*"
- Rescreen of both ears even if only one ear fails initial screening

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Hearing Screening Protocols - NICU

- Automated-ABR technology recommended as the primary screening tool for use in the NICU for infants admitted for > 5 days



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Re-Screening Protocols - NICU

- NICU infants not passing AABR screening referred immediately to an Audiologist for audiologic rescreening/ diagnostic assessment
 - Any 'rescreening' must include ABR
 - First diagnostic testing may occur prior to NICU discharge

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Audiologic Evaluation

- Should be performed by audiologists experienced in pediatric hearing assessment
- Initial audiologic test battery to confirm hearing loss must include:
 - Physiologic measures
 - When developmentally appropriate, behavioral methods
 - Completed in both ears regardless of the results of screening tests

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Audiologic Evaluation – Birth to 6 months (Developmental Age)

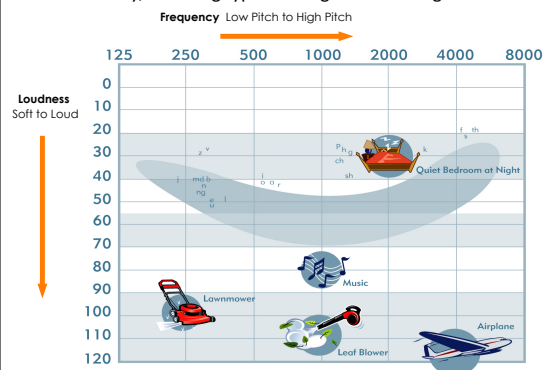
- Child and family history
- Frequency-specific AC (air conduction) ABR
- Frequency specific BC (bone conduction) ABR, when indicated
- Click-evoked ABR
 - if infant has risk indicators for neural HL
 - any infant demonstrating no response on FS-ABR requires click-evoked ABR
- Some infants with neural HL have no risk indicators*
- OAE (DPOAE or TEOAE)
- Tympanometry using 1000-Hz probe tone
- Observation of auditory behavior
 - As cross-check; not for assessment or amplification fitting

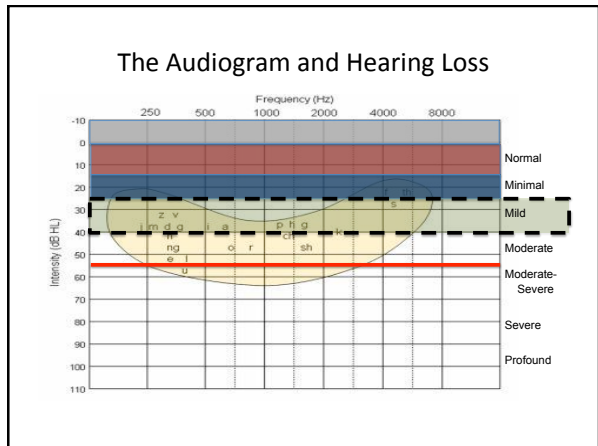
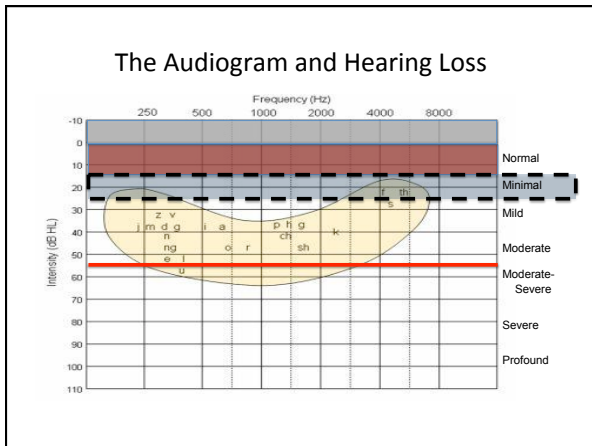
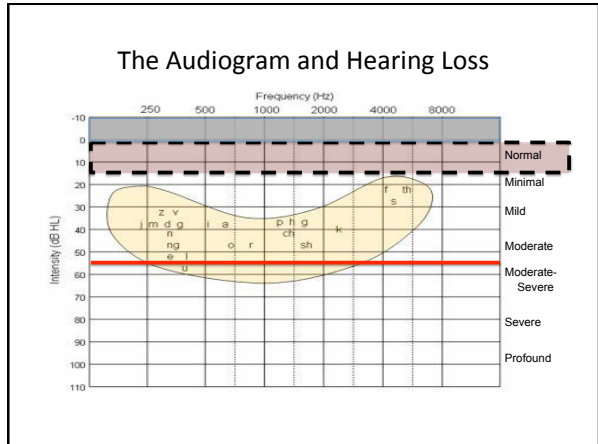
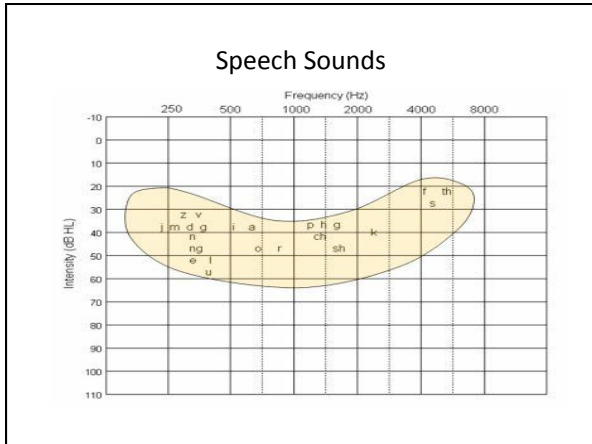
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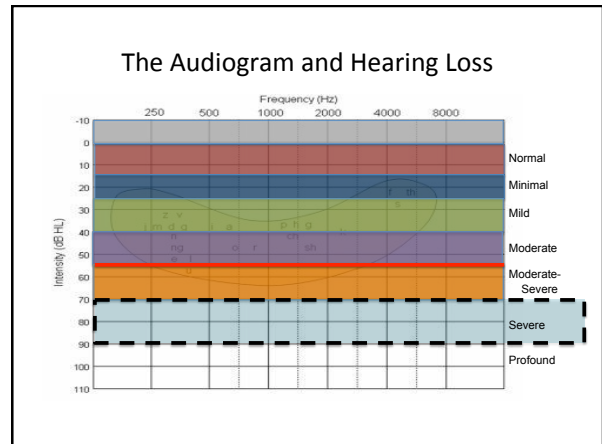
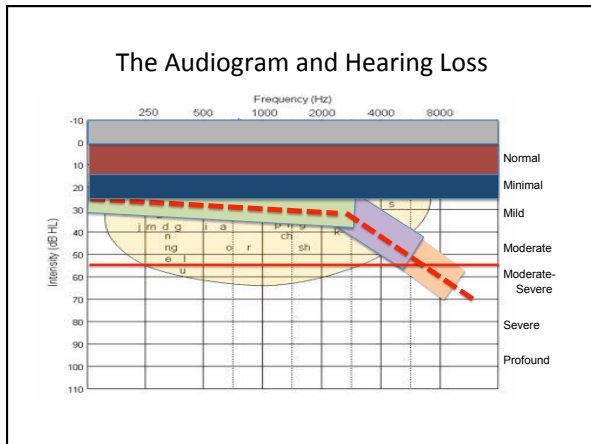
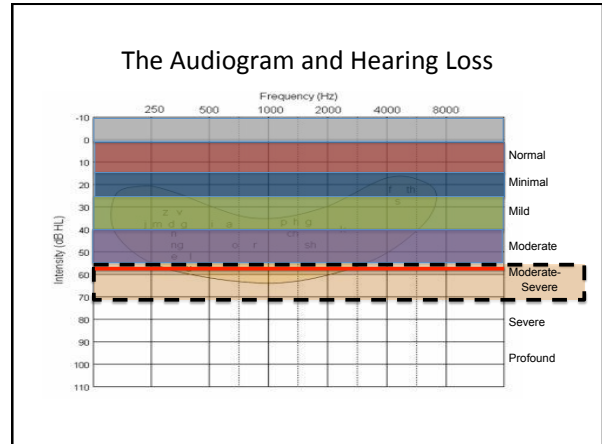
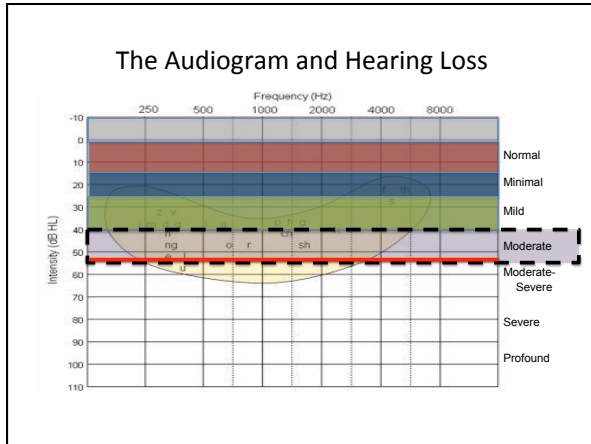
Audiologic Evaluation – 6 months to 36 months

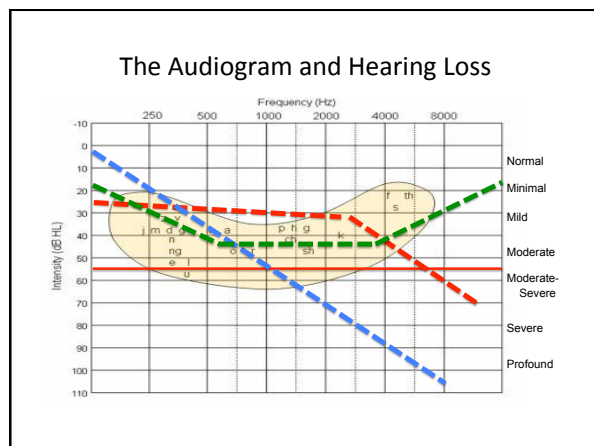
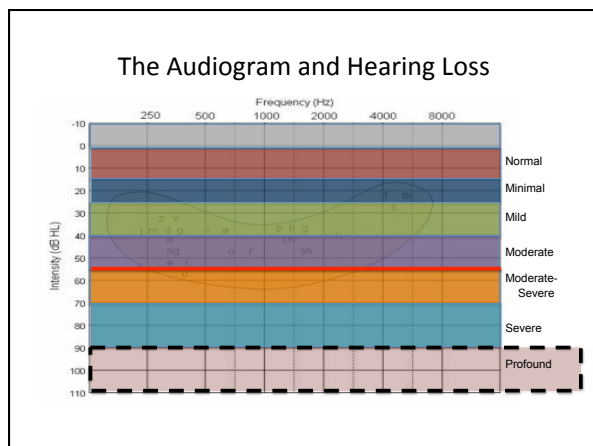
- Child and family history
- Parent report of auditory and visual behaviors and communication milestones
- Behavioral audiometry (VRA, CPA), including:
 - Pure-tone audiometry across the frequency range for each ear
 - Speech detection and speech recognition measures
- OAE testing
- Acoustic immittance measures: Tympanometry & Acoustic Reflex Thresholds
- ABR testing if responses to behavioral audiometry are not reliable *OR* if ABR testing has not been performed previously

Audiogram – A graph of an individual's hearing sensitivity, including type and degree of hearing loss









Two On-line Resources

Auditory Transduction

by Brandon Pletsch

Hearing Loss Simulation links
successforkidswithhearingloss.com


- ### Treatment and Intervention
- Early intervention for overall development
 - Communication modalities
 - Emotional
 - Social
 - Cognitive
 - Audiologist work with and refer to
 - Early interventionists
 - Speech-language therapists – specialized in hearing impairment
 - Educators for the deaf or hard of hearing

Treatment and Intervention

Medical intervention



- surgical treatment
- treatment for chronic middle ear disorder

Hearing aids
Cochlear implants
FM systems



JCIH 2007 - Amplification

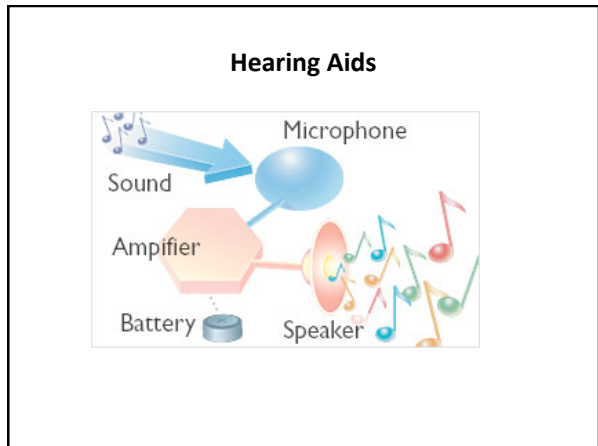
Infants diagnosed with permanent hearing loss should be fit with amplification within one month of hearing loss identification



Hearing Aids



earmold

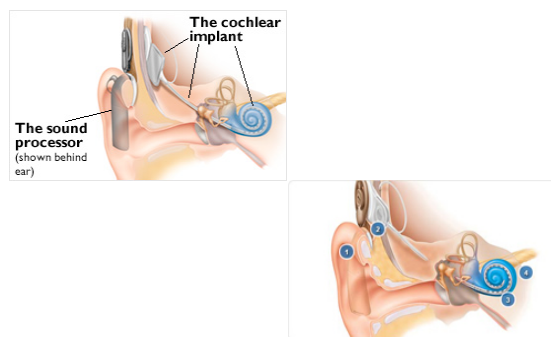


Cochlear Implant Candidacy Criteria

- Lack of benefit from amplification
- Age: 12 months (FDA, insurance) but sometimes younger
- Degree of hearing loss: bilateral severe to profound
- No medical contraindications
- Education environments and services appropriate for post-CI au re/habilitation
- Family factors (motivation, expectations)



Cochlear Implant



FM Systems



Early Care & Education Staff

- Important member of the child's early intervention team
- Questions to ask in order to facilitate maximum inclusion:
 - What can the child hear with and without amplification?
 - What is the optimal communication distance for the child?
 - How can you be trained in trouble shooting the amplification devise?
 - What supportive strategies would help?

Maximize the Auditory Environment

- Ensure amplification system is working
- Audiologist train in device use
- Thoughtful placement to learning centers
- Be aware of and reduce background noise
- Make sure child's attention is focused on the speaker and talk naturally and clearly

The Listening Bubble

Not in range!



In range & listening!



Out of 'ear shot' means language is not caught!

Highlight the Visual Environment

- Position children with HL so they can easily visually focus on activities
- Be sure lighting is appropriate
- Direct to auditory language information
- Ensure child positioning in relationship to the teacher that promotes positive social relationships while enhancing learning

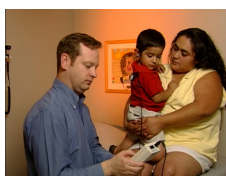
Audiological Monitoring and Managing Hearing Loss

- Hearing can change and get worse
- Plan for future needs - amplification flexibility
- Monitor hearing aid/cochlear implant function – trouble shoot
- Provide educational input and consultation
 - classroom modifications
 - FM
 - educational strategies



Working Collaboratively With Audiologists

1. Make out reach efforts - individual or group
2. Encourage mutual information sharing
3. Invite participation
4. Keep asking questions



Take Home Message

- Hearing loss is described by the parts of the ear affected and can be temporary or permanent
- An audiogram is how we graph hearing sensitivity and it is very important to develop an understanding of what it means
- Even mild and moderate hearing loss significantly affects ability to hear speech which affects speech and language development

Take Home Message

- Children who refer from screening can and should be assessed as soon as possible to maximize development of maturing auditory skills; sets the stage for language development
- Family choices for treatment and intervention often includes hearing aids/cochlear implants AND early intervention (communication strategies)
- Questions about hearing? Ask your Audiologist!

