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Using Outcome Measures to Optimize Pediatric Hearing Aid Fittings

Marlene Bagatto, Au.D., Ph.D.
bagatto@nca.uwo.ca

Learning Outcomes

After this course, participants will be able to:

- Describe the rationale for using outcome measures;
- Explain tools included in a pediatric audiological monitoring protocol; and
- Apply outcome measures for infants and children who wear hearing aids.
Hearing Aid Fitting

“The goals of prescription are to improve the ability to hear and thereby facilitate the development of sensory and perceptual skills, receptive and expressive language, speech production and literacy, academic performance, and social-emotional growth.”

~Carney & Moeller, 1998
Pediatric Hearing Aid Fitting

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
Importance of Guidelines/Protocols

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
In the clinic, outcome measures...

- can be used to measure the impact of the hearing aid(s) on the child’s development;
- include caregivers in the management process;
  - good observers of their child’s auditory behaviours
  - develop a shared language with professionals
  - active members of the team
- support collaboration with other professionals involved with the child.

In EHDI programs, outcome measures...

- provide systematic clinical data;
- can be used to assess the overall quality of the program;
- demonstrate to stakeholders the impact of the program for children with permanent hearing loss and their families.
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

Linguistic Input
Consistent Hearing Aid Use
Audibility

Moeller, Tomblin, McCreery, Walker, Arenas, Harrison, Spratford, Bentler, Holte, Roush, Oleson, Van Buren, Ambrose, Unflat-Berry
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.

Considerations for Outcome Evaluation

- Target Population: Infants & young children who wear hearing aids
- Good Statistical Properties
- Purpose: Measure the impact of the hearing aid fitting
- Clinically Feasible
- Administration & Interpretation: By Audiologist
- Clinically Meaningful
Types of Outcome Measures

**Objective**

*Capacity Measure:*
What the child can do in the clinic

*Example:* Child’s ability to detect low level speech sounds

**Subjective**

*Performance Measure:*
What the child can do in the real world.

*Example:* Parent’s observation of child’s performance using a questionnaire.

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Good auditory-related outcomes infer good audibility from hearing aids.

- Evaluating the *quality* of the hearing aid fitting is an important part of outcome evaluation.

- Determine whether an individual child’s fitting is providing a typical degree of audibility.

- Provides overall quality assurance of hearing aid fitting for EHDI programs as a whole.
Electroacoustic Verification

The Speech Intelligibility Index (SII)
- An updated version of the Articulation Index (AI), standardized in 1997

How to interpret:
- 0 means no speech is audible
- 1 means 100% is audible
- This doesn’t mean that 100% will be heard correctly.
Clinical Application of SII


SII Norms for Pediatric Hearing Aid Fittings


Moodie et al. 2017
SII Range for Soft & Average Speech within Verifit

Hearing Aid Fitting Details
- RECD
- MPO
- SII

Functional Outcomes
- Subjective
- Objective
Purpose of the UWO PedAMP

- Intended to be used with children with permanent childhood hearing loss from birth to 6 years who may or may not wear hearing aids

- Consists of several outcome evaluation tools that aim to measure auditory-related outcomes in infants and young children including the following dimensions:
  - Subjective assessment of early auditory development
  - Subjective ratings of auditory performance in daily life
UWO PedAMP developed with a Community of Practice

- Avoid tools that:
  - are too lengthy or complicated
  - rely on information or scoring by other professionals (e.g., standard language measures)

- Include tools that:
  - have good statistical properties
  - have good clinical feasibility and utility
  - support family-centered practice
  - help you collaborate better with others

- Maximize efficiency and interpretation through:
  - Visual tools to permit rapid scoring
  - Data to support interpretation

**Tools within the UWO PedAMP**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Purpose</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplification Benefit Questionnaire</td>
<td>• Acceptance &amp; use of hearing aids&lt;br&gt; • Satisfaction with services</td>
<td>11 items&lt;br&gt; 5 point rating scale</td>
</tr>
<tr>
<td>Hearing Aid Fitting Details</td>
<td>• Quality of hearing aid fitting</td>
<td>RECD, MPO, Speech Intelligibility Index (SII)</td>
</tr>
<tr>
<td>LittEARS Auditory Questionnaire Tsiakpini et al, 2004</td>
<td>• Receptive &amp; semantic auditory behaviour&lt;br&gt; • Expressive vocal behaviour</td>
<td>35 items&lt;br&gt; Yes/no response</td>
</tr>
<tr>
<td>Parents' Evaluation of Aural/Oral Performance of Children (PEACH) Ching &amp; Hill, 2005</td>
<td>• Communication in quiet &amp; noise&lt;br&gt; • Responsiveness to environment</td>
<td>13 items&lt;br&gt; 5 point rating scale</td>
</tr>
</tbody>
</table>
### Appointment Type (Aided)

<table>
<thead>
<tr>
<th>Details</th>
<th>Initial Assessment</th>
<th>Prefitting</th>
<th>Initial Fitting</th>
<th>30 Day Recheck</th>
<th>3 month Recheck</th>
<th>6 month Recheck</th>
<th>Yearly Rechecks</th>
<th>Event Driven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hearing Aid</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Details</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IHP Hearing</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Aid Benefit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LittEARS</td>
<td></td>
<td>Establish Unaided Baseline: Administer at one of these appointments</td>
<td>✓</td>
<td>If score ≥27 &amp; &gt;24 mos, stop LittEARS, use PEACH.</td>
<td>✓</td>
<td>If score ≥27 &amp; &gt;24 mos, stop LittEARS, use PEACH.</td>
<td>✓</td>
<td>If score ≥27 &amp; &gt;24 mos, stop LittEARS, use PEACH.</td>
</tr>
<tr>
<td>PEACH</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

UWO PedAMP Manual: www.dslio.com

### OIHP Amplification Benefit Questionnaire

- 11-item questionnaire jointly developed by the OIHP and Child Amplification Laboratory at UWO

- 5-point rating scale for parents addressing:
  - Acceptance and use of hearing aids
  - Auditory performance for different levels of sound
  - Effectiveness of service delivery
  - Overall satisfaction
  - Final question is open-ended asking about how hearing aid services could be improved

Where to find: www.dslio.com
Administration of the OIHP Amplification Benefit Questionnaire

- Initially completed by the caregiver after the child has worn hearing aids for 3 months or more
  - Gives respondent a chance to become comfortable with child's hearing aids and services offered

- Re-administered at follow-up visits

- Translated into several languages

Hearing Aid Fitting Details

- Real-Ear-to-Coupler Difference (RECD)
  - Measured
  - Predicted
  - Used other ear values
  - Used previously measured values

- Maximum Power Output (MPO)
  - Measured? Yes/No

- Speech Intelligibility Index (SII) values
  - Soft = 55 dB SPL
  - Average = 65 dB SPL
LittlEARS (Tsiakpini et al, 2004; Med-El)

- Goal: to assess auditory development during first 2 years of hearing
  - Receptive auditory behaviour
  - Semantic auditory behaviour
  - Expressive vocal behaviour

- Format: 35 yes/no questions listed in developmental order

LittlEARS

- Scoring: All ‘yes’ answers are added and compared to average and minimum values

- Normative data collected with 218 German-speaking families (Weichbold et al, 2005)
  - Reliable
  - Good internal consistency
  - Good discriminative ability
  - Good correlation of overall score and age of child
  - Validated in several languages (Coninx, et al, 2009)
LittlEARS Score Sheet (Adapted from MED-EL)

Meeting Auditory Development Milestones

Not Meeting Auditory Development Milestones

Extended age range.

Norms end at 24 months.

LittlEARS Results:
Children who wear hearing aids

Bagatto et al, 2016

77% of typically developing children are meeting auditory development milestones

Bagatto et al, 2016
Case Study: Benny

- History:
  - Born 28 weeks gestational age
  - Spent 10 weeks in NICU
  - Refer in both ears on neonatal hearing screening

- Audiology Assessment:
  - 9 months (6 months adjusted)
  - 11 months (8 months adjusted)

- Results indicated ANSD positive in both ears

Child has ANSD
Summary: Benjamin

- LittLEARS scores = 8 and 17

- Initially, Benjamin was not meeting auditory development milestones for his chronological or adjusted ages. Two months later, his auditory development improved to where he was meeting auditory development milestones for both his chronological and adjusted ages according to the LittLEARS Auditory Questionnaire.

PEACH (Ching & Hill, 2005; NAL)

- Goal: to evaluate effectiveness of device for infants and children with hearing impairment

- Format: 13 item questionnaire assesses
  - hearing aid use
  - loudness discomfort
  - communication in quiet and noise
  - phone use
  - responsiveness to environmental sounds
PEACH Rating Scale

- 5-point rating scale
- Includes most of the scenarios from the Diary
- Parents think about their child’s behaviour over the past week in relation to each question
  - Can be done in one appointment
  - No follow-up interview by clinician necessary
- Percentage scoring

Normal hearing children perform here (90%) by 3 yrs (Ching & Hill, 2005).
88% of typically developing children demonstrate typical auditory performance

Bagatto et al, 2016

PEACH Results: Children who wear hearing aids

Bagatto et al, 2016
SII Data from Current Study

UWO PedAMP

- A guideline consisting of several outcome evaluation tools that aim to measure *auditory-related outcomes* in infants and young children
  - Visual tools to permit rapid scoring
  - Data to support interpretation

- The UWO PedAMP will evolve through clinical implementation
  - Community of practice is important to support uptake
Case Example

- Bilateral moderately-severe hearing loss
- Aided at 4.5 yrs of age
- Late fitting due to lack of follow-up
- Typically developing

Advantages of Subjective Outcome Measures

- Families become good observers of their child’s auditory behaviours in the real world
- Families develop a shared language with the clinician
- Can be conducted with children who have complex needs
- No special equipment required
- Available in several languages
  - Use interpreter if needed
Objective Outcome Measures

- Ling 6 (HL) Detection Task
  - Recorded and calibrated signals
  - Scollie et al, 2012

- UWO Plurals
  - Recorded and calibrated signals
  - Glista et al, 2012

The Ling 6 Sounds

- /m/, /u/, /a/, /i/, /ʃ/, and /s/
  - These span the speech frequencies

- Originally proposed for live voice use by therapists:
  (see Ling, 1989 for more detail)
  - Probe whether child can detect all sounds
  - Probe whether child can discriminate the sounds
  - Do these prior to every therapy session
    - Protects against running a therapy session during a period of hearing aid malfunction, etc.
A specific tool: Ling 6 (HL)
Scollie et al, 2012

- Pre-recorded female utterances of each sound
- Norms for detection in dB HL in sound field
- Scoring corrections, a score sheet, and a CD

- Normally hearing listeners:
  - Detect the sounds between –10 and 10 dB HL
  - Have average test-retest reliability of 1–2 dB and a range of test re-test of one to two step sizes

Score Sheet

Normal range

Plot (un)aided thresholds as you would on an audiogram.
Sample Case

- Age 3 yrs 6 mos
  - Moderate SNHL bilaterally

- Fitting: DSL v5.0

- Standard audiometry, good reliability on Ling6

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The UWO Plurals Test

Glista et al, 2012

- Developed to be similar to a research task used in evaluating hearing aid bandwidth at Boys Town (Stelmachowicz, Pittman, Hoover, & Lewis, 2002)

- Nouns in singular & plural form at a high SNR
  - The task is to hear the word-final fricative
  - Sensitive to high frequency audibility

- UWO version uses 15 nouns: ant, balloon, book, butterfly, crab, crayon, cup, dog, fly, flower, frog, pig, skunk, sock and shoe
  - Pre-recorded, calibrated, available on a CD with scoring and interpretation guidelines
Scoring & Critical Differences

Aided test #1: 64% correct

Aided test #2, after re-adjusting: 79% correct

- The plotted score falls outside the shaded region and is therefore significantly better.
- The re-adjustments improved the score significantly.
- Note that this test does not assess correct speech sound identification.
Factors Influencing Outcome

Outcomes of Children with Hearing Loss

Linguistic Input

Consistent Hearing Aid Use

Audibility

ABQ, PEACH, Datalogging

Quality of Hearing Aid Fitting (SII)

Moeller, Tomblin, McCreery, Walker, Arenas, Harrison, Spratford, Bentler, Holte, Roush, Oleson, Van Buren, Ambrose, Unflat-Berry

Importance of Outcome Evaluation

- Patients
  - Track and monitor
  - Involve parents – result: good observers
  - Shared language

- Audiologists
  - Way to measure impact of hearing aid fitting
  - Improve efficiency and effectiveness of service delivery
  - Improve communication with families and professionals

- EHDI
  - Measure how program is doing
  - Helps describe patterns that affect children within the program
What gets measured gets managed.

~ P. Drucker (?)