OUTCOMES OF CHILDREN WHO ARE HARD OF HEARING
Disclosure:

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- I do not intend to discuss an unapproved/investigative use of a commercial product/device.
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WHY STUDY CHILDREN WHO ARE HH?

- Major gaps in research on infants & children who are HH
  - Small samples
  - Mixed samples (deaf and hard of hearing)
  - Varied measures & conclusions
  - Limited information about aided hearing
- NHS provides opportunities to study
  - Early development
  - Impact of changes in service delivery
- Need for a population-based sample
WHERE WE ARE HEADED

• Introduction of our research study
• Six “best practice” goals (ACCESS)
  • How are we doing?
  • What are the implications for practice?
• Future directions
NEW PRACTICES ➔ NEW OUTCOMES?
Importance of Access to Input

- Exposure to linguistic input is essential for language development
- Exposure to **more words** is a potent factor
- Infants are active learners who find patterns in input
- GOAL = rich input & good access
Delays in HA fitting

Inconsistent HA use

Limitations of Hearing Aids

Environmental effects

Variations in exposure
MULTI-SITE STUDY OF OUTCOMES

• Participating sites:

• Sample
  • Infants and preschoolers
  • English spoken in the home
  • No major secondary disabilities
  • Bilateral PTA of 25-75 dB HL (.5, 1, 2, 4 kHz)
  • Age-matched children with typical hearing
  • Came from 17 states; 76% id through NHS
ACCELERATED LONGITUDINAL DESIGN

- Retrospective data prior to enrollment obtained through medical records
- Cross-sectional and longitudinal
HH-TH MATCHED SAMPLE

<table>
<thead>
<tr>
<th></th>
<th>HH</th>
<th>TH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of subjects</strong></td>
<td>316</td>
<td>115</td>
</tr>
<tr>
<td><strong>Hearing (PTA)</strong></td>
<td>25-75 dB HL</td>
<td>&lt; 20 dB HL</td>
</tr>
<tr>
<td><strong>Age ranges</strong></td>
<td>0:6 to 6:11 at entry</td>
<td></td>
</tr>
<tr>
<td><strong>Nonverbal IQ</strong></td>
<td>Broadly within average range</td>
<td></td>
</tr>
<tr>
<td><strong>Maternal education</strong></td>
<td>Matched but &gt; US sample</td>
<td></td>
</tr>
<tr>
<td><strong>Language use</strong></td>
<td>Spoken English in the home</td>
<td></td>
</tr>
<tr>
<td><strong>Additional disabilities</strong></td>
<td>No autism; no major vision, cognitive, or motor disabilities</td>
<td></td>
</tr>
</tbody>
</table>
BEST PRACTICE GOALS

All families receive timely follow up

Carefully fit and consistently worn devices

Exposure to language input is optimized

Set the bar high & Super-size services
ALL FAMILIES RECEIVE TIMELY FOLLOW-UP

HOW ARE WE DOING? PRACTICE IMPLICATIONS?
### Timing of Follow-up After NHS

<table>
<thead>
<tr>
<th>1-3-6 Benchmark (n=193)</th>
<th>Mean age (months)</th>
<th>Range (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All children were screened by 1 month</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confirmation of HL by 3 months</td>
<td>6.78</td>
<td>.5-70</td>
</tr>
<tr>
<td>HA fitting by 6 months</td>
<td>10.33</td>
<td>1.5-72</td>
</tr>
<tr>
<td>Entry into EI by 6 months</td>
<td>7.74</td>
<td>0-57</td>
</tr>
</tbody>
</table>

Gender, test site, PTA, **maternal education**

Holte, et al. AJA, 2012
MOTHER’S EDUCATION RELATES TO FOLLOW-UP TIMING

Holte, et al. AJA, 2012
## What Causes Delays in Follow-Up?

### Common reasons for delay from UNHS to diagnostic test
- Multiple re-screenings
- Family chose to wait before scheduling diagnostic test
- Family was assured that not passing the screening was likely due to something other than the child’s hearing
- Delayed due to treatment of middle ear problems

### Reasons for delay from diagnostic test to confirmation of HL
- Multiple ABRs
- Recurrent middle ear infections
- ABR was normal or near normal

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Holte, et al., AJA, 2012
PRACTICE IMPLICATIONS

• Allot priority appointments
• Avoid multiple rescreens and ABRs
• Provide access to specialized providers
  • Multiple tests suggests need for pediatric audiologists and knowledgeable physicians
• Develop unique supports for families who may be “at risk”
  • Link access and development
  • More intensive supports

Holte, et al., AJA, 2012
LATE ID: INTERVENTION BEFORE HEARING TEST

- No NHS at birth ($n = 5$), passed NHS at birth & later identified ($n = 49$), unknown ($n = 3$)
- First evaluation 28 months; Confirmation & HA fitting ~ 30 months
- In EI for > 1 year before receiving a hearing test
- 60% with one or more JCIH-identified risk factors

Walker, et al., AJA, 2014
Late-ID ➔ Late HA fit ➔ Reduced language experience

Need for regular surveillance

Enrollment into early intervention has the potential to reduce delays

Walker, et al., AJA, 2014
CAREFULLY FIT AND CONSISTENTLY WORN HAs

HOW ARE WE DOING? PRACTICE IMPLICATIONS?
CAREFULLY FIT HEARING AIDS

- Audiologists measure hearing aids in the child’s ears
- Fit HAs to ideal TARGETS
  - GOAL = bullseye (low error)
- Provide good audibility
  - Audibility = access with hearing aids
  - Measured on scale from 0 (not audible) to 100 (fully audible)
  - Speech Intelligibility Index or SII
  - Minimum goal = 65 (SII)

McCreery, Bentler, Roush, Ear & Hearing, 2013
THREE IMPORTANT FINDINGS

1. **Audibility matters** for children learning spoken language
   - 3 & 5 year olds with more audibility from HAs had better outcomes
     - Speech ($n = 179, r = .27, p = .0003$)
     - Language ($n = 155, r = .23, p = .004$)

2. Benefits were similar for children with **mild** and moderately-severe hearing levels

3. Benefits clearer with **longer use** (all $p$ values $< .05$)
   - Supports early fitting!!

Tomblin et al, *JAMA Otolaryngology*, 2014
ARE HAs WELL FIT? CONSISTENT BULLSEYES?

• Examined HA fitting for 195 children

• 55% of children – targets missed in at least one ear
  • Missed targets reduce audibility!

• 26% of children showed less than adequate audibility (< 65 SII)

ARE HAs WORN CONSISTENTLY?

Walker, et al., in preparation

Data logging

- Infant (n=32)
- Preschool (n=91)
- School-age (n=108)

Average hours of use

Age Group

Walker, et al., in preparation
More challenges:

- Younger children
- Mild hearing levels
- Less resourced families

Walker, et al., LSHSS, 2013
Put an X in the boxes below to indicate how consistently your child uses HAs in the situations listed:

<table>
<thead>
<tr>
<th>Situation</th>
<th>Never (0)</th>
<th>Rare (1)</th>
<th>Sometimes (2)</th>
<th>Often (3)</th>
<th>Always (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Car</td>
<td></td>
<td></td>
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<tr>
<td>12. Day Care</td>
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<td>13. Meal Time</td>
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<td>14. Playing Alone</td>
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<td>15. Book Sharing</td>
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<td>16. Playground</td>
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<tr>
<td>17. Public (store, zoo, restaurant)</td>
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</tbody>
</table>
CHALLENGES TO HA USE: CHILD STATE

Walker, et al., LSHSS, 2013
PRACTICE IMPLICATIONS

- Be good consumers of pediatric audiology practice
  - HAs measured in the ear
  - Match targets to optimize audibility
  - Team with the audiologist

- Support families encountering challenges in device use
  - Mild hearing levels
  - Toddlers
  - Less resourced families

- Understand & address family-identified needs

Moeller, et al., AJA, 2009
EXPOSURE TO INPUT IS OPTIMIZED

HOW ARE WE DOING? PRACTICE IMPLICATIONS?
IS THE LANGUAGE EXPOSURE RICH?

- Caregiver-child interactions at 3 years of age
- Art Gallery procedure (Adamson, et al., 2004)

HIGH LEVEL
M What are they do/ing?
C They’/re fish/ing.
M Oh have you ever been fishing?
C Yeah.
M When did you go fishing?
C Before I born.
M And did the place look like this?

LOW LEVEL – (Test and Directive)
M What is this?
M Come sit down.
M Say, “Pooh.”

Ambrose et al., in preparation
HOW RICH IS THE INPUT?

- HH group exposed to significantly:
  - fewer high-level utterances
  - more directive utterances
  - less complex sentences
  - fewer different words

- Language scores related to:
  - high-level utterances ($r = 0.57$)
  - directives ($r = -0.38$)

Ambrose et al., in preparation
QUALITY PROMOTES ACCESS

- Full day recordings with LENA device
- Both groups exposed to about 60 conversational turns per hour
- Conversational turns associated with child language outcomes ($r = .62, p = .01$)

Van Dam, Ambrose, & Moeller, JDSDE, 2012
Children (n = 28) were 2-3 years of age
Average age at HA = 4.8 months
Full day recordings with LENA
High rates of TV \rightarrow fewer conversational interactions \rightarrow weaker language skills

Ambrose, Van Dam, & Moeller, Ear & Hearing, 2014
PRACTICE IMPLICATIONS

- Increase meaningful conversational turns
- Promote parental understanding of value of conversational interactions
- Reduce TV and other sources of background “noise”
- Promote Language Rich Environment (LRE)
SET THE BAR HIGH &
SUPER-SIZE SERVICES!

HOW ARE WE DOING? PRACTICE IMPLICATIONS?
LANGUAGE AT 3 YEARS OF AGE

Mean TH = 101.32; Mean HH = 88.83 (p = .001, d = 0.747)
Mean TH = 115.16; Mean HH = 97.42 (p = .001, d = 0.961)
SPEECH AT 3 YEARS OF AGE

Mean TH = 100.05; Mean HH = 85.02 ($p = .004$, $d = 0.921$)
Child with bilateral mild-moderate hearing levels
SPEECH AT 5 YEARS OF AGE

Mean TH = 104.59; Mean HH = 92.09 ($p = .002$, $d = 0.843$)
PRACTICE IMPLICATIONS

• Many children who are HH are performing like matched peers with TH
• We need high expectations for achievement
• Proportion of children falling behind is concerning
• We cannot be complacent!
  • Need earlier identification of children who struggle, so interventions can be altered or intensified
  • Need to re-define what it means to be “within the average range”
  • Possible cascading effects on later literacy & socialization
SUPER SERVICES: FAMILY PARTICIPATION

Chi square = 112; $p < .0001$
Range in Provider Specialization Scores

Early Services Professionals n=131

Group 1
Group 2
Group 3

Harrison, Page, et al., in preparation
SPECIALIZED PROVIDERS MORE CONFIDENT IN...

- Assessing Speech & Language
- Assessing Communication Approach
- Designing Intervention Goals
- Developing Oral Language
- Inserting Earmolds & Checking HAs Ling Sounds
- Developing Listening Skills

All p values < .05;

Harrison, Page, et al, in preparation
• Promote service delivery mechanisms that actively involve families
• Ensure that early intervention providers have the specialized expertise needed
• Conduct further research to link interventions with child and family outcomes
BEST PRACTICE GOALS

All families receive timely follow up

There is reason for optimism, but not complacency!

Set the bar high and Super-size services!
FUTURE DIRECTIONS

Outcomes of School Age Children who are Hard of Hearing

Complex Listening Skills in School-Age Hard of Hearing Children
Pediatric Audiology

Biostatistics, Linguistics, & Psychology

Child Language

Project Management