

Bone Conduction Hearing: A Natural Pathway to Hearing

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- Previously, Member of TX Board of Examiners in Speech Pathology & Audiology
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- Vice President, Consumer Affairs, Cochlear Americas
- Manage Cochlear Americas HOPE program
- Address public policy issues impacting our recipient community
- Previously, Executive Director of HLAA and AG Bell
- Advocate for consumers and families

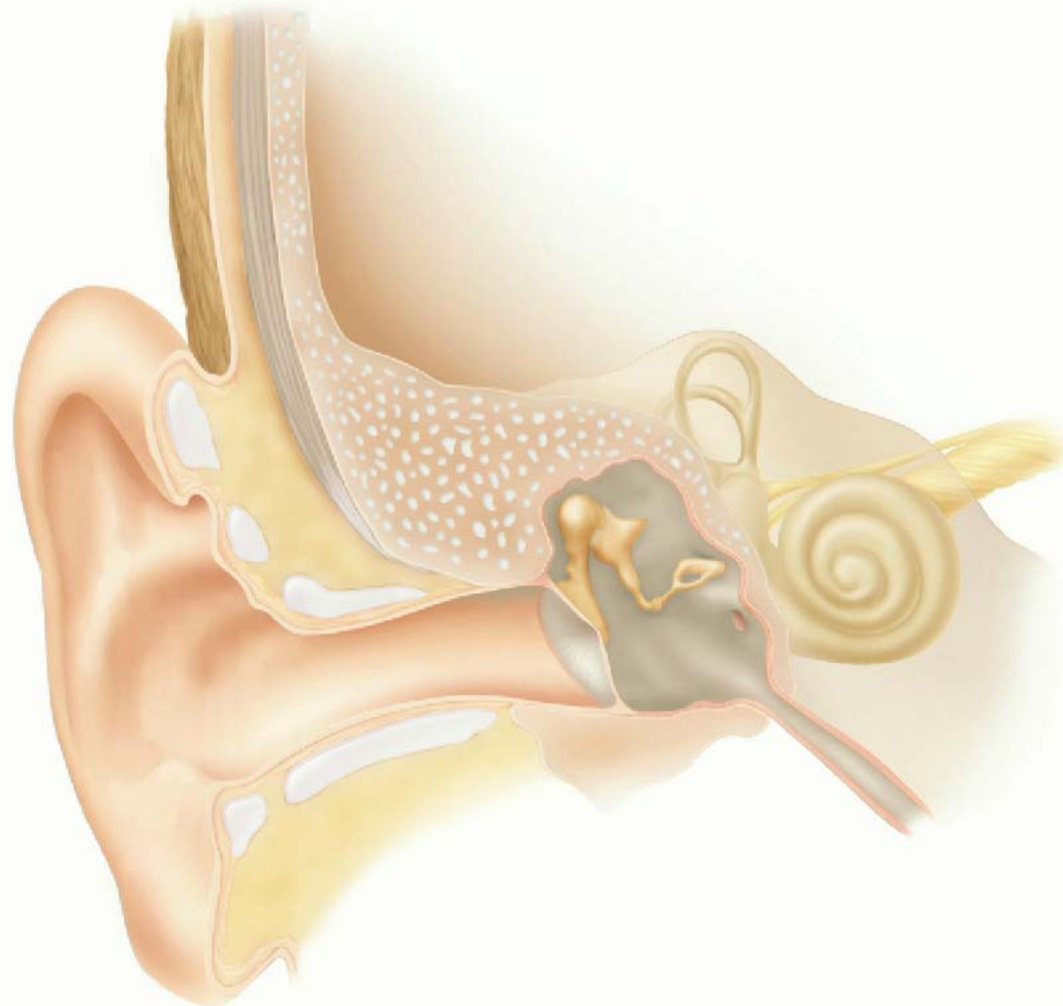
Presentation topics

- How the Ear works
- Types of Hearing Loss
- Audiogram Patterns
- Possible causes for each type of Hearing loss
- Treatment Options
- Bone Conduction Hearing Devices
- Case Studies
- How Early Intervention can help a child who may be a candidate for bone conduction hearing

Major Divisions of the Ear

- Outer Ear (Pinna and Ear Canal)
- Middle Ear (Eardrum, Ossicular Chain)
- Inner Ear (Cochlea)

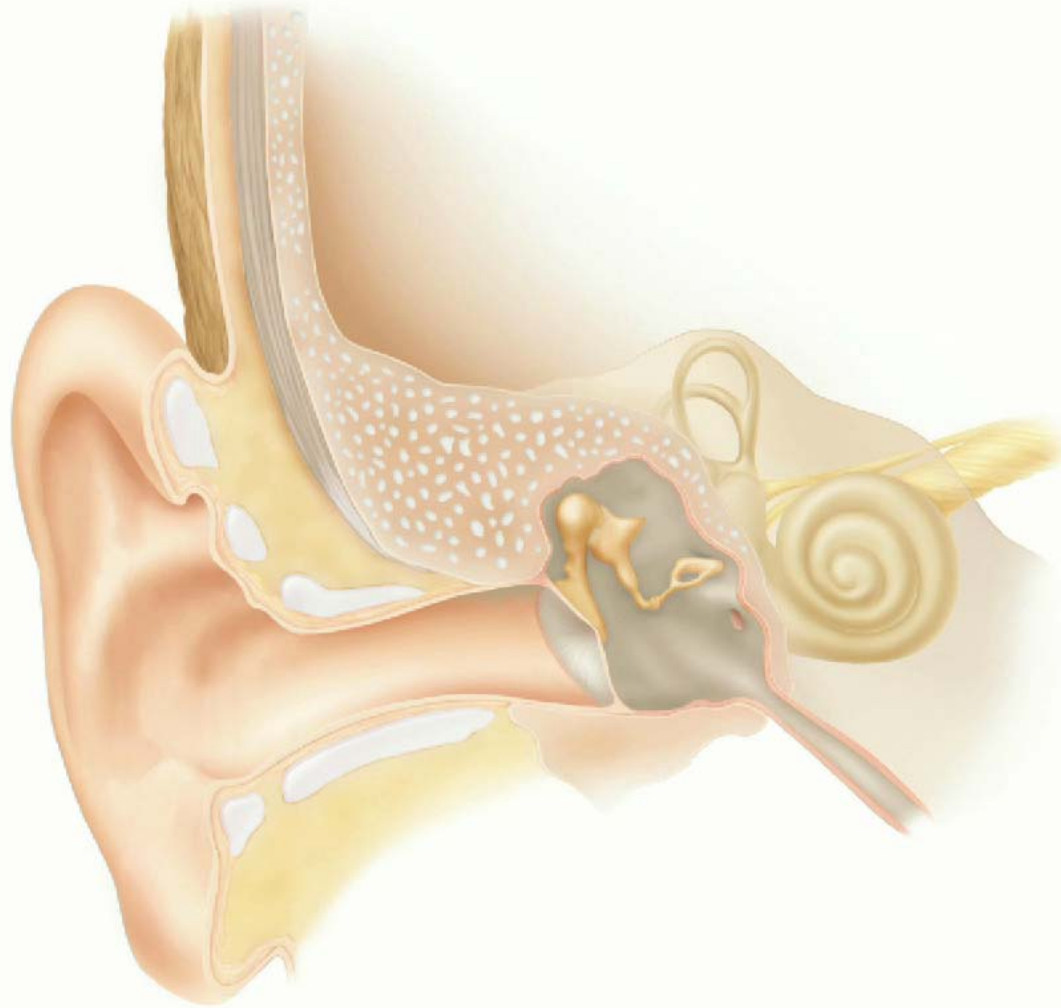
The Ear



Types of Hearing loss

- Conductive
- Sensorineural
- Mixed

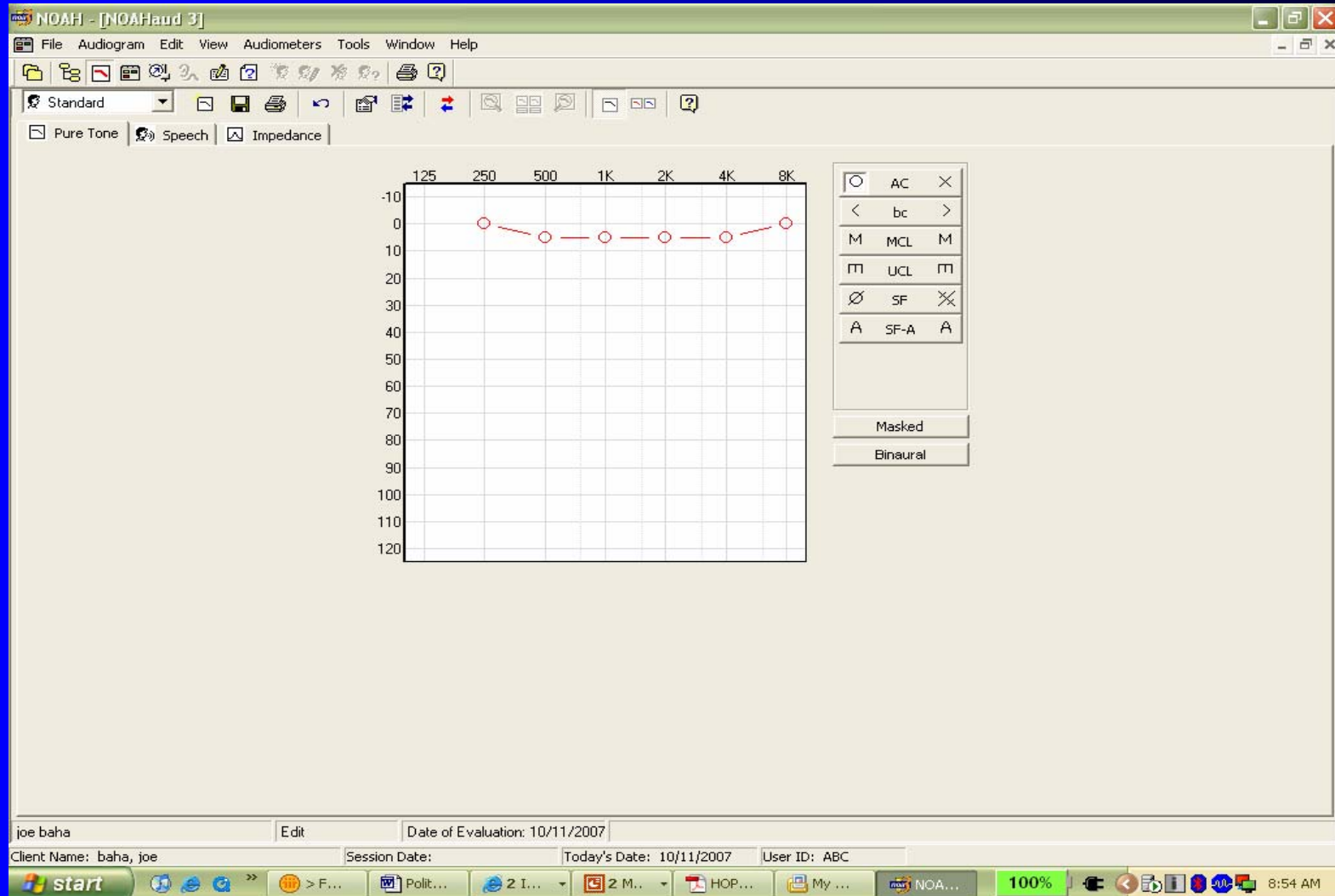
The Ear



The Hearing Evaluation

- A primary goal of the clinical evaluation of hearing is to identify the type and severity of the hearing loss
- Done by testing both the air conduction and bone conduction pathways
- Principal tool used in this evaluation is the Audiometer
- Results are recorded in a standard format: **The Audiogram**

THE AUDIOGRAM



Conductive Loss

- Something is blocking the transmission of airborne vibration of air particles striking the Ear Drum (tympanic membrane)
- Wax (Cerumen) or other debris
- Malformed or blocked ear canal
- Collapsing ear canal

Conductive Loss

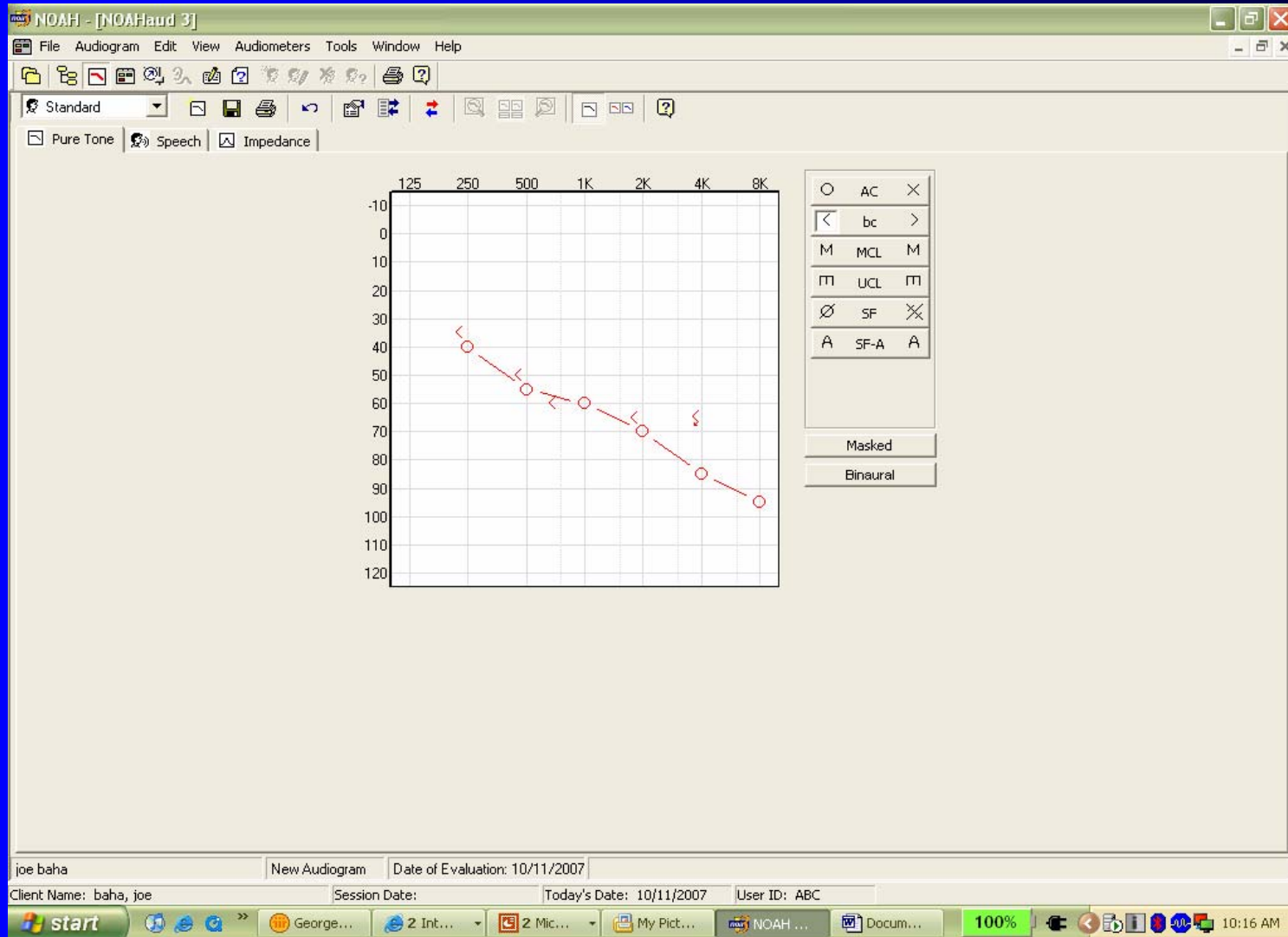
- Tympanic membrane perforation
- Tympanosclerosis
- Cholesteatoma
- Disarticulation or malformation of the ossicles.
- Surgical alteration of the middle ear for disease management

Sensorineural Loss

- Mechanical vibrations are entering the cochlea but the hair cells are damaged and the vibration is not converting correctly to the electrical stimulation the pathway requires
 - Noise Induced damage
 - Viral insult (Meningitis or CMV)
 - Ototoxic agents
 - Unknown congenital factors
 - Acoustic Nerve tumors

THE AUDIOGRAM

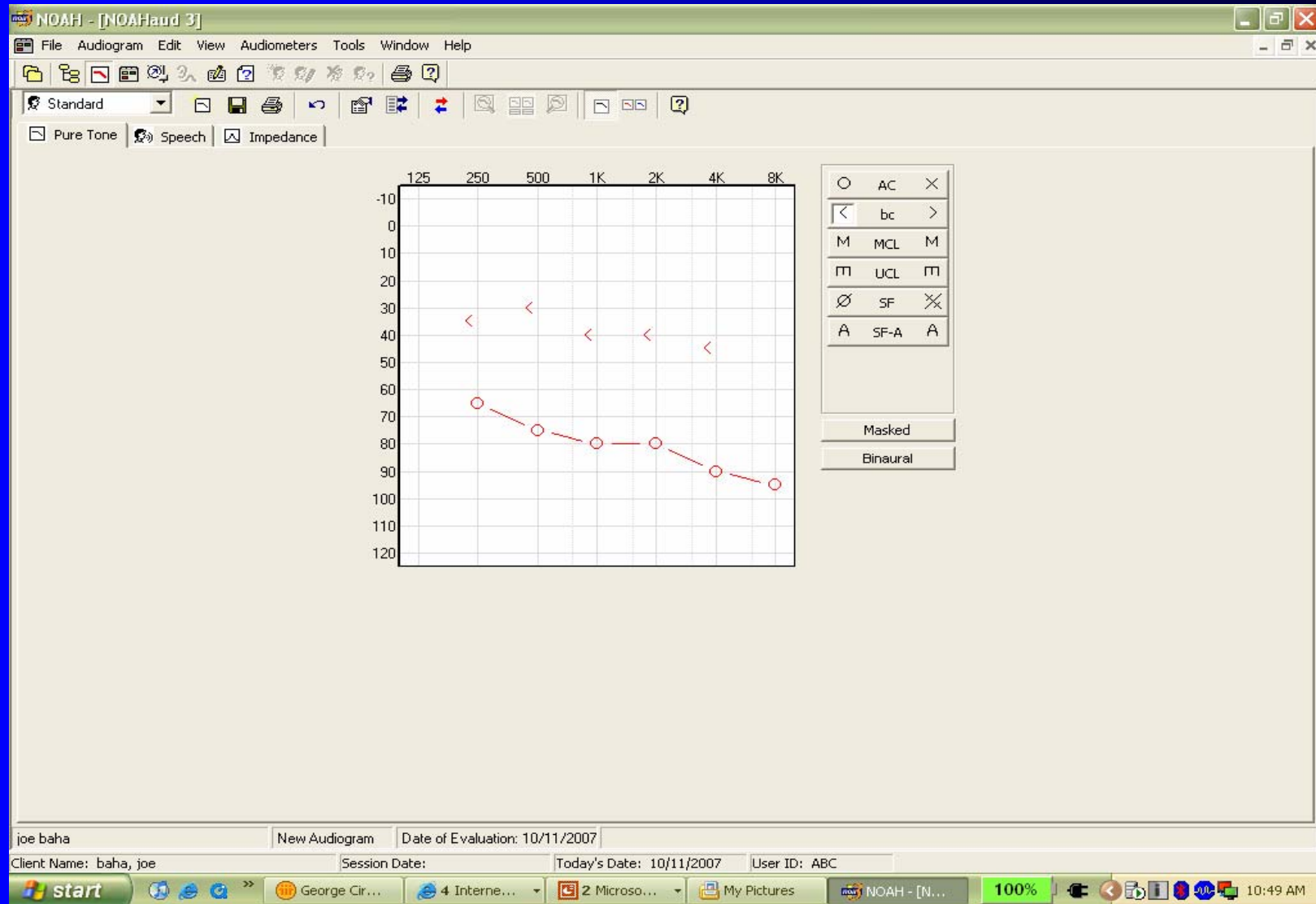
Sensorineural



Mixed Loss

- Combination of both the interruption of vibration energy passing through the outer and middle ear and interruption of function of the hair cells in the inner ear
- Cholesteatoma with massive destruction and infiltration into the cochlea
- Congenital malformation of both the middle ear and cochlea
- Damage to the ossicles and temporal bone due to head trauma

THE AUDIOGRAM Mixed



Treatment Options

Conductive Hearing Loss

- Medical/Surgical: Removal of foreign body, surgical alteration of malformation (canalplasty)
- Myringotomy with vent tubes
- Tympanoplasty
- Mastioidectomy
- Middle ear reconstruction
- Amplification (hearing aid fitting)

Treatment Options

Sensorineural Loss

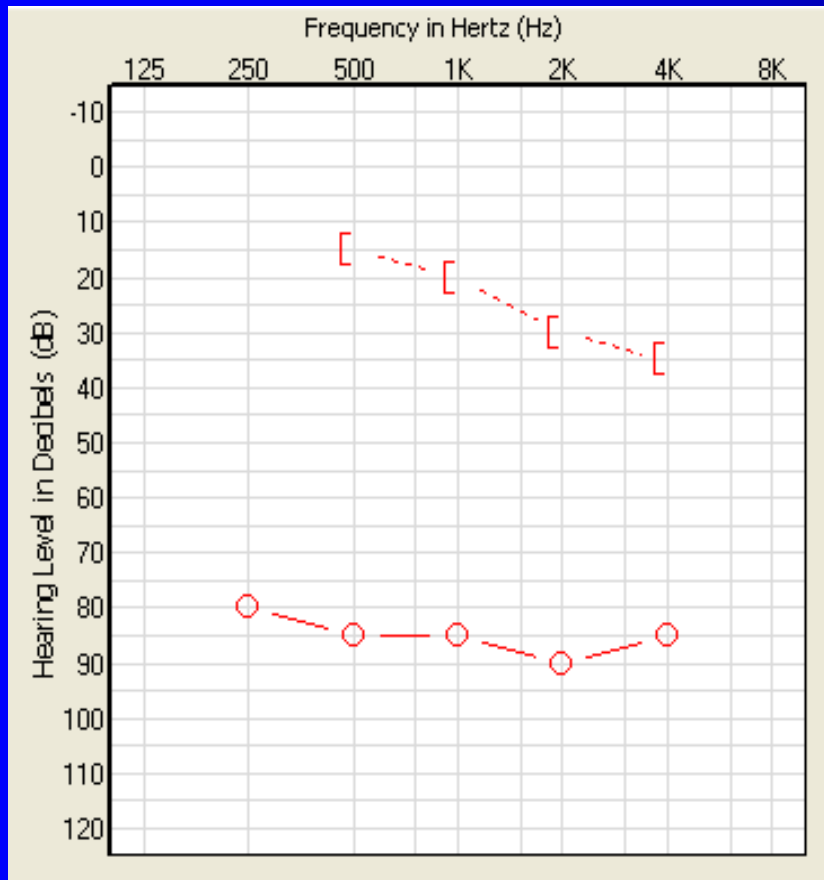
- Since the root cause of this type of hearing loss is at the level of the cochlea or hearing nerve, Hearing aid amplification is the treatment of choice for mild through severe degrees of hearing loss.
- For losses severe and greater, Cochlear Implants or electrical stimulation of the cochlea has been effective.
- With hair cell damage, the amount of amplification or gain applied is dependant on the cochlea and tolerance for loud sounds.

Mixed Hearing Loss

Application of acoustic amplification for mixed losses has to consider both the conductive component (blockage of sound transmission) and the damage to the hair cells in the cochlea

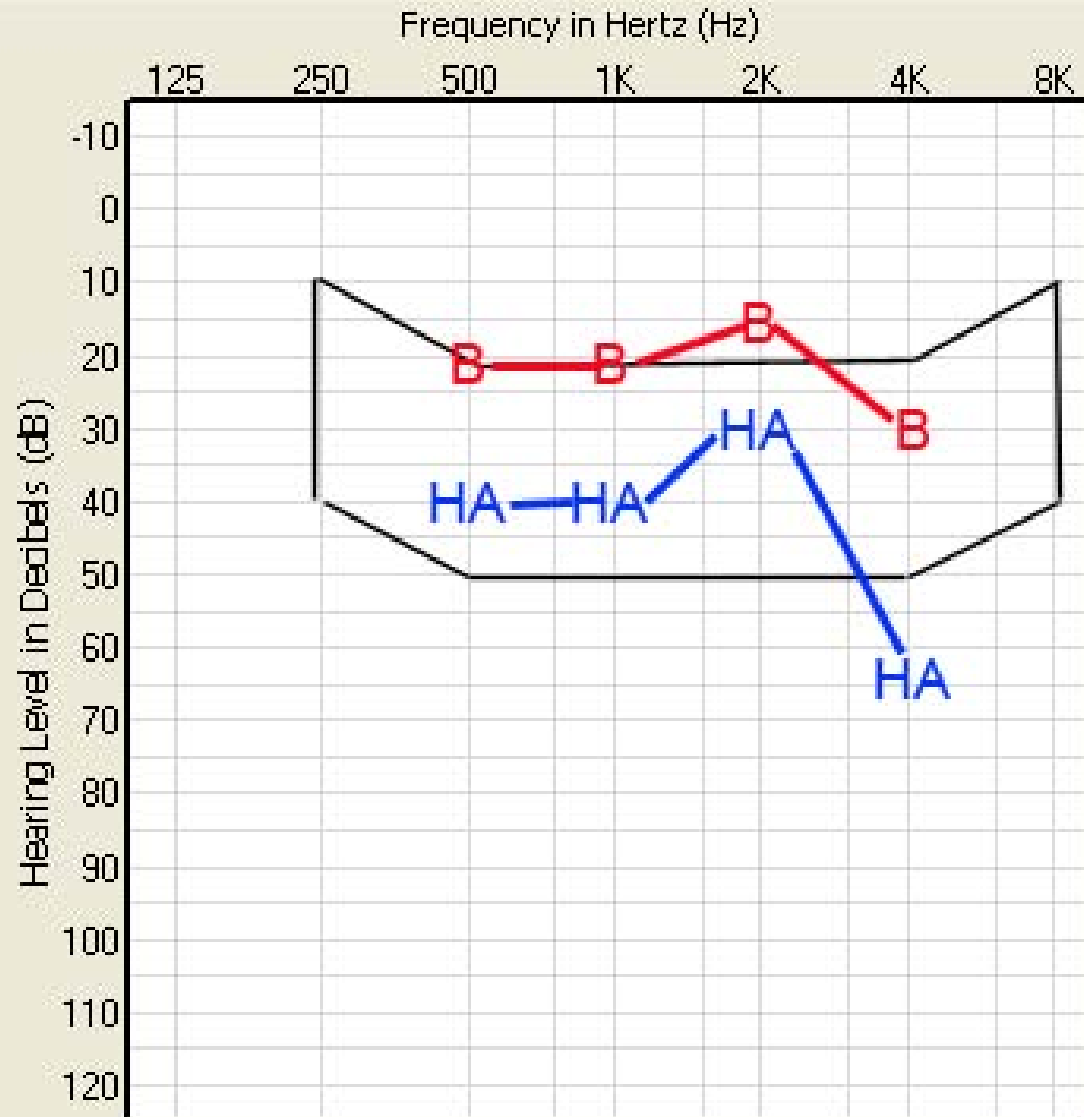
- ✓ Conductive Loss = 100% compensation
- ✓ Sensorineural Loss = 50% compensation
- ✓ Most modern fitting formulas are based on these guidelines

Case: Mixed Loss (child)



- HA (1000Hz)
 - 20dBSNHL
 - + 65dBCHL
 - = 85dBHL
 - = $10+65 = 75\text{dB}$
- Bone Conduction
 - 20dBSNHL

Aided Thresholds



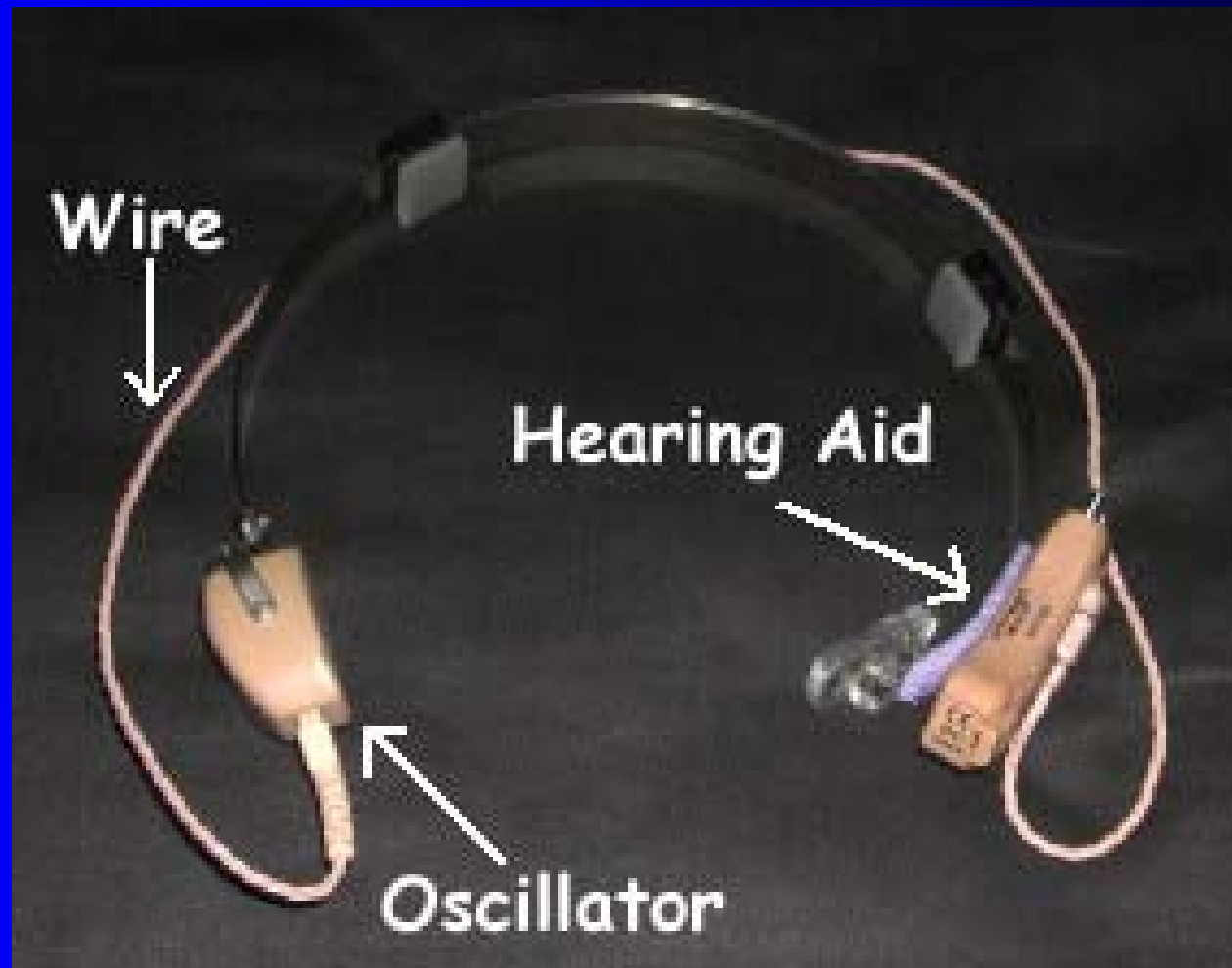
Mixed Hearing Loss

In the previous slide one can see that the Bone Conduction device provided a significant improvement as compared to the Air Conduction hearing aid

In order to allow the Air Conduction device to be effective one must use a high power device and this will require a tight fitting (fully occluding) earmold. This creates other potential problems.

Bone Conduction Hearing Aids

Traditional Bone Conduction Hearing Aid



Traditional Bone Conduction Hearing Aid



Traditional Bone Conduction Hearing Aid

This device is a conventional Air Conduction hearing aid (Power Device) that has been modified to drive a Bone Conduction Oscillator. All of this is mounted to a spring steel band and is worn on the head. The spring steel band produces sufficient force to allow the vibration from the oscillator to drive the skull.

Net Result: A VERY tight fit, often resulting in discomfort.

Traditional Bone Conduction Hearing Aid

Due to the configuration of traditional Bone Conduction devices, long term compliance with wearing has been a problem.

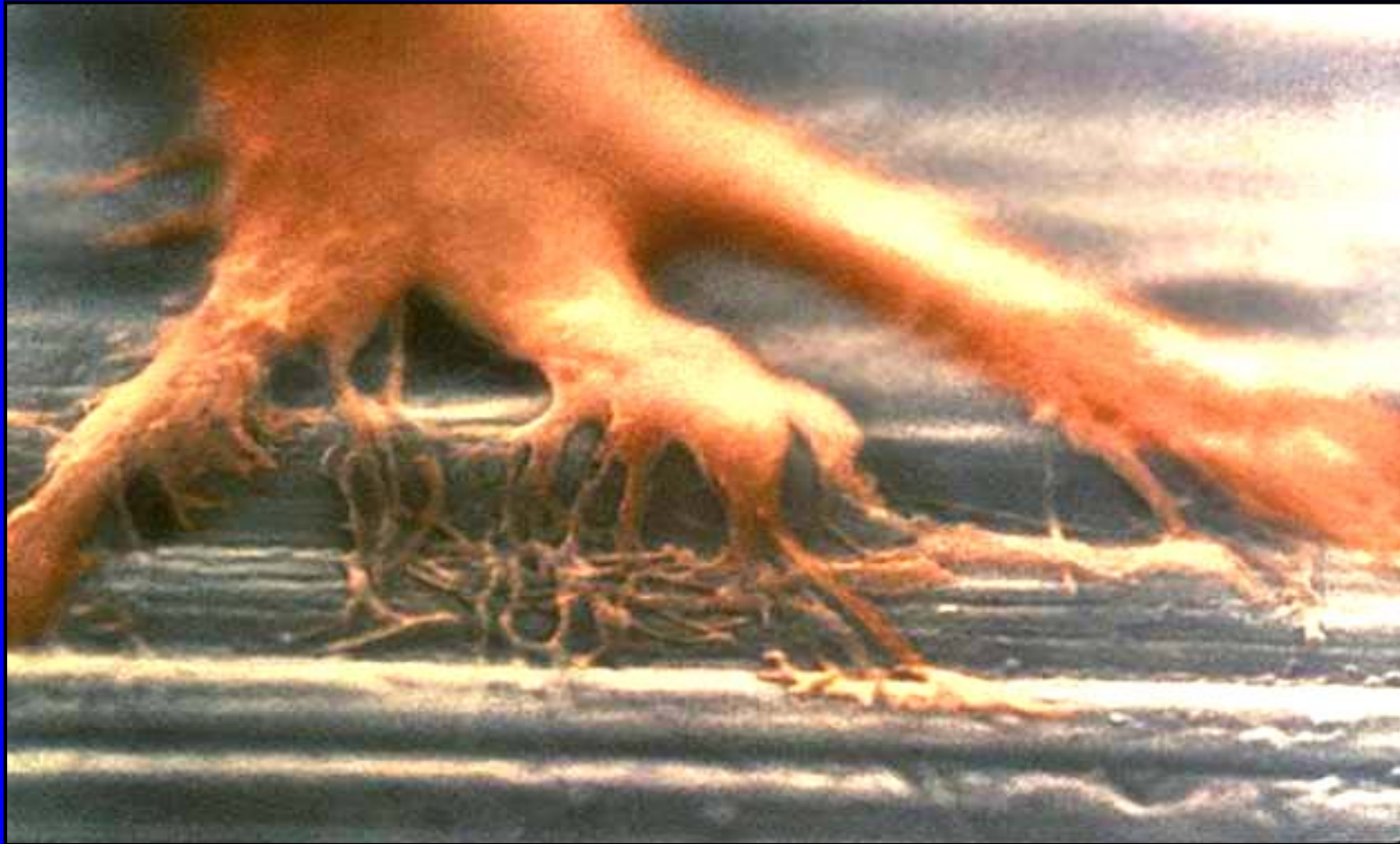
There is also a loss of vibratory energy because of the soft tissue between the oscillator and the actual skull.

Bone Anchored Hearing System

Due to the work of Branemark and Tjellstrom, the Baha was developed, ushering in the era of Direct Bone Conduction in 1977.

System uses the principle of Osseointegration, whereby a Titanium fixture is surgically implanted in the skull with a skin penetrating abutment that holds a sound processor that attaches externally to the skull.

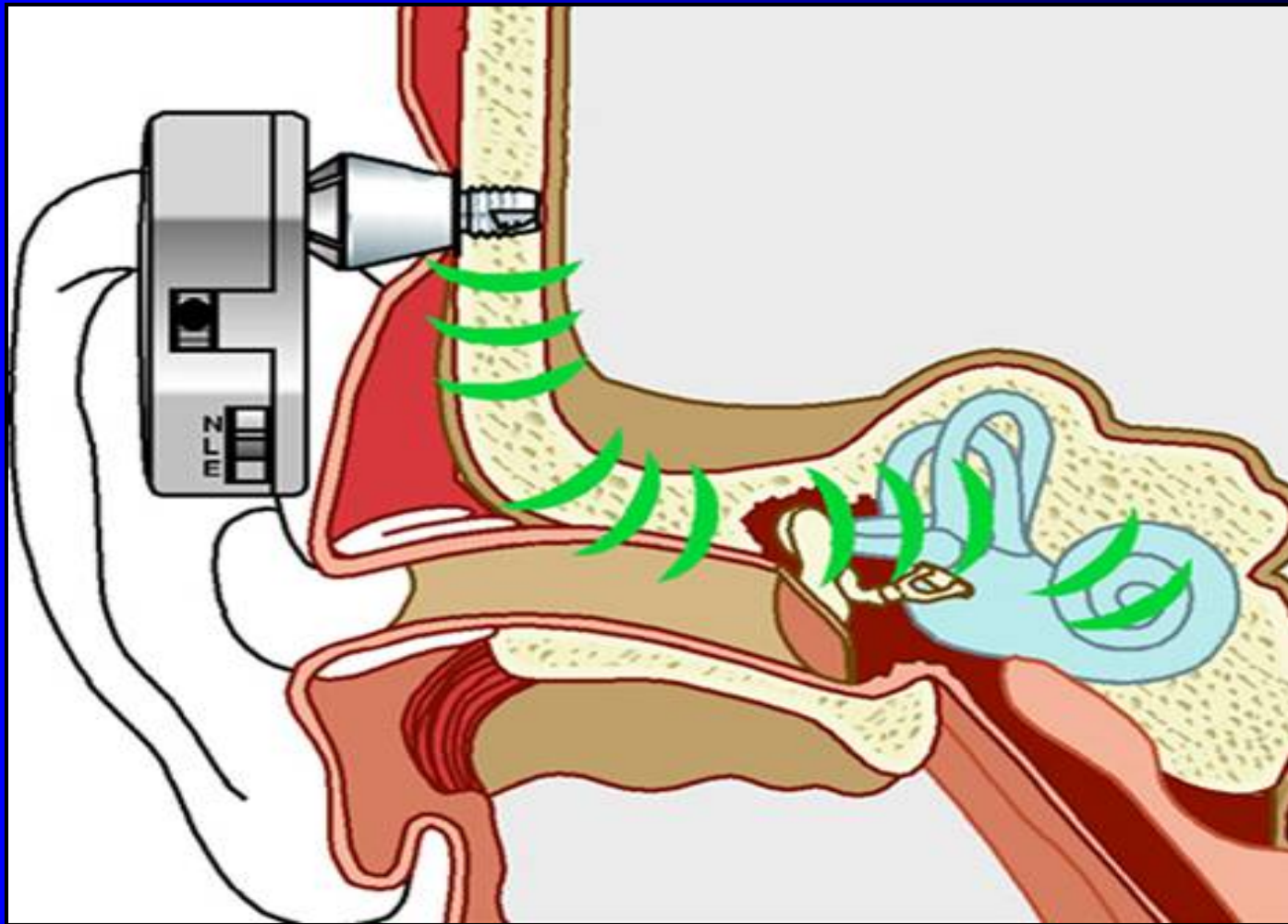
Bone Anchored Hearing System



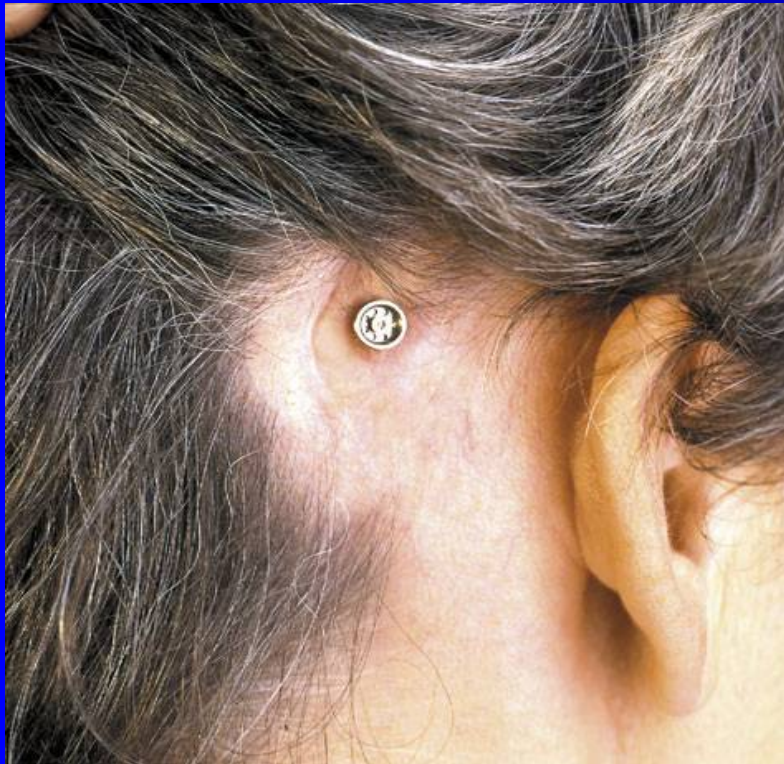
Bone Anchored Hearing System



Bone Anchored Hearing System



Bone Anchored Hearing System



Baha System

FDA Indication Criteria

- ≥ 5 years of age
- ≤ 45 dB HL BC pure tone average (PTA) (.5, 1, 2 and 3K Hz) \geq to 60% speech discrimination scores (using standardized tests)
- For bilateral fitting - Symmetric bone conduction thresholds defined as less than 10 dB difference in the PTA (.5, 1, 2, and 4K) or less than 15 dB at individual frequencies.

Bone Anchored Hearing System

Since the Baha Sound Processor can be mounted on a steel test band or the Soft Band, a potential candidate can be evaluated or may trial the device to determine clinical outcome. This is the only implantable hearing system where this can be done.

For children under 5 years of age, the Soft Band may be used until the child is 5 when implantation of the fixture can be accomplished.

Bone Anchored Hearing System

Evaluation methods



Bone Anchored Hearing System

Softband



Bone Conduction

A natural pathway to hearing

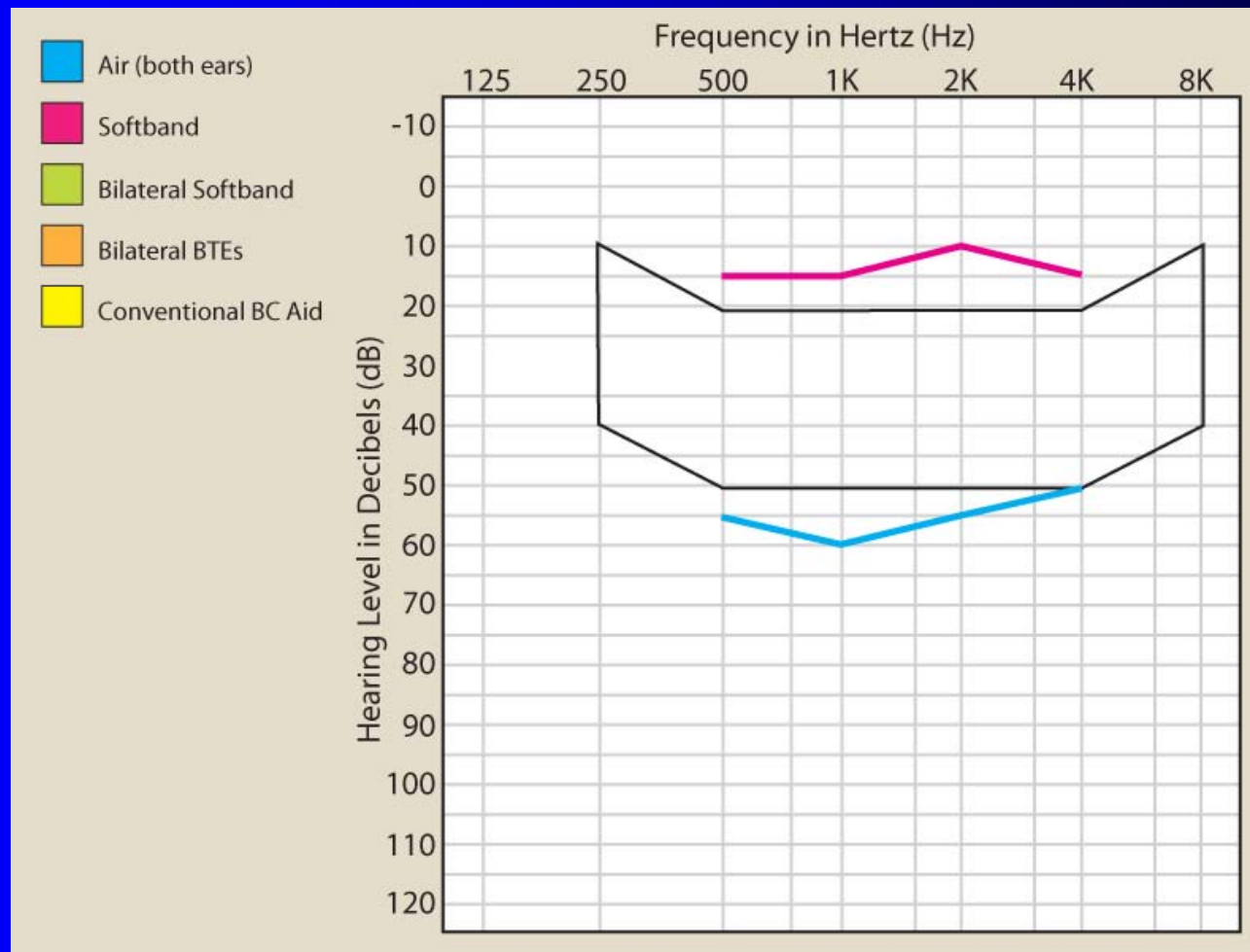
- Bone Conduction is sometimes thought of as a historical footnote
- Application of Bone Conduction amplification can be very useful in patients with cranial-facial anomalies
- Bone Conduction amplification can be very useful in management of Conductive hearing loss
- Direct Bone Conduction via Baha can bypass long term fitting issues.

Case Studies from Arkansas Children's Hospital

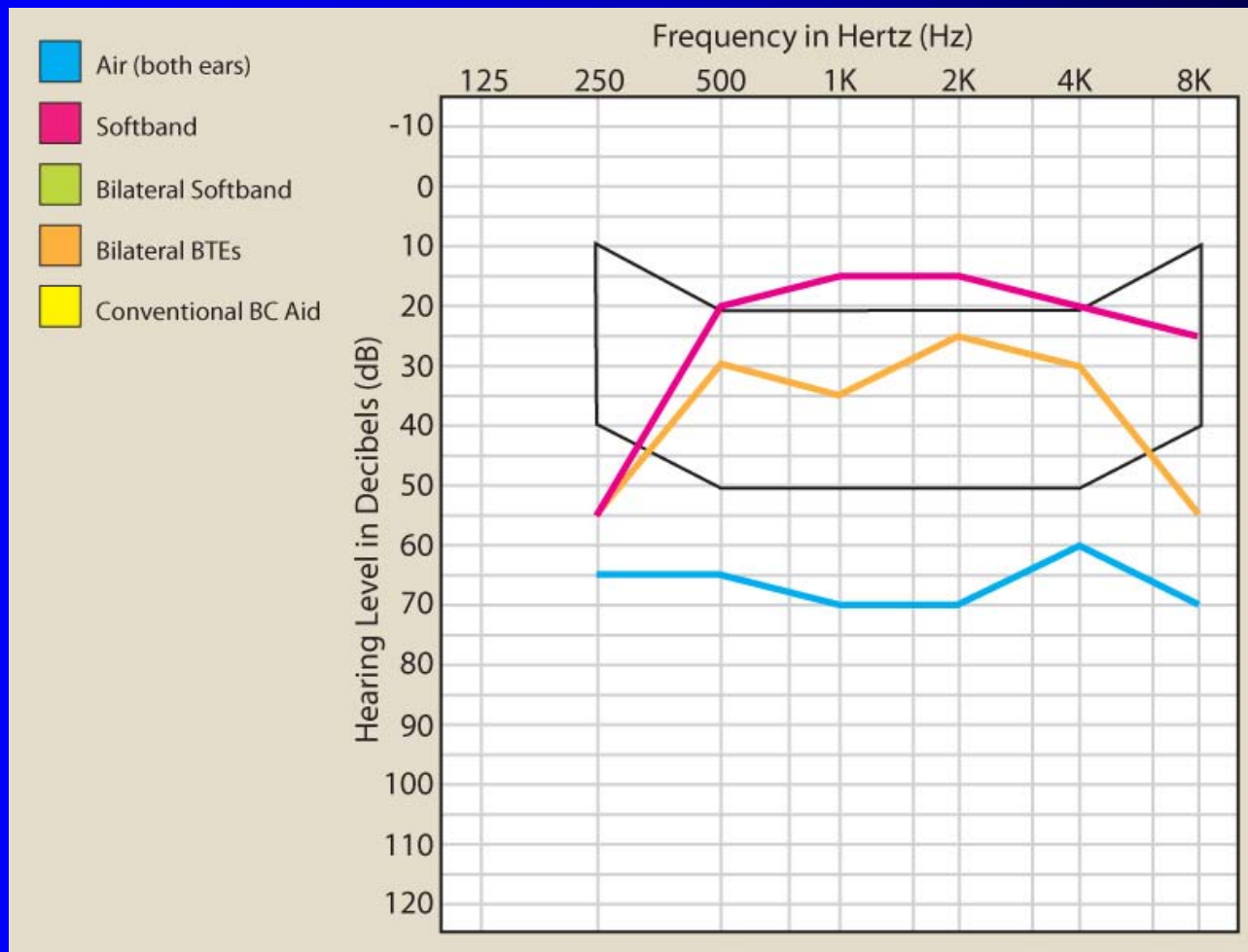
Arkansas Children's Hospital

- Arkansas Children's currently following ~100 children utilizing Baha for "permanent" hearing loss
- 60 have or began with Softband
- Treating children with a range of etiologies (i.e., conductive—unilateral or bilateral, SSD, Treacher Collins, atresia)
- Following case studies represent range of children served

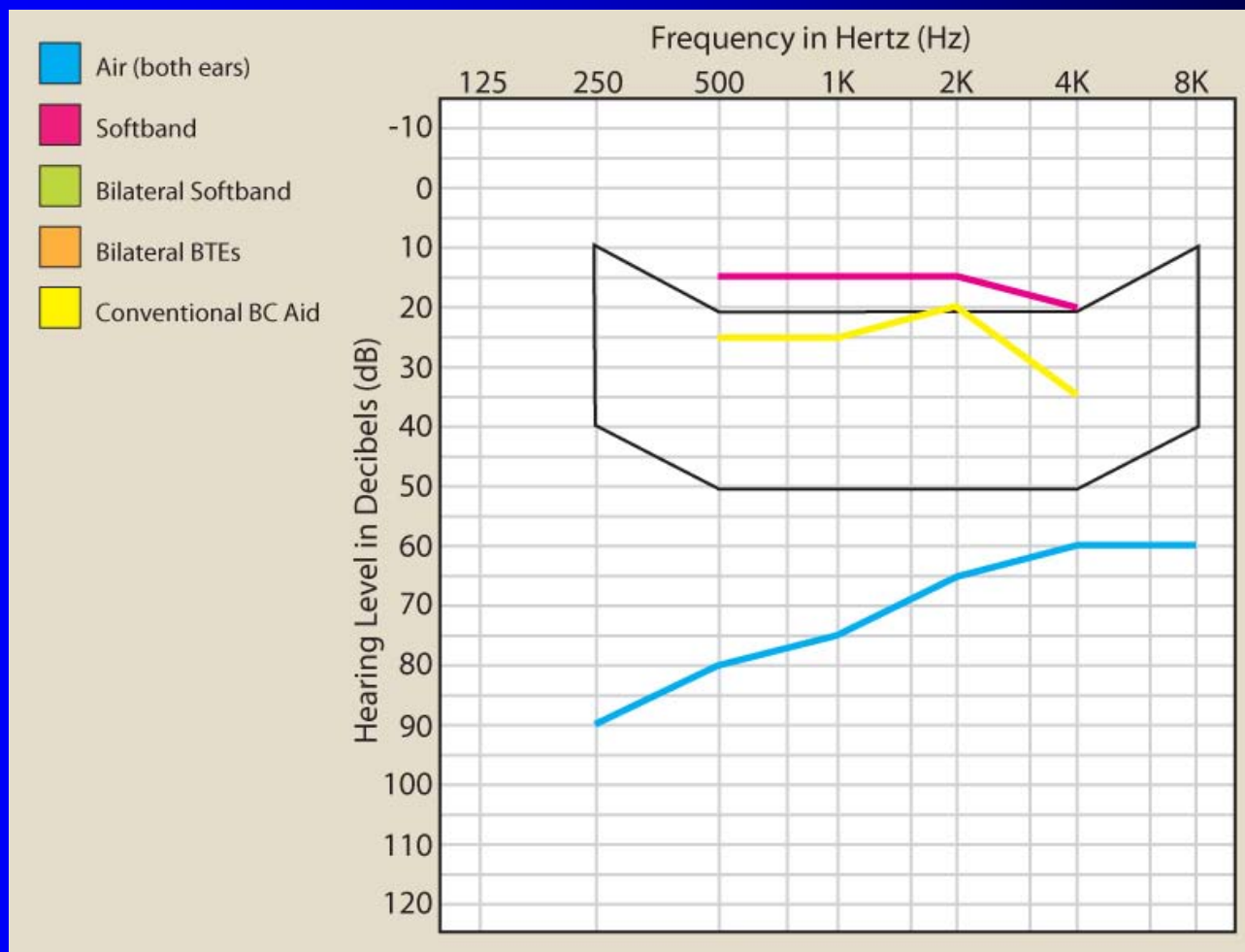
Clayton - DOB April 2004



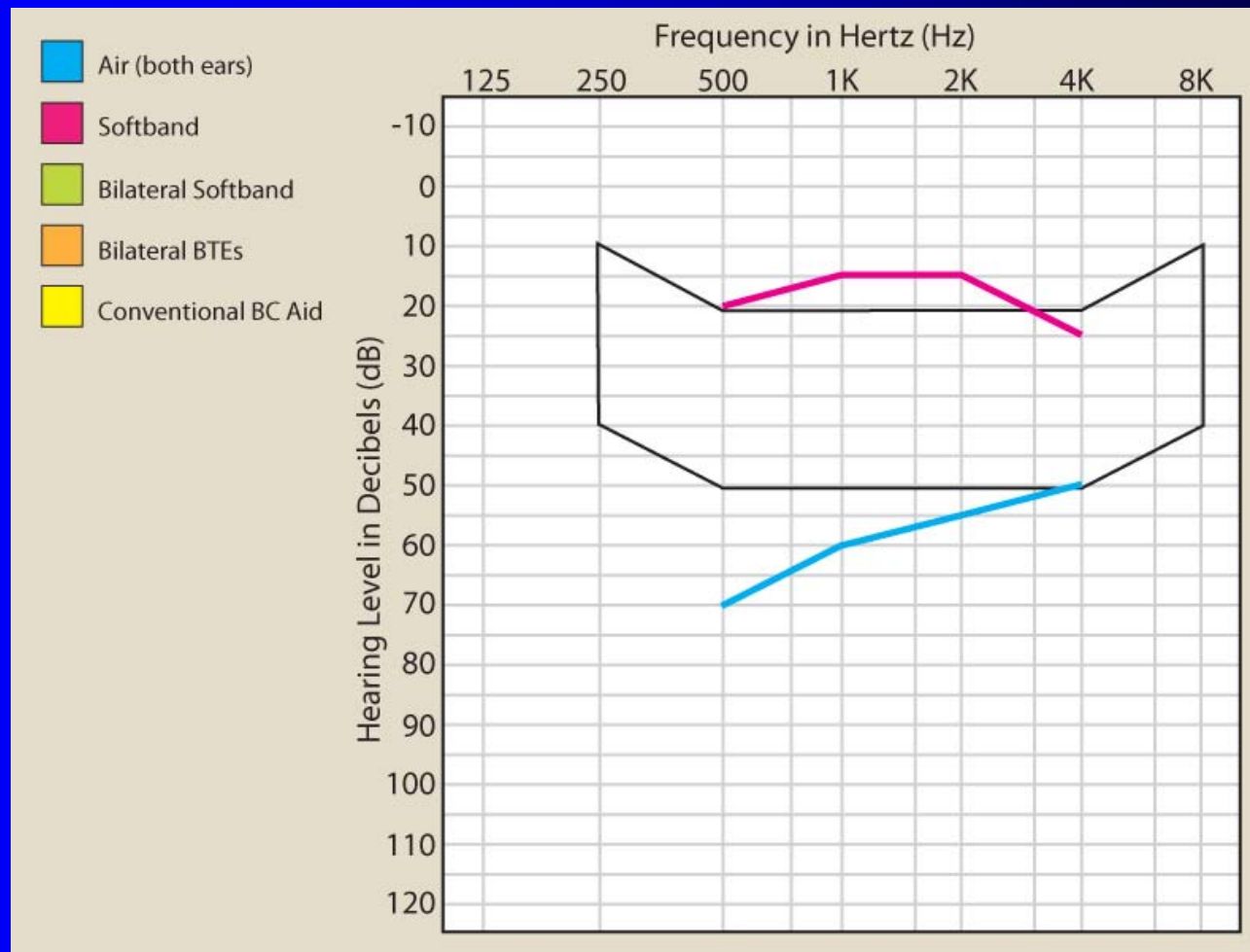
Caitlyn - DOB February 1991



Mary - DOB June 1996

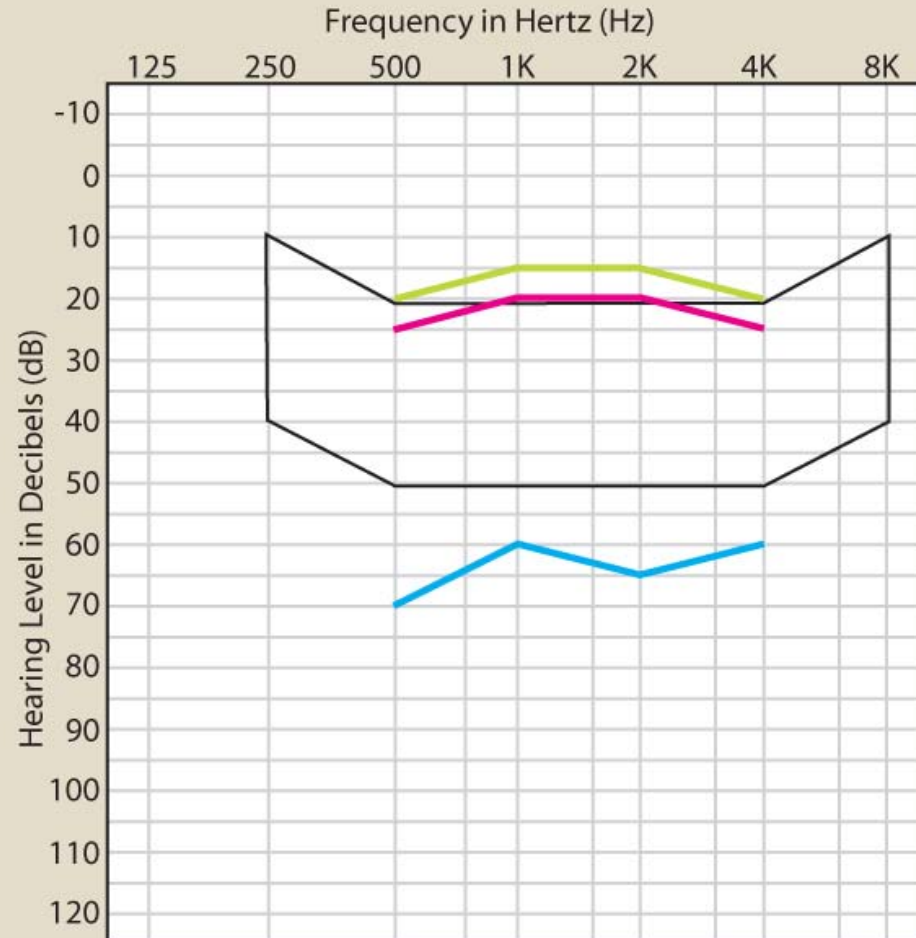


Beth - DOB March 2006



Erin - DOB December 2004

- Air (both ears)
- Softband
- Bilateral Softband
- Bilateral BTEs
- Conventional BC Aid



Unilateral Hearing Loss

- Defined as permanent loss of any degree in one ear
- Often not identified, or if identified, no intervention is pursued as impact not thought to be significant
- Children with unilateral HL → 10 times more likely to fail a grade than normally hearing peers*
- Also at greater risk for social-emotional difficulties**

*Bess & Tharpe, 1984; Oyler et al, 1988.

**Bess & Tharpe, 1998, Bovo et al, 1988.

Incidence of Unilateral HL in Children

- Newborns: 1 in 1,000 or 0.1% (Prieve et al, 2000)
- School age: 3% (Bess & Tharpe, 1998)
- Likely much of above “increase” was unidentified HL through EHDI (Oyler & McKay, 2008)

Early Intervention Support

- Children who benefit from bone conduction advance with spoken language approaches
- Require many of same supports/ services as children with sensorineural HL
 - Auditory therapy and parent training to promote spoken language development
 - Evaluate for speech therapy
 - Consider FM
 - Ongoing assessment of child's progress
- ***Do not minimize impact of moderate-severe and/or unilateral HL***

Hands on with Bone Conduction Hearing