Examining Recommendations for Hearing Aid Use in Children with Unilateral Hearing Loss

Marlene Bagatto

Unilateral Hearing Loss in Children Conference
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Philadelphia, PA, USA
Background

- Evidence exists demonstrating the benefits of hearing aids for bilateral sensorineural hearing loss
- Protocols are less well-established for other groups of children
  - Auditory neuropathy spectrum disorder
  - Minimal/mild bilateral
  - Unilateral

Outcomes of Children with Hearing Loss
Ear & Hearing, 2015; Bagatto et al, 2016
Early Intervention

- Research suggests that in some cases, children with UHL/MBHL may have poorer outcomes than children with more severe bilateral hearing losses
  - Identified earlier and receive more services

- Consensus is to provide early intervention services
  - Goals to monitor audiometric thresholds and developmental progress
    - At risk of developing bilateral hearing loss

Degree / Type of Unilateral Hearing Loss (ABR)
Considerations for Management of UHL in Children

• Speech perception scores of children aged 7 through 12 years of age with UHL showed no significant aided benefit or detriment in the conditions assessed

• On the other hand, subjective assessment of aided benefit was noted at home and at school by the children as well as their parents

• Improved sound localization abilities if receive hearing aid before age 5 years
  • Aided 9 years or later had impaired localization abilities

• Critical period for optimizing bilateral auditory pathways

Management of UHL in Children

- Cincinnati Children’s Hospital review of evidence
- School-age children with any degree of unilateral SNHL
  - Excludes children with conductive losses
- Provides technology decision support based on degree of hearing loss

![Graph showing hearing threshold levels and frequency](image)
Management of UHL in Children

Degree of Unilateral Sensorineural Hearing Loss

- Severe to Profound
  - FM trial first line intervention
  - Educate about hearing aid use as second line

- Mild to moderately severe
  - HA trial first line intervention
  - And/or FM system (classroom vs coupled with HA)
Management of UHL in Ontario EHDI

• Infants and young children identified with UHL comprise approximately 15% of children seen within the Ontario Infant Hearing Program (IHP)

• IHP Provision of Amplification Protocol (2007) and other guidelines (American Academy of Audiology, 2013) advises providing hearing aids to these children on a case-by-case basis

• Lack of clearer recommendations imposes a challenge for IHP Audiologists and the families of infants and young children with UHL with whom they work
Management of UHL in Ontario EHDI

• Protocol addendum (2014) endorses the Cincinnati statement (2009) to support the management recommendations for infants and children with USNHL

• FM use for children with mild to moderate USNHL

• Monitor hearing aid benefit (more on “aidable” later)

• Consider child/family preferences, development, environment, education, and medical factors when making technology recommendations
Percentage of Ontario IHP Children with Unilateral Hearing Loss Provided with Hearing Aids (2011 Birth Cohort)

- **Mild**
- **Moderate**
- **Moderately-Severe**
- **Severe**
- **Profound**

Bar chart showing the percentage of children aided based on the degree of hearing loss in their affected ear.
LittlEARS Scores for IHP Children with Unilateral Hearing Loss

- **Mild Unaided**
- **Mild Aided**
- **Moderate Unaided**
- **Moderate Aided**
- **Moderately-Severe Unaided**
- **Moderately-Severe Aided**
- **Severe Unaided**

**Axes**:
- **Y-axis**: LittlEARS Score
- **X-axis**: Age (months)
Overall PEACH Scores for IHP Children with Unilateral Hearing Loss

- Mild Unaided
- Mild Aided
- Moderate Unaided
- Moderate Aided
- Moderately-Severe Unaided
- Moderately-Severe Aided
- Severe Unaided
- Severe Aided
- Profound Unaided

Degree of Hearing Loss vs. Overall PEACH Score (%)
Outcome Measures

Subjective
Objective
Survey of Pediatric UHL Management Practices in North America

Dave Gordey
Lisa Davidson
Judith Lieu
Marlene Bagatto
I use the following outcome measures to evaluate the hearing aid fitting for infants and children with *mild to moderately-severe* UHL (N = 179)

<table>
<thead>
<tr>
<th>Answer Choices</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aided audiogram in soundfield (no masking)</td>
<td>17.88</td>
</tr>
<tr>
<td>Aided audiogram in soundfield (with masking noise or plugging the better ear, where appropriate)</td>
<td>59.78</td>
</tr>
<tr>
<td>Aided speech testing</td>
<td>60.34</td>
</tr>
<tr>
<td>Aided speech testing in noise (where appropriate)</td>
<td>64.25</td>
</tr>
<tr>
<td>Recorded/calibrated Ling 6 (HL) Test (Glista et al, 2014)</td>
<td>12.29</td>
</tr>
<tr>
<td>Live voice Ling 6</td>
<td>43.58</td>
</tr>
<tr>
<td>Parent/caregiver questionnaire (e.g., LittLEARS, ELF)</td>
<td>69.83</td>
</tr>
<tr>
<td>I don’t use outcome measures</td>
<td>3.35</td>
</tr>
</tbody>
</table>
Air Conduction Hearing Aid for Mild USNHL in Children
Decision Support Guide for Hearing Aid Use in Infants & Children with Minimal/Mild Bilateral Hearing Loss

Marlene Bagatto & Anne Marie Tharpe

A Sound Foundation Through Early Amplification Conference Proceedings
July 2014
MINIMAL/MILD BILATERAL HEARING LOSS

- Readiness, Motivation
- Access to speech
- Developmental status, Ambulatory status, Environment, Outcomes
- Venting, RECD
- Hearing aid gain/output & noise floor
- Ear Canal Size & Acoustics
- Configuration & Degree of Loss
- High Frequency, Flat

Case-by-case Reasoning for Minimal/Mild Bilateral Hearing Loss

Family Factors
Flat 25 dB HL

Configuration & Degree of Loss

Ear Canal Size & Acoustics

Hearing aid gain/output & noise floor

Unaided Speech
High Frequency Hearing Loss

Configuration & Degree of Loss

Ear Canal Size & Acoustics

Hearing aid gain/output & noise floor

SII Unaided = 89%
SII Aided = 94%

Hearing aid noise
MINIMAL/MILD BILATERAL HEARING LOSS

Case-by-case Reasoning for Minimal/Mild Bilateral Hearing Loss

Readiness, Motivation

Access to speech

Hearing aid gain/output & noise floor

Ear Canal Size & Acoustics

Venting, RECD

Configuration & Degree of Loss

High Frequency, Flat

Developmental status, Ambulatory status, Environment, Outcomes

Family Factors

Child Factors
Air Conduction Hearing Aid for USNHL in Children
Air Conduction Hearing Aid for Mod to Mod-Severe USNHL

• Most available devices can provide appropriate match to prescriptive targets within +/-5 dB on average, across frequency

• Potential speech perception performance is good with appropriately fitted device if follow current fitting protocols

• Currently no adjustment to DSL prescriptive target for a UHL fitting

Bagatto et al, 2016; Moodie et al, 2017; McCreery et al, 2013
Electroacoustic Verification - SPLogram

- Aided Speech
- MPO
- Unaided Speech

Predicted from coupler measurements & the RECD
Air Conduction Hearing Aid for USNHL in Children

![Graph showing frequency and hearing threshold level](image)
Air Conduction Hearing Aid for Severe to Profound UHL

- Few available devices can provide appropriate match to prescriptive targets within +/-5 dB on average, across frequency
  - Impacted by ear canal characteristics
  - Reduced dynamic range

- Tolerance for amplified sound

- Potentially poor speech perception performance
  - Difficult to measure in infants
Is the affected ear “aidable”? 

• Assumption that measureable hearing is usable hearing 

• In infants and young children, difficult to assess dead regions or speech perception abilities 

• Can a fitting be achieved without feedback? 

• What about crossover?
Safety / Risk is a Concern for Profound Fittings

• Counsel against the use of hearing aids in high sound levels

• Use lower gains for high noise environments

• Monitor audiograms for changes

• Recommendations not necessarily for children with USNHL
Considerations: Sev/Pro UNSHL

• What should we base our management recommendations on:
  • Audiogram?
  • Speech perception abilities?
  • Potential for intervention with other technologies?

• Intervention with a child should not be pursued if there is lack of benefit
  • Hearing aid trial
  • Meaningful monitoring (outcome measures)
Bone Conduction Hearing Aid for UCHL in Children
Bone Conduction Device Fitting Practices in Children (in prep)

Dave Gordey & Marlene Bagatto
Pediatric Hearing Aid Fitting

Assessment
Evaluation / Validation
Verification
Prescription & Selection
Options for Delivering Bone Conducted Sound

Direct Drive vs Skin Drive systems

- **Direct Drive** devices send vibrations via direct route to bone
- **Skin Drive** devices send vibrations through the skin to bone

- Softband and magnet solutions provide similar performance

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Surgical Eligibility

- Children must have sufficient skull thickness and bone quality before implantation of a magnet, abutment or active bone stimulator can be considered
  - At least 2.5 mm thick (Davids et al, 2007; Papsin et al, 1997; Tjellstrom et al, 2001)
  - Currently the smallest implant available is 3 mm thick

- Currently, the placement of a bone anchored implant is recommended around age 5 years
  - Hakansson et al, 1990; Wade et al, 2002
  - Surgical criteria varies from country to country
Non-Surgical Option
Headband or Softband

• Delivers sound via vibrations across the skin to the skull. Device is snapped onto a soft headband for use; no surgery is required.

• Recommended for children with conductive or mixed hearing losses who do not have properly formed outer ear or ear canal to accommodate a BTE hearing aid.
Infants with unilateral & bilateral aural atresia....

• Will be identified at birth through EHDI programs

• Are candidates for bone conduction hearing devices on a soft headband
  – Many programs recommend trial with this before pursuing surgical option

• Are not eligible for surgical device for several years
How do I fit/verify bone conduction hearing devices (BCD) to infants/children?
Improving Clinical Practice: Current Research

Clinician Survey → Retrospective File Review → Draft Protocol

Prescriptive Targets → Equipment → Clinical Application

Hodgetts & Scollie, 2017, IJA
Skull simulator
Clinical populations & devices
Q6 My workplace is set-up with the following equipment: (check all that apply)

Answered: 117   Skipped: 28

- Sound field speakers in sou...: 98.29%
- CD player: 86.32%
- Recorded speech materials: 93.16%
- Two channel audiometer: 99.15%
- Real-ear hearing aid test system: 96.58%
- Skull simulator: 13.68%
- None of the above: 0%
Clinical Verification of Devices

Q13 I verify my bone conduction devices for children using: (select one)

Answered: 111  Skipped: 34

- a). Sound field testing: 86.49%
- b). Test box measurements: 11.71%
- c). Sound field and test box measurements: 1.80%
- d). i do not verify: 0%

Validation tool in AC HA Fittings
Current Work: Retrospective File Review

**Purpose:** To gain further knowledge about the clinical fitting and management of infants and young children who wear BC devices

**Collaborators:** *The Pediatric Bone Conduction Working Group*
- Boys Town National Research Hospital
  - Michelle Vogel, Ashley Kaufman
- Children’s Hospital of Philadelphia
  - Joy Peterson, Laurie Mauro
- Cincinnati Children’s Hospital
  - Annemarie Wollet, Michael Scott
- Institute for Reconstructive Sciences in Medicine, Alberta, Canada
  - Meredith Haluschak
- Saskatoon Health Region, Canada
  - Charlotte Douglas, Lynne Brewster
- University of Miami Children’s Hearing Program
  - Kari Morgenstein
- Western University
  - Christine Brown, Marlene Bagatto
Results:
Fitting/Verification Method

![Bar chart showing the percentage of fitting/verification methods. The chart indicates that the majority of the method is Autofit, with a smaller percentage for In situ and Other.](chart.png)
Results: Outcome Measures

![Outcome Measure Chart]

- **≤24 mos**: LittlEARS
- **≥24 mos**: PEACH, Ling 6 (HL), None
Conclusions

• BCD on softbands are fitted to infants and young children
  – Unilateral atresia/microtia

• Due to the lack of necessary elements for verifying BCD, clinicians are applying their own strategies
  – Variability across clinics and clinicians

• Some consistency in outcome measurement tools used for validation
  – LittlEARS, PEACH, Ling 6 (HL)
Important Updates

• DSL targets for Oticon Ponto BCD unilateral percutaneous fittings for adults (Hodgetts & Scollie, 2017)
• Skull simulators for clinical hearing aid test systems
Counseling Families: UHL

- Reduced audibility
- Localization of sounds
- Listening in noise
- Speech and language development
- Social-emotional development
- Learning and/or cognitive development
- “Training” for alternative technologies
Supporting Clinical Recommendations for Children with USNHL

• Degree of loss in affected side

• Child factors
  – Speech and language status (functional assessments)
  – Cognitive ability or academic progress
  – Motivation
  – Potential acceptance

• Family factors
  – Understanding of management options
  – Understanding of child’s hearing difficulty
  – Readiness and motivation