# Importance of Early Intervention in Cases of Unilateral Hearing Loss

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# Objectives


- Define different types of unilateral hearing loss in children
- Identify possible adverse effects of unilateral hearing loss in children
- Compare early intervention and management options for unilateral hearing loss

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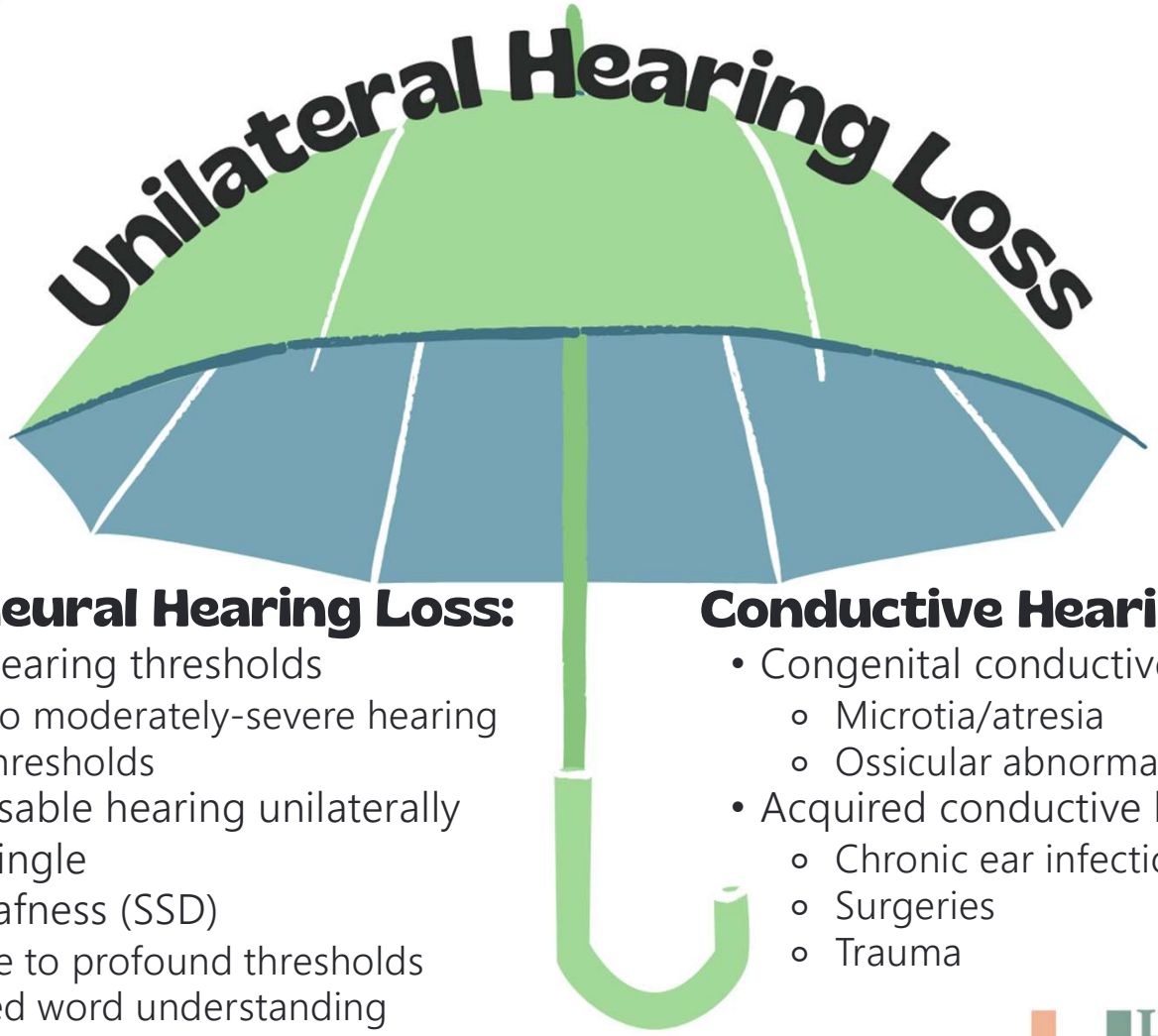
# Unilateral Hearing Loss



## Sensorineural Hearing Loss:

- Aidable hearing thresholds
  - Mild to moderately-severe hearing loss thresholds
- Limited usable hearing unilaterally (LUHU)/Single Sided Deafness (SSD)
  - Severe to profound thresholds
  - Limited word understanding

## Conductive Hearing Loss:

- Congenital conductive hearing loss
  - Microtia/atresia
  - Ossicular abnormalities
- Acquired conductive hearing loss
  - Chronic ear infections
  - Surgeries
  - Trauma

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# Incidence of Unilateral Hearing Loss

- Hearing loss occurs in 1-3 per 1000 births
  - 30-40% of all cases of hearing loss are unilateral hearing loss cases
  - 3-8.3% of the general population

Microtia/atresia occurs in 1.55 per 1000 births

20% of congenital SSD cases have cochlear nerve aplasia or severe hypoplasia

50% of children with UHL showed progression in one or both ears over time

Lazzerini et al. (2023), (Fitzptrick et al., 2018)

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# Challenges with Unilateral Hearing Loss

- Spatial hearing/localization
- Speech in noise
- Listening from a distance

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# Effects of Unilateral Hearing Loss

- **Speech and language delays**
  - Lower language scores compared to normal hearing siblings
  - 2.5 times more likely to receive speech and language therapy
  - 4-9 times more likely to be delayed in auditory and pre-verbal vocalization

(Lieu et al. 2010), (Lieu et al. 2012), (Lieu 2004),
(Borton et al. 2010)
(Kishon-Rabin et al. 2015)

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# Effects of Unilateral Hearing Loss

- **Speech and language delays**
- **Cognitive delays**
  - Lower IQ scores (6.4 point difference on average)

(Lieu et al. 2010), (Lieu et al. 2012), (Lieu 2004),
(Borton et al. 2010)
(Kishon-Rabin et al. 2015)

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# Effects of Unilateral Hearing Loss

- **Speech and language delays**
- **Cognitive delays**
- **Worse academic performance**
  - 22% to 35% rate of repeating at least one grade
  - 12% to 41% receiving additional educational assistance
  - More likely to require an Individualized Education Plan (IEP)
  - Listening fatigue

(Lieu et al. 2010), (Lieu et al. 2012), (Lieu 2004),
(Borton et al. 2010)
(Kishon-Rabin et al. 2015)

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# Effects of Unilateral Hearing Loss

- **Speech and language delays**
- **Cognitive delays**
- **Worse academic performance**
- **Psychosocial impacts**
  - Lower quality of life scores

(Lieu et al. 2010), (Lieu et al. 2012), (Lieu 2004),
(Borton et al. 2010)
(Kishon-Rabin et al. 2015)

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# Neuroplasticity

- Cross-modal reorganization
  - A sensory modality (for example: vision or hearing) may recruit another sensory system as compensation for deficits in the deprived/inactive modality
  - May explain why children with unilateral hearing loss have limited benefit from devices if implemented past the critical time frame

- Cross-modal reorganization can occur even with mild hearing losses

- Children with SSD have exhibited evidence of decreased activation of attention networks, as well as other abnormalities in brain activity associated with executive function, cognition, and language comprehension

(Sharma et al., 2016)

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# Neuroplasticity- Cross-Modal Reorganization

- **Case Study completed by Sharma et al 2016:**
  - 9-year-old girl
  - Progressive SSD (severe to profound hearing loss in the right ear)
    - Idiopathic hearing loss beginning at age 5
  - Underwent a trial with a CROS and FM system
  - Denied approval for a bone conduction device by insurance
  - Testing completed pre- and post- cochlear implantation completed at age 9

(Sharma et al., 2016)

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# Neuroplasticity- Cross-Modal Reorganization

- **Pre CI implantation:**
  - Findings indicated age-appropriate development of the central auditory pathway in the normal hearing ear
  - Delayed responses in the affected ear suggesting immature development of the pathway
  - Found to have overall increased listening effort and cognitive load
  - Evidence of cross-modal reorganization
    - Visual area of the brain was found to be more active
    - Somatosensory area of the brain was found to be more active

(Sharma et al., 2016)

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# Neuroplasticity- Cross-Modal Reorganization

- **Post CI implantation results indicated:**
  - Less reliant on the visual part of the brain than pre-implant
  - Complete reversal of the recruitment of the somatosensory part of the brain
  - More typical development of binaural auditory pathways post implantation
  - Decrease in overall listening effort

  - Behavioral testing:
    - Speech perception scores improved significantly
    - Sound localization improved to just outside the normal range for typically hearing adults

(Sharma et al., 2016)

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# Children's Hearing Program

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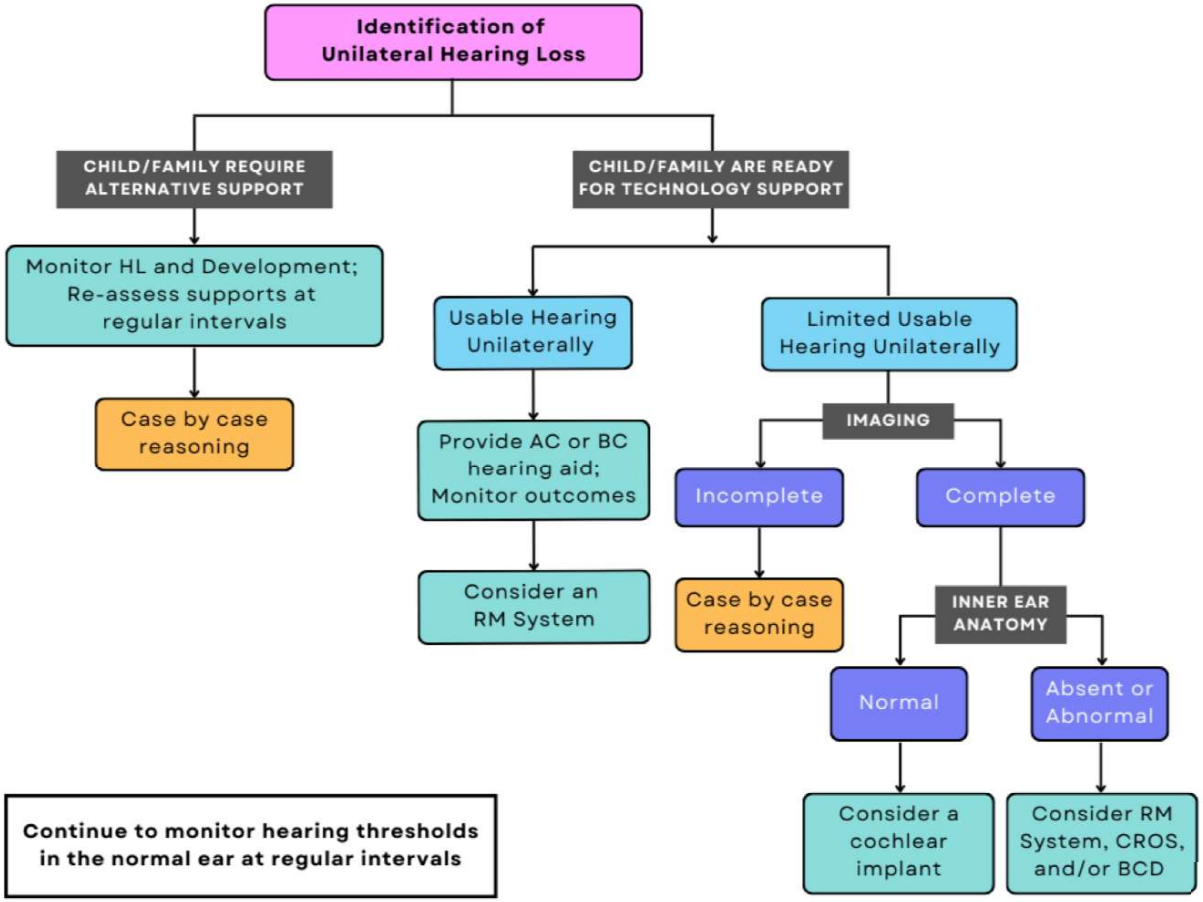
PSYCHOLOGISTS

SOCIAL WORK

AUDITORY VERBAL THERAPISTS

DEAF EDUCATION

# Current Guidelines:




2023 Protocol for the Provisional Amplification
Ontario Infant Hearing Program

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# Air Conduction Hearing Aids

- Hearing aids are an option when hearing thresholds are within an aidable range and a child has word understanding ability

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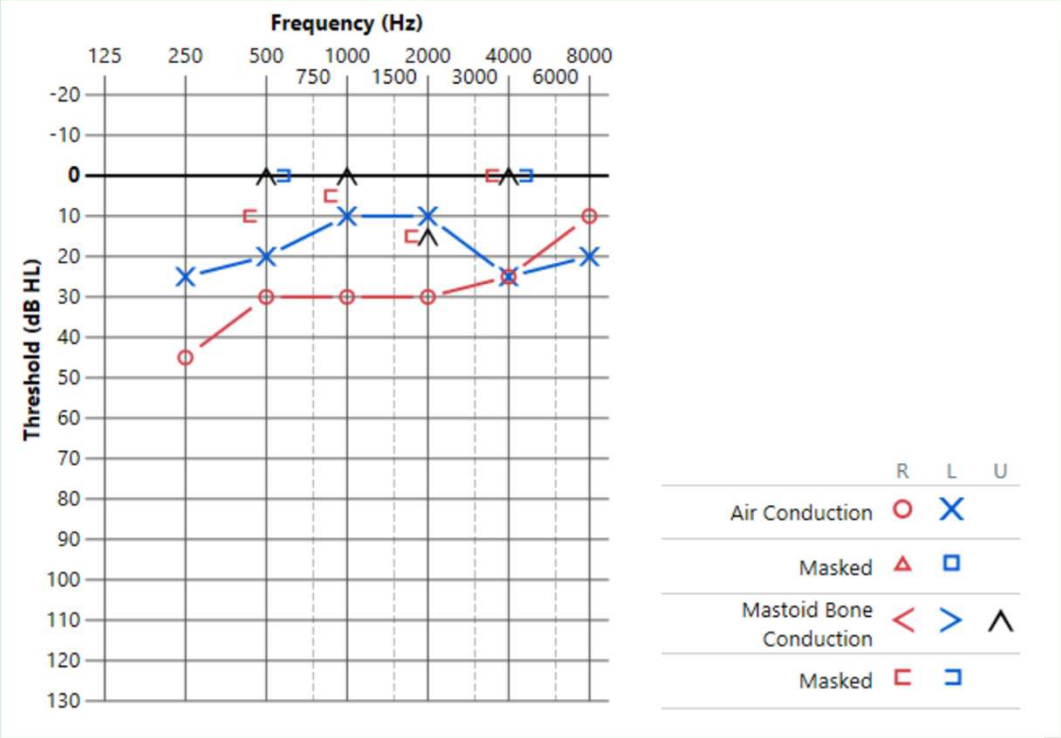
# AC Hearing Aids- Case Study

- 6-year-old girl, wears right hearing aid
- Hearing loss secondary to tympanic membrane perforation




Mild to moderate conductive hearing loss rising to normal peripheral hearing sensitivity in the right ear

<u>Functional testing scores:</u>
Speech in noise testing (BKB-SIN)


**No hearing aid:** Moderate SNR loss (6.5 dB)

**Hearing aid:** Responses within the normal range (-1 dB SNR)

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# Bone Conduction Device (BCD)

- An option if a child has a conductive or mixed hearing loss
- A re-routing option for children with SSD

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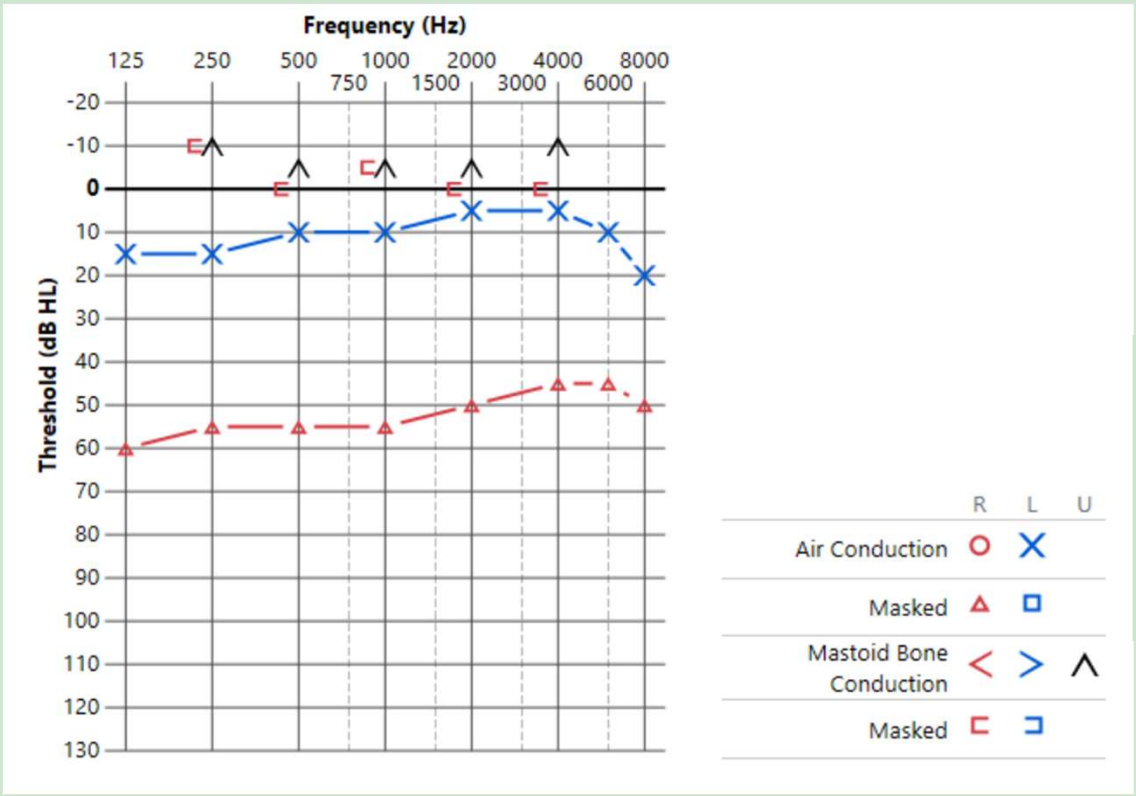
# Bone Conduction Device- Case Study

- 6-year-old boy with right sided microtia/atresia
- Wears a BAHA 6 Max on a softband




Moderate to moderately-severe conductive hearing loss in the right ear

<u>Functional testing scores:</u>

Speech in noise testing (Spanish HINT)

**No BCD:** 4% words correct

**With BCD:** 73% words correct

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# Contralateral Routing of Signals (CROS)

- Does not stimulate ear with hearing loss
- Takes information from hearing loss side and sends it to the hearing ear


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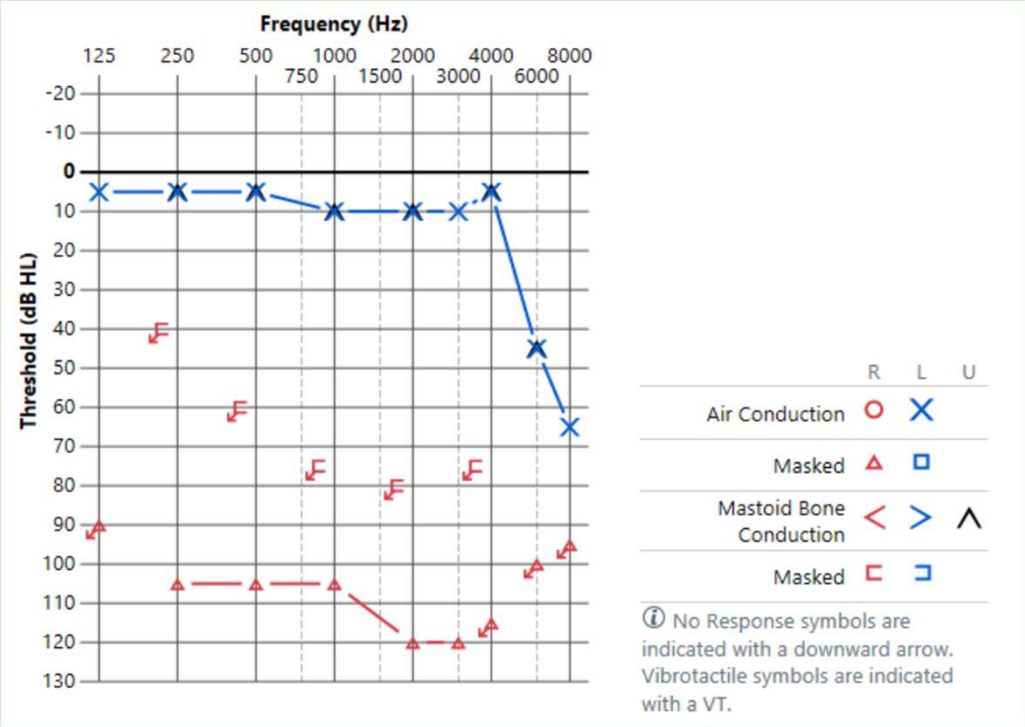
# CROS- Case Study

- 12 year-old-girl
- Hearing loss secondary to bacterial meningitis




Profound sensorineural hearing loss in the right ear
Progressive sensorineural hearing loss in the left ear

<u>Functional testing scores:</u>
Speech in noise testing (BKB-SIN)

**No CROS:** Responses within the normal range (2.4 dB SNR)

**With CROS:** Also within the normal range (1.9 dB SNR) however improvement is noted

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# Cochlear Implant (CI)

- Direct stimulation of ear with hearing loss
  - severe to profound hearing loss
  - poor word understanding

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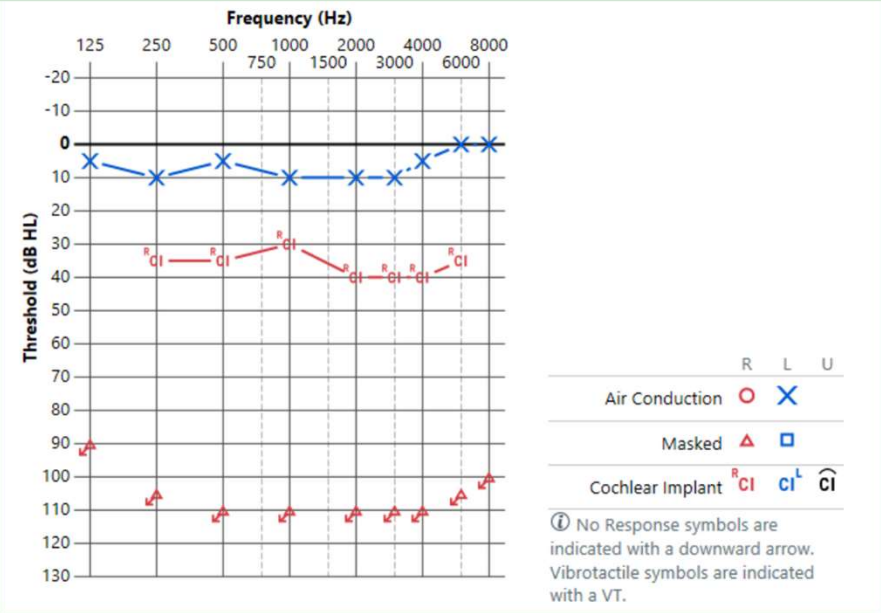
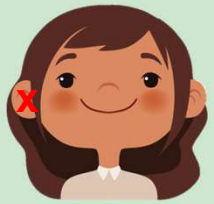
# Cochlear Implant- Case Study

- 10-year-old girl
- Congenital SSD




Profound sensorineural hearing loss in the right ear

<u>Functional testing scores:</u>
Speech in noise testing (BKB-SIN)



**No Cochlear implant:** Mild SNR Loss (4.2 dB SNR)

**With Cochlear Implant:** Responses within the normal range (2 dB SNR)

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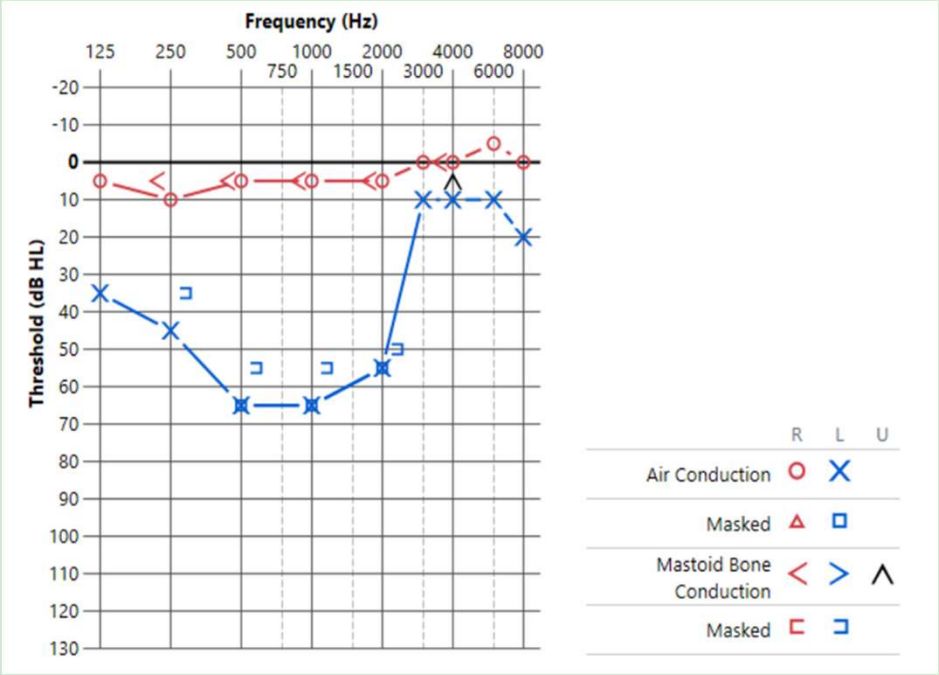
# Devices don't always improve outcomes

- 9-year-old girl
- Inner ear anomalies
- Long time hearing aid user




Left sensorineural hearing loss

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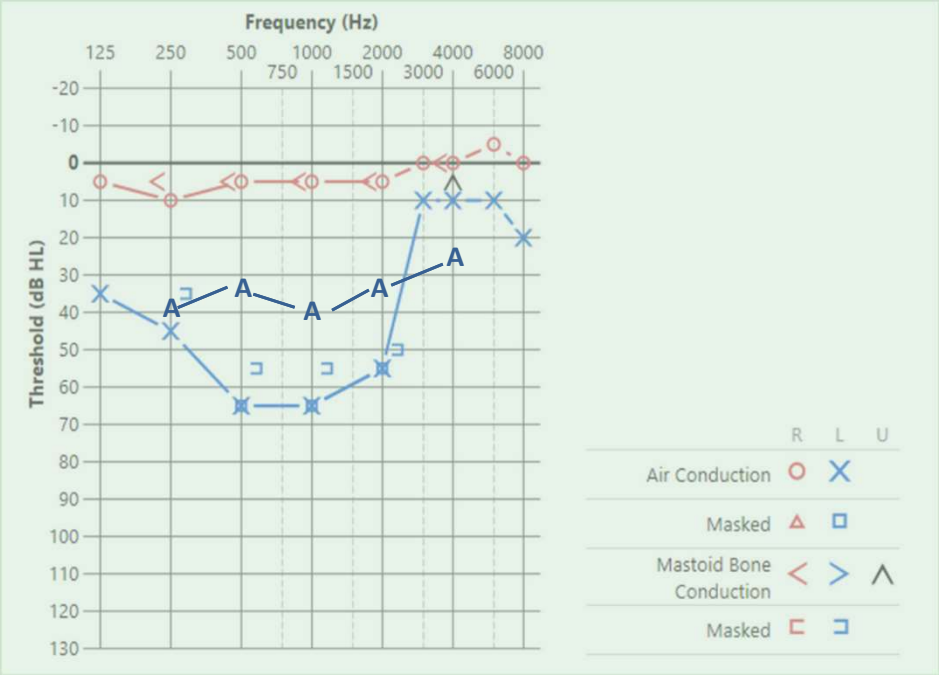
# Devices don't always improve outcomes

- 9-year-old girl
- Abnormal vestibular anatomy
- Long time hearing aid user




Left sensorineural hearing loss

<u>Functional testing scores:</u>
Speech in noise testing (BKB-SIN)


**No hearing aid:** Responses within the normal range (-0.8 dB SNR loss)

**With hearing aid:** Also within the normal range (0.2 dB), however it is noted to be worse

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# No Devices

Devices do not work for every individual, especially if implemented later on in life.

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# Classroom Accommodations

- Hearing assistive technology (HAT)
  - Ear-level
  - Soundfield

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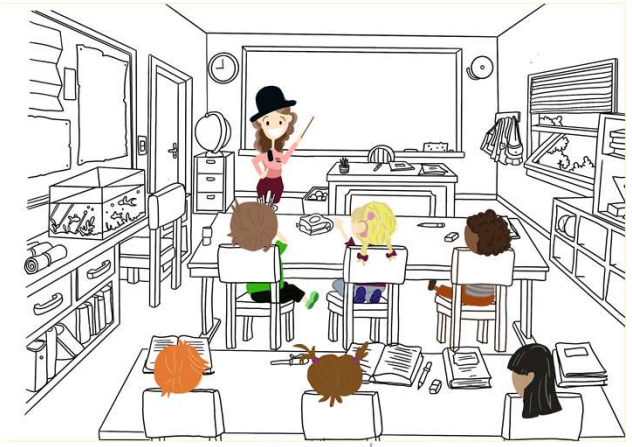
# Hearing Assistive Technology

- No amplification
- Teacher wears a microphone
- Student wears an ear level transmitter or there is a soundfield speaker so that the teacher's voice is audible in their normal hearing ear
- Improves speech in noise and listening at a distance



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# Classroom Accommodations

- Hearing assistive technology (HAT)
  - Ear-level
  - Soundfield
- Preferential and Strategic seating
  - Better hearing ear away from background noise and towards teacher
  - Close to the front
- Repetition
- Visual cues
- Note taker

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# Monitoring

If a family elects to not move forward with a device for a UHL, monitoring is IMPERATIVE.

- Audiometric thresholds
- Socioemotional outcomes
- Speech and language milestones
- Academic performance

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# Conclusion

Unilateral hearing loss- One size does not fit all!

Early diagnosis, intervention, and monitoring, improve outcomes

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# References


Bagatto, M., Scollie, S., Moodie, S., Seewald, R., Hyde, M., El-Naji, R., Brown, C., Beh, K., Glista, D., Hawkins, M., Viji Easwar, Tharpe, A. M., Crukley, J., Levy, C., Zimmo, S., Moodie, S., Richert, F., & Parsa, V. (2023). IHP_Amplification Protocol_2023.01_FINAL_August15

Bell, R., Mouzourakis, M., & Wise, S. R. (2022). Impact of unilateral hearing loss in early development. Ovid Technologies (Wolters Kluwer Health). 10.1097/moo.0000000000000848

Borton, S. A., Mauze, E., & Lieu, J. E. C. (2012). Quality of life in children with unilateral hearing loss: A pilot study. American Speech Language Hearing Association. 10.1044/1059-0889(2010/07-0043)

Cho Lieu, J. E.Speech-language and educational consequences of unilateral hearing loss in children

Fitzpatrick, E. M., Gaboury, I., Durieux-Smith, A., Coyle, D., Whittingham, J., & Nassrallah, F. (2018). Auditory and language outcomes in children with unilateral hearing loss. Elsevier BV. 10.1016/j.heares.2018.03.015

Kishon-rabin, L., Kuint, J., Hildesheimer, M., & Ari-even Roth, D. (2015). Delay in auditory behaviour and preverbal vocalization in infants with unilateral hearing loss. Wiley. 10.1111/dmcn.12812

Lazzerini, F., Bruschini, L., Fiacchini, G., Canzi, P., Berrettini, S., & Forli, F. (2023). The role of bone-anchored hearing devices and remote microphones in children with congenital unilateral hearing loss. MDPI AG. 10.3390/brainsci13101379

Lieu, J. E. C., Tye-Murray, N., Karzon, R. K., & Piccirillo, J. F. (2012a). Unilateral hearing loss is associated with worse speech-language scores in children. American Academy of Pediatrics (AAP). 10.1542/peds.2009-2448

Lieu, J. E. C., Tye-Murray, N., Karzon, R. K., & Piccirillo, J. F. (2012b). Unilateral hearing loss is associated with worse speech-language scores in children. American Academy of Pediatrics (AAP). 10.1542/peds.2009-2448

Sabbagh, S., Amiri, M., Khorramizadeh, M., Iranpourmobarake, Z., & Nickbakht, M. (2021). Neonatal Hearing Screening: Prevalence of Unilateral and Bilateral Hearing Loss and Associated Risk Factors. Cureus, 13(6), e15947. https://doi.org/10.7759/cureus.15947

Sharma, A., Glick, H., Campbell, J., Torres, J. D., Dorman, M., & Zeitler, D. M. (2016). Cortical plasticity and reorganization in pediatric single-sided deafness pre- and postcochlear implantation. Ovid Technologies (Wolters Kluwer Health). 10.1097/mao.0000000000000904

van Wieringen, A., Boudewyns, A., Sangen, A., Wouters, J., & Desloovere, C. (2019). Unilateral congenital hearing loss in children: Challenges and potentials. Hearing Research, 372, 29-41. 10.1016/j.heares.2018.01.010


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