Minimal and Unilateral Hearing Loss in Children: Implications for Management

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Normal Hearing

- Between -10 and 15 dB for children (Clarke 1981; Diefendorf & Gravel, 1996)
- Between 0 and 20-25 dB for adults
Minimal Hearing Loss

- PTA between 15 and 25 dB bilaterally
- High-frequency sensorineural loss = ≥ 2 frequencies above 2 kHz in one or both ears
- Loss of any degree in one ear
Binaural Advantages

Head Shadow = 6 – 12 dB

Binaural Summation = 3-10 dB
Binaural Advantages

Localization

![Graph showing interaural level difference vs. frequency with angles of 30° and 90° indicating localization advantages.]
Grade Failure Rate

Bess et al. Oyler and Matkin

Percentage

UHLs District Norms

Bess & Tharpe, 1986
62% of those with academic difficulty had hearing loss of the right ear.
Behavior problems include social withdrawal, inattention, distractibility, & aggression.
UHL and Speech-Language Scores
(Lieu, Tye-Murray, & Piccirillo, 2010)

• Sibling-controlled study of 6-12 y.o. with UHL
• n = 148
• Oral & Written Language Scales (OWLS)

Results:
• Children with UHL had poorer language comprehension, oral expression, and oral composite scores
• No right- or left-ear differences
Impact of Unilateral Conductive HL on Academic Performance
(Kesser, Krook, Gray, 2013)

• Case control survey
• School children with aural atresia
• None repeated a grade but 65% required resource help
• 45% received speech therapy
Psychoeducational Outcomes: Minimal/Mild Bilateral Hearing Loss
SAMPLE SELECTION: Minimal Hearing Loss
(Bess, Dodd-Murphy, & Parker, 1998)

• Grades: 3, 6, 9
• Examined:
  • demographics
  • educational performance
  • functional health status
  • behavior
Failure Rates of Children with MSHL & with NH
(Bess et al., 1998)
Children with Minimal Sensorineural Hearing Loss (MHL) reported less energy than children with Normal Hearing (NH).
Listening Effort

Attental requirements necessary to understand speech
Hypothesis:

Assuming a limited effort capacity, performance on a secondary task will decrease when the primary listening task is made more difficult, regardless of whether primary-task performance is affected.
Dual-Task Paradigm

- **Subjects**
  - 14 children with mild HL matched with NH children for grade level
  - Ages between 6 – 11 years

(Bourland-Hicks & Tharpe, 2002)
Dual-Task Paradigm

- Primary task: speech recognition in noise (PBK)
- Secondary task: button push to random presentations of probe light
Dual Task Paradigm

No difference in baseline RTs between groups
What is the effect of hearing loss on subjective reports of fatigue in school-age children?
What they did...

- 10 children (10-13 yrs) with hearing loss (CHL) and 10 age-matched peers with normal hearing (CNH)
- Subjective ratings of fatigue using the PedsQL Multidimensional Fatigue Scale
- All had normal non-verbal intelligence
What they did...

**Method:**

PedSQL Multidimensional Fatigue Scale:

- General Fatigue (e.g., “I feel tired”)
- Sleep/Rest Fatigue (e.g., “I rest a lot”)
- Cognitive Fatigue (e.g., “It is hard for me to think quickly”)
- Composite Score
What they found...

More Fatigue

PedsQL Score

General  Sleep/Rest  Cognitive  Overall

CHL  CNH

More Fatigue
Why is this important?

The fatigue scores indicated more fatigue experienced by CHL than children with cancer, rheumatoid arthritis, diabetes, and obesity (Varni et. Al, 2002; 2004; 2009; 2010)
Current Status of Hearing Technology Use
Hearing Technology Options for UHL

• Traditional hearing aids
• Contralateral Routing Of Signal (CROS) hearing aids
• Frequency modulated (FM) systems
• Cochlear implants
Traditional Hearing Aids for UHL

• Unaidable hearing
  – Profound SNHL
  – Very poor word recognition
  – Marked intolerance for amplified sounds

(Valente et al., 2002)
Traditional Hearing Aids for UHL

- Binaural interference - decrease in bilateral performance when an individual is receiving asymmetric auditory input (Jerger et al, 1993)
- Evidence of BI for adults, but not children, when listening to asymmetrically-degraded speech (Rothpletz et al, 2004)
- No binaural advantage when listening to asymmetrically-degraded speech (Rothpletz et al, 2004)
CROS HAs for UHL

• CROS HAs are considered for those ineligible for other technology
• CROS HAs are not recommended for consideration until child is able to control his/her communication environment (AAA, 2003; Kenworthy et al., 1990)
• Useful for children who do not have access to FM or need assistance outside of school
Transcranial CROS Aids

• Quasi-transcranial – high level AC signal creates vibration of skull to stimulate opposite ear

• True transcranial – BC signal is transmitted from poor ear to opposite normal cochlea (e.g., BAHA)

• BAHA can be considered at age 5 years and above; however, data from the pediatric population are lacking (AAA, 2003)
Cochlear Implantation for SSD

• Most work has been done on adults as tinnitus-reduction treatment

• Recent systematic review of literature (17 studies, Vlastarakos et al., 2013)
  – Post-lingually deafened adults and children only
  – Tinnitus improvement
  – Wider use of implantation in SSD

• Better outcomes with shorter length of deafness
When to fit a UHL or MBHL?

Babies are usually at a close distance to the caregiver allowing for an optimal signal-to-noise ratio.
After 12 months, they venture off...
Hearing Technology Guide for MBHL

Bagatto & Tharpe
Case-by-case Reasoning

Configuration & Degree of Loss
- High Frequency, Flat

Ear Canal & Earmold Acoustics
- Venting, RECD

Hearing aid gain/output & noise floor

Family Factors

Readiness, Motivation

Child Factors

Developmental status, Ambulatory status, Environment, Outcomes
Traditional HAs for Infants & Young Children with MBHL

- Consider acoustic modifications, shorter speaker-listener distance, and increased voice volume
- Will have large RECDs leaving only a few dB recommended gain across frequencies
- Counsel regarding need for amplification as RECD decreases
- Consider noise floor of HAs – typically not heard by those with greater degrees of HL
Importance of RECD
Influence of External Ear Canal

The sound pressure level (SPL) at the eardrum will vary across individuals for the same HL level.
Variability in RECDs in Infants (2-6 mos)

(Bagatto, Seewald, Scollie, & Tharpe 2006)
High Frequency Hearing Loss: Hearing Aid Guide

Ventable

Yes → Ambulatory

- Yes → Recommend Hearing Aids
- No

No

Ambulatory

- Yes
- No

Consider:
- Acoustic Environment
- Electroacoustic Characteristics
- Ear Canal Acoustics
- Child & Family Factors

Bagatto & Tharpe, 2014)
Flat Hearing Loss: Hearing Aid Guide

- Ambulatory
  - Yes
    - Venable
      - Yes
        - Recommend Hearing Aids
      - No
        - Consider: Acoustic Environment
  - No
    - Venable
      - Yes
        - Consider: Electroacoustic Characteristics
      - No
        - Consider: Ear Canal Acoustics
        - Consider: Child & Family Factors
Minimal/Mild Bilateral Hearing Loss:
FM System Guide

- **Group Environment**
  - Yes: Recommend FM System
  - No:
    - Caregiver Readiness
    - Child & Family Factors
    - Acoustic Environment

Recommendation does not change based on Ambulation
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<thead>
<tr>
<th>Tool</th>
<th>Target</th>
<th>Age</th>
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<tr>
<td>Early Language Milestone Scale-II</td>
<td>Receptive &amp; expressive language</td>
<td>B-36 mos</td>
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<td>Early Listening Function</td>
<td>Auditory detection</td>
<td>Infants &amp; toddlers</td>
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<td>Pre-School SIFTER</td>
<td>Classroom listening behavior</td>
<td>3 yrs to K</td>
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<td>SIFTER</td>
<td>Classroom listening behavior</td>
<td>Grade school</td>
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<td>Communication &amp; Symbolic Behavior Scales</td>
<td>Language &amp; symbolic development</td>
<td>Infants &amp; toddlers</td>
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Importance of Monitoring

• As the child’s ear canal grows and changes, the acoustic properties change which impact hearing thresholds (dB HL)
  – Important to consider when monitoring hearing levels and considering intervention strategies

• Children in the first 3 years of life experience otitis media with effusion (OME) which can increase hearing thresholds
  – Include immittance measures in audiological monitoring protocol

• Audiologists should closely monitor the child’s functional auditory abilities as part of routine evaluation
  – Recommend every 6 months
  – Intervention strategies should be adjusted as needed
“... hard-of-hearing children are not easily recognizable and often are mistaken for children with vague, sometimes exotic, always bewildering ‘problems.’ Thus, ...they are invisible children.”

(Julia Davis, 1977)