Beyond the Audiogram: Evaluating and Treating the Whole Child
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From training to the trenches
• Understanding what it means to evaluate the whole child (and by whole child we mean whole family)
  – Using evidence based recommendations
  • PedAMP
  • Moving from theoretical to true life

Road Map
• Using PEDAMP to guide decision making
  – Objective assessments (review)
  – Subjective assessments (review)
• Moving from HA to CI
  • Candidacy
  • Improving the outcomes of children with CIs
    – Equipment options
  • Supporting the bimodal user

Collaborative Effort
• Families
• Audiologists
• Speech-Language Pathologists
• Other Early Intervention Providers (Deaf Educators)
• Otologist

Objective Assessments
• Immittance testing
• OAEs
• ABR - We recommend the British protocol
• Behavioral testing every 3 months until age 7
  • Routine evaluations, HA checks, aided testing
• Real Ear Verification
  • RECD measurements
• Speech Intelligibility Index (SII)

Speech Intelligibility Index
• What is it?
  – Percent of speech that is audible in quiet environments at soft (55 dB) and average (65 dB) levels.
  – For hearing losses ≥ 62 dB SPL level distortion factor is applied
• SII ≠ Speech Perception scores
• SII will decrease as degree of hearing loss increases
### Subjective Assessments

- IT-MAIS
- MAIS
- LittlEARS® Auditory Questionnaire
- PEACH: Parents’ Evaluation of Aural/Oral Performance in Children

### LittlEARS®

- 0-24 months (based on chronological age)
- Assesses:
  - Receptive & semantic auditory behavior
  - Expressive (vocal) behavior
- Yes/No format; in age-dependent order
- 4th grade reading level; can be administered a variety of ways
- Normative data for children w/ or w/o HAs/CIs
- 26 different languages

(Creins, et al., 2009; Tsaikpini et al., 2004, Copyright MED0EL 2004)

### PEACH

- 24 months and older
  - Not age based
- Diary, transformed to rating scale
- Quiet & Noise subscales
- Used with children using HAs/CIs
  - Use with non-users (ANSD; inconsistent users)
- Sensitive to changes in frequency response slopes in hearing aids.

(Ching & Häßle, 2007)

### Marrying the Objective to the Subjective

- UWO PED AMP: University of Western Ontario Pediatric Audiological Monitoring Protocol
  - Infant Hearing Program
    - Hearing Aid Fitting Protocols
    - SII Normative Values
  - Parent Questionnaires
    - LittlEARS® and PEACH
  - Amplification Benefit Questionnaire (theirs)
  - Daily Listening Questionnaire (ours)

### Implementation at our clinic

- Diagnosis of hearing loss/ reconfirm
  - Initiate FAITH protocol
- Hearing aid fitting
  - RECD measures and real-ear verification
  - Collection of SII results
  - LittlEARS® or PEACH (baseline)
  - Incorporating results of HA fitting in parent counseling
- HA check (1 month)
  - Daily Listening Questionnaire

### Every 3 months or sooner

- Unaided testing
- Aided testing (if time allows)
- RECD measures
- Real ear verification
  - May need to change gain settings based on RECD changes or changes in hearing
- SII
- LittlEARS® or PEACH
When to become concerned

- Limited auditory progress
  - LittEARS®/PEACH
  - SLE
- Poor SII scores despite appropriately fit hearing aids

Addressing the concern

- Recheck hearing
  - Repeat ABR testing if behavioral results are inconclusive/inconsistent
- Datalogging and Daily Listening Questionnaire
  - Guides the conversation if the child is not wearing technology all waking hours
  - Initiate HA trial for children not currently in technology (i.e. mild or unilateral losses, ANSD)
  - Provide strategies/equipment to improve wear time

Persistent concern

- CI candidacy
  - Initial CI
  - Second CI (Bimodal to bilateral)
- Increase in speech and language intervention?
- What is happening in AV therapy?
  - Diagnostic therapy

Pediatric CI Candidacy

FDA Guidelines

- 12 months of age or older
- Profound bilateral SNHL (> 90 dB HL)
- Little to no benefit with appropriately fit hearing aids
- Limited auditory progress
- Family motivation
- Appropriate expectations
- No medical contraindications

Candidacy by Manufacturer

<table>
<thead>
<tr>
<th>Degree &amp; Type of Hearing Loss</th>
<th>Cochlear</th>
<th>Advanced Bionics</th>
<th>Med El</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 2 yrs: Bilateral profound SNHL (&gt;90 dB HL)</td>
<td>Bilateral, profound SNHL (&gt;90 dB HL)</td>
<td>Bilateral, profound SNHL (&gt;90 dB at 1000 Hz)</td>
<td></td>
</tr>
<tr>
<td>≥ 2 yrs: severe to profound SNHL</td>
<td>≤ 30% correct word recognition on MNT or LNT</td>
<td>&lt; 20% correct word recognition for MNT or LNT</td>
<td>&lt; 20% correct word recognition for MNT or LNT</td>
</tr>
<tr>
<td>Speech Perception (older children)</td>
<td>≤ 4 yrs: &gt; 20% on simple open-set words (MNT/LNT)</td>
<td>&lt; 4 yrs: &lt; 12% on difficult open-set words (PB-K) or &lt;30% on open-set sentences (HINT-C)</td>
<td></td>
</tr>
</tbody>
</table>

What about our youngest kiddos?

- Infants typically use a whole year of listening before producing their first word
  - A child with severe to profound HL who cannot be implanted before 12 months of age will then need 2 years before they produce their first word (in theory)
- Crucial milestones for receptive language development are being met for typically hearing children before 12 months of age.
What are these infants missing?

The opportunity to:

- At 6 months
  - Link meaningful sound patterns (mommy, daddy, uh-oh, bye bye) (Tincoff & Jusczyk, 1999)
- At 7.5–12 months
  - Develop word segmentation abilities (Jusczyk et al., 1999; Bortfeld et al., 2005; Seidl & Johnson, 2008)
- At 8 months of age:
  - Establish longer-term word storage (up to 2 weeks) (Jusczyk & Hohne, 1997)

What if we implant earlier?

- There is significant research suggesting:
  - Better word learning (Houston & Miyamoto, 2010; Houston et al., 2012)
  - Better expressive and/or total language (Cuda et al., 2014; Holmes et al., 2013; Nicholas & Geers, 2013; Tobey et al., 2013; Toribio et al., 2006)
  - Speech perception (Tajudeen et al., 2010)

When compared with those receiving CIs later

What about older children?

- These children may have progressive losses
- They may have speech and language within normal limits
- As speech perception testing gets harder, they may struggle more
- They may exhibit increased listening effort. Listening requirements increase as children age (moving to more lecture-based learning).

Tools to evaluate older child

- Recorded speech testing and testing in noise are important facets of a speech test battery for candidacy (to establish baseline for post-CI)
  - Keep the bar high on expectations
  - Use of questionnaires from parents and teachers

Transitioning to a CI as an older child

- Counseling
- Realistic Expectations
- Home and School Support

What about bimodal pediatric users?

- Is their contralateral ear benefitting from a HA?
- Has their hearing deteriorated in the HA ear?
- Do they have the best available technology for that ear? (AB & Phonak; Cochlear & Resound)
- How do speech scores between conditions compare?
  - CI only, HA only, CI + HA
- Subjectively, can the child report about the HA?
  - Do they reject wearing it or are they inconsistent?
Making the transition

With older children (~5-6 years and older)
– Discuss how their second CI may sound different at first (they likely do not remember getting their first CI).
– Realistic expectations
– Listening practice (motivational apps)

Case Studies

ES: ANSD
AA: Progressive hearing loss
HA: Making the decision as an older child with support

New frontiers in Pediatric CI?

• Electroacoustic Stimulation (EAS)
• Hybrid Cochlear Implantation
• Electrode array options (Atraumatic surgical techniques)
• CI for SSD

Disclosures

• N6 sound processors and acoustic components were provided by Cochlear Corporation.

EAS in Children

Hearts for Hearing

• 12 Children with electric-acoustic stimulation
• A variety of electrode arrays, sound processors, and acoustic amplification devices
• A variety of modes of stimulation between ears
  – Bilateral EAS
  – EAS one ear with electric on opposite ear
  – EAS one ear with acoustic on opposite ear

Reporting on...

• 7 children fitted with the Nucleus 6 electric-acoustic processor
Recipients

- Age range: 7 yrs, 6 mo to 16 yrs, 7 mo
- Length of CI use: 5 mo to 7 years
- 2 males, 5 females

Recipients’ Technology

<table>
<thead>
<tr>
<th>Recipient</th>
<th>Left Ear</th>
<th>Right Ear</th>
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</thead>
<tbody>
<tr>
<td>SP</td>
<td>Nucleus CI 512</td>
<td>Nucleus CI 512</td>
</tr>
<tr>
<td>AA</td>
<td>Phonak Naida SP V</td>
<td>CI24RE Contour Advance</td>
</tr>
<tr>
<td>JM</td>
<td>CI24RE Contour Advance</td>
<td>Phonak Naida SP V</td>
</tr>
<tr>
<td>AP</td>
<td>Nucleus CI 422</td>
<td>Nucleus CI 422</td>
</tr>
<tr>
<td>JF</td>
<td>Phonak Naida Q70-RIC</td>
<td>Nucleus Hybrid</td>
</tr>
<tr>
<td>BJ</td>
<td>Nucleus CI 422</td>
<td>Nucleus CI 422</td>
</tr>
<tr>
<td>HA</td>
<td>Nucleus CI 422</td>
<td>CI24RE Contour Advance</td>
</tr>
</tbody>
</table>

All seven of these recipients used the Nucleus 6 EAS processor for their implanted ear(s)

Mean Pre-CI Audiogram

Pre- and Post-op Audiometric Results

EAS Fitting

Acoustic and electric allocation based on the “meet protocol”

Assessment

- BabyBio Sentences (Spahr et al., 2014)
  - Quiet at 60 dBA
  - Noise
    - +10 dB SNR
    - +5 dB SNR
    - 0 dB SNR
  - Different conditions
Assessment

- Questionnaires – Before and after EAS
  - Speech, Spatial, and Qualities of Hearing Scale (SSQ) – Comparative Version (Gatehouse & Noble, 2004) (Jensen et al., 2009)
  - Child’s Home Inventory of Listening Difficulties (CHILD) – (Anderson & Smaldino, 2000)
  - Listening Inventory for Education-Revised (LIFE-R) – (Anderson et al., 2011)

Bilateral EAS

Best EAS

Bimodal vs. Combined

SSQ - Comparative

CHILD
Special Considerations

- Challenge to fit receiver into a young child’s ear
- Receiver wire length and pressure
- Custom ear shells facilitate a better fit and retention
  - Size and shape
  - Work with different labs

Take Home...

- Consider EAS from the “get go” for residual hearing up to 70-85 dB
- Consider providing overlap of acoustic & electric hearing
- Evaluate to ensure we see benefit over time with long-time CI users

Moving forward

- Aggressive audiological management is necessary from the start
- Consider the whole child
  - Objective and subjective measurements guide decision making & help with counseling
  - Consider Bilateral vs. Bimodal
  - Residual hearing
Thank you for your attention.

References


References Continued


