Guiding the Provision of Hearing Devices to the Pediatric Population

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Current Development and New Directions in Pediatric Audiology
5th Phonak European Pediatric Conference
June 17, 2016
Berlin, Germany
A Sound Foundation Through Early Amplification

Chicago, 1997

Richard Seewald, John Bamford, Judith Gravel, Pat Stelmachowicz, Anne Marie Tharpe, Ora Buerkli
Identified a need for an international pediatric conference that dealt with issues that follow newborn hearing screening.
In 1997 Topics Included.....

- Frequency-specific evoked potential audiometry in infants
- Fitting a wide dynamic range of speech into a narrow dynamic range of hearing
- Electroacoustic and audiometric measures
- Instructing families on the use of hearing aids
- Evidence on very early service delivery

- Pediatric Working Group Position Statement (1996)
18 Events Worldwide
Current Topics Include

- Minimal and mild hearing loss in children
- Wideband tympanometry
- Aided corticals for outcome assessment
- Modern hearing aid technologies
- Effects of noise and reverberation on speech perception
- Listening quality
- Family-centered early intervention

Beyond Newborn Hearing Screening
Provision of Hearing Aids

- An integral part of early hearing detection and intervention (EHDI) programs
- Supports the infant’s communication development, if fitted and monitored properly
- Clinicians have access to evidence-based guidelines and protocols to support their practice
Guideline vs Protocol
Guideline

- **Systematically developed statements** to assist clinicians in fitting hearing aids to the pediatric population

- **Summary and appraisal** of the best available research evidence or expert consensus

- Does not provide information about the **exact clinical processes** that would fulfill the guideline
Protocol

- **Specifics** about how to execute a guideline

- **Tailored** for use with specific equipment or test signals

- **Details** that allow a *step-by-step operationalization* to fulfill a guideline
  - Morris, 2003
Provision of Hearing Aids

- Suitable technology and evidence-based hearing aid fitting guidelines and protocols support accurate and safe hearing aid fittings for the pediatric population
  - American Academy of Audiology, 2013
  - Australian Protocol; King, 2010
  - British Columbia Early Hearing Program, 2006
  - Modernizing Children’s Hearing Aid Services, 2005
  - Ontario Protocol: Bagatto et al., 2010; 2016
AAA Pediatric Amplification Guideline (2013)

- Assessment, candidacy, support
- Device selection, earmold selection, prescription
- Verification and fine tuning (probe mic) with speech & for each feature
- Validation (outcome measurement) for every child

To ensure that needs are met
After new features
Ontario Infant Hearing Program Protocol

• Version 2014.01
  • Editors: Marlene Bagatto & Susan Scollie
    www.dslio.com

• Journal of the American Academy of Audiology Special Issue, March 2016

• Topics include:
  • Survey of current pediatric amplification practices
  • Updates to Ontario Amplification Protocol
  • Noise Management for children’s hearing aids
  • Frequency Lowering technology for children
  • Safety of hearing aid fitting
  • Outcomes of Auditory Neuropathy Spectrum Disorder
Examined the hearing, speech, language and psychosocial outcomes of children who are hard of hearing with respect to access to early intervention.

Boys Town National Research Hospital
University of Iowa
University of North Carolina
Factors Influencing Outcome

Outcomes of Children with Hearing Loss
Ear & Hearing, 2015
Factors Influencing Outcome

- Linguistic Input
- Consistent Hearing Aid Use
- Audibility

Outcomes of Children with Hearing Loss
Ear & Hearing, 2015
Two Essential Components

1) Use of well-defined, evidence-based protocols

2) Detailed monitoring of the performance

.......in all aspects of the EHDI Program.
What can happen when we don’t use the same evidence-based protocols?
Hearing Instrument Fittings of Pre-School Children: Do We Meet the Prescription Goals?

Susan Strauss & Catherine van Dijk
International Journal of Audiology
2008
Method

• Measured the output from 20 children’s hearing instruments – total of 31 ears – moderate to profound hearing loss.

• Instruments fitted by a variety of clinicians in a variety of ways.

• Compared the measured outputs to the DSLv5 prescribed levels for each child.
Results: 65 dB SPL (average speech) input
34 – 47% of fittings ±5 dB of DSL Target
Results: 90 dB SPL narrow band (MPO) input
34 – 39% of fittings ±5 dB of DSL Target

92% were ≥5 dB below DSL target
Fit-to-Targets for the DSL v5.0 Hearing Aid Prescription Method for Children

Sheila Moodie and
The Network of Pediatric Audiologists of Canada
Method

- Measured the output from 109 children’s hearing instruments – total of 161 ears – mild to profound hearing loss.

- Instruments were fitted in 9 clinical sites in 5 different Canadian Provinces using the DSL prescription procedure and the same verification protocol.

- Compared the measured outputs to the DSLv5 prescribed levels for each child for soft, average and loud speech inputs and for the maximum hearing aid output.
Results: 65 dB SPL (average speech) input
80% of fittings ±5 dB of DSL Target

Average fit to target was ±2 dB
Results: 90 dB SPL narrow band (MPO) input
75% of fittings ±5 dB of DSL Target

Average fit to target was ±4 dB
Importance of Guidelines/Protocols

Good Outcomes

- Evidence
- Systematic
- Practical

Good Outcomes
What are the elements of a good pediatric hearing aid fitting protocol?
Pediatric Hearing Aid Fitting is a Process

1. Audiometric Assessment
2. Prescription and Selection
3. Evaluation of Auditory Performance
4. Hearing Aid Verification
Infants are not small adults

- Different listening needs
  - Pre-lingually hearing impaired
  - Critical period for language learning is birth to 2 years of age

- Significantly smaller ears
  - Ear canals grow and change

- Unable to provide verbal feedback about hearing aid fitting
  - Depend on caregiver for hearing aid use, monitoring and maintenance
Goals:

- Identify infants with hearing loss and define the impairment by 3 months corrected age
- Initiate intervention by 6 months corrected age
Complete Assessment Required

- Description of hearing *in each ear* is required prior to proceeding with hearing aid fitting
  - Degree, configuration, type

- Estimation of thresholds with air- and bone-conducted stimuli for *at least* two frequencies per ear
  - Include case history, otoscopic examination, immittance, diagnostic OAEs
Infant Hearing Assessment

- Infants under 6 months of age cannot perform behavioural hearing test
Audiological Evaluation: 0-6 mo

- Estimates of hearing sensitivity are derived from FS-ABR measurements

- Hearing aid selection and fitting proceeds using ABR threshold estimates
  - Intervention is *not* postponed for collection of behavioural data
Best Practice: ABR Corrections

Ensure a smooth transition from electrophysiologic hearing assessment to early hearing aid fitting: *standardized nHL to eHL corrections.*
VRA Assessment

- Conducted using insert earphones
  - Soundfield testing is not ear specific
- Connect inserts to personal earmolds
  - Better retention and acceptance
Best Practice: Measure the RECD

Account for the child’s unique ear canal: measure the Real Ear to Coupler Difference (RECD), routinely.
Variable Ear Canal Acoustics

- Large variability in ear canal SPL across infants and young children

- Must account for this variability in both audiologic assessment and in hearing instrument fitting
RECDs in Infants 2 to 6 months of age
Infants versus Average Adult

The graph illustrates the comparison between infants and average adults in terms of RECD (Relative Ear Canal Diameter) against frequency. The graph highlights a 20 dB difference between the two groups. The "Infant" and "Average Adult" labels indicate distinct trends in the data.
The RECD is used in **two** places:

- **HL Threshold + RECD + RETSPL**
  - = Real Ear SPL Threshold

- **Coupler SPL or gain + RECD + MLE**
  - = predicted Real Ear SPL or gain

For BTEs, this needs to account for earmold!
Best Practice: Generic Fitting Formula

Evidence-based prescription: *can be used with any make/model of hearing aid and provides support for pediatric fittings.*
Objectives of Early Amplification

- Provide amplified signal that is audible for various input levels
- Avoid distortion
- Ensure availability of sounds across a broad frequency range
- Allow for sufficient electroacoustic flexibility
  - To account for changes in ear canal acoustics and/or auditory characteristics
### Change Description

<table>
<thead>
<tr>
<th>Change Description</th>
<th>Change amount and direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult/acquired versus pediatric/congenital target</td>
<td>7 dB reduction for moderate losses, 3 dB for severe losses.</td>
</tr>
<tr>
<td>Interpolation</td>
<td>Greater number of target values across frequencies when working with partial audiograms.</td>
</tr>
<tr>
<td>Compression threshold</td>
<td>Less gain and output for low-level inputs due to prescribed compression threshold. Inputs of 70 dB and above are not affected.</td>
</tr>
<tr>
<td>Output limiting</td>
<td>Narrowband output limiting targets largely unaffected. Output limiting for speech may cause target reductions of 5 to 10 dB if test level is high.</td>
</tr>
<tr>
<td>Quiet versus noisy environments</td>
<td>Compression threshold raised by 10 dB and gain reduced at low-importance speech frequencies by about 5 dB.</td>
</tr>
<tr>
<td>Binaural fittings</td>
<td>Optional. Will reduce targets for speech by 3 dB. Output limiting targets are not affected.</td>
</tr>
<tr>
<td>Conductive or mixed hearing loss</td>
<td>Increases gain by up to 9 dB for mild losses, 5 dB for severe losses, depending on magnitude of air-bone gap.</td>
</tr>
</tbody>
</table>
Best Practice: Real-ear Verification

Set the hearing aid for the infant or child, focusing on the long term levels of conversational speech: 
verify every hearing aid, and fine tune to target. Use speech-based equipment.
Frequency (Hz)

MPO

Predicted from coupler measurements & the RECD

Decibels Sound Pressure Level

Aided Speech

<table>
<thead>
<tr>
<th>Test</th>
<th>Stimulus</th>
<th>Level</th>
<th>SII</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Speech-std(1) Avg (65)</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Speech-std(1) Soft (55)</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Speech-std(1) Loud (75)</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>MPO</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Unaided avg (65)</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Pediatric Norms
(Bagatto et al, 2011: Trends; 2016: JAAA)
Assess the unique needs of the infant and family: carefully consider factors for mild, unilateral and ANSD fittings; assess the need for noise management and frequency lowering for each infant. Work with the family to support shared decision-making.
Included in Ontario Protocol

- Decision Guide for hearing aid use in children with mild bilateral hearing loss (Anne Marie Tharpe)
  - Noise Management
    - Candidacy criteria
    - Verification protocol
  - Frequency Lowering
    - Candidacy criteria
    - Verification protocol
  
  Example: Fewer hours of daily hearing aid use
  Example: /s/ sound inaudible
Verify Noise Reduction

Output of hearing aid does not change with loud speech input when ANR on versus off.

Average of 6 dB noise reduction is noted for ‘Air Conditioner’ and ‘On the bus’
Minimum Audible Output Frequency
Best Practice: Outcome Evaluation

At regular intervals, use age-appropriate outcome measures to assess the impact of the hearing aid fitting: demonstrates progress for the infant in the early stages of hearing aid use; monitor throughout intervention and when hearing aid changes.
Joint Committee on Infant Hearing Goal 6:

“All children who are D/HH should have their progress monitored every 6 months from birth to 36 months of age through a protocol that includes the use of standardized, norm-referenced developmental evaluations...”

~ JCIH, 2013
## Contents of the UWO PedAMP

<table>
<thead>
<tr>
<th>Tool</th>
<th>Purpose</th>
<th>Description</th>
</tr>
</thead>
</table>
| Amplification Benefit Questionnaire | • Acceptance & use of hearing aids  
• Satisfaction with services | 11 items  
5 point rating scale |
| Hearing Aid Fitting Details | • Quality of hearing aid fitting | RECD, MPO, Speech Intelligibility Index (SII) |
| LittLEARS Auditory Questionnaire  
*Tsiakpini et al, 2004* | • Receptive & semantic auditory behaviour  
• Expressive vocal behaviour | 35 items  
Yes/no response |
| Parents’ Evaluation of Aural/Oral Performance of Children (PEACH)  
*Ching & Hill, 2005* | • Communication in quiet & noise  
• Responsiveness to environment | 13 items  
5 point rating scale |
Pediatric Hearing Aid Fitting is a Process

- Audiometric Assessment
- Evaluation of Auditory Performance
- Prescription and Selection
- Hearing Aid Verification
Good Fittings Contribute to Good Outcomes

Outcomes of Children with Hearing Loss
Ear & Hearing, 2015
Application of Guidelines/Protocols

- Evidence
- Systematic
- Practical

Good Outcomes
DANKE!!