Outcomes of Children with Hearing Loss

A study of children with mild-severe hearing loss

A study funded by the National Institutes of Health – National Institute on Deafness and Other Communication Disorders (NIH-NIDCD)
Grant # DC009560
Project Background

• December 2006 NIH/NIDCD convened a meeting regarding the state of knowledge regarding children with mild-severe hearing loss

• Identify research gaps in:
  – Language and Literacy
  – Speech Recognition and Production
  – Academic Achievement
  – Psychosocial Development
  – Research Methodology

• Spring 2007 call for proposals
Prevalence and Incidence of Pediatric Hearing Loss In the U.S.

- 3/1000 newborns have hearing loss. \(^1\)

- Incidence increases by school age to 6/1000.
  - late identification
  - late onset
  - progressive hearing losses

- 930,000 children 6-19 years of age have mild to severe HL \(^2\) If children 1-6 are included the number is estimated to be well above 1 million. (NHNES, NIDCD)
Why is the OCHL Study Important?

- Most outcome studies have focused on children with severe to profound hearing loss
- Few have focused on children with mild-severe hearing loss
  - Sample sizes are small or are mixed HH/D
  - Lack of control of amplification histories/audibility
  - Few studies have attempted a population sample
    - Samples of convenience
- Need to understand sources of individual differences
Why is the OCHL Study Important?

• Gaps in the Research
  – Reduced body of literature regarding children with hearing losses less than severe or profound. To date, the largest group of subjects consisted of a group of 40 children
    • What are the unique needs of these children today?
    • What else can we do to better serve them?
  – Limited research on the access to, benefits from, and outcomes of services for children with mild to severe hearing losses.
  – Is early identification and intervention helping to reduce speech, language and academic delays?
All Degrees of HL
Place Children at Risk

- Children with "minimal losses:
  - 37% fail one grade
  - 8% don’t have skills at grade level
  - 12-41% receive educational assistance

“Minimal Is not inconsequential”
~Fred Bess
Speech Production

- Delays in onset of babble increase with increases in level of hearing loss (Carney, 1996)
- Some children are at risk for slow transitions from babble to word production (Moeller et al, 2007)
- Differences in consonant repertoires (McGowen et al, 2008: Moeller et al, 2007)
- Speech production generally intelligible as children mature
Receptive and Expressive Language

- Wide variability is found in previous studies of language abilities of children with hearing loss.
- Children with hearing loss perform similarly to age matched peers on grammar (Briscoe, Bishop & Norbury, 2001)
- Children with hearing loss performed similarly to younger children with normal hearing on tests of grammar understanding
- Speech production generally becomes more intelligible as children (Gilbertson & Khami, 1995)
Academic Outcomes

- Educational success is strongly tied to performance in language and communication skills.

- The extent to which HL limits development of language may reflect academic outcomes in school.
  - Verbal IQ
  - Speech Perception in Noise
  - Localization of Sound
Social Communication Outcomes

- More likely than their peers to demonstrate concerns about making friends, being teased and being socially accepted

- Delays in the use of advanced language to explain complex cognitive processes and social reasoning skills (ex: recounting past events, making excuses) 9

- Social reasoning, Theory of Mind and narrative discourse skills

- These skills are essential for social interactions and literacy development 10-12
Recent Changes that May Promote Better Outcomes
• Newborn Hearing Screening
  – 96% of newborns are screened at or shortly after birth in the U.S.
  – *However, as many as 80% of mild bilateral and unilateral losses can be missed at birth*  
  – About 50% of babies who do not pass NHS do not receive follow-up care

• Technological advances in amplification provide improved access to spoken language
  – Frequency Compression Hearing Aids
  – Personal FM use at home and school
  – Increased bandwidth, directional microphones
  – Noise reduction
• Early Intervention Programs
  – By first grade, children identified before 6 months are 1-2 years ahead of their later identified peers in language, cognitive and social skills. 17, 20, 21

  – Parents of Early Identified Children are better prepared to implement Early Intervention goals 22
OCHL Overview

• Five Year Longitudinal Study

• Involving three research teams at different locations
  – The University of Iowa
  – Boys Town National Research Hospital
  – The University of North Carolina
OCHL Goals

1. Measure the developmental, behavioral, and familial outcomes of children with mild to severe hearing loss.
2. Examine the background characteristics of the child and family.
3. Characterize intervention services and factors associated with service variations.
OCHL Goals

4. Identify variance in age of fitting and type of hearing aid, and identify barriers in hearing aid use.

5. Identify to what extent child, family, and community factors contribute to the access of intervention services and functional outcomes.
Target Populations

• 400 children with hearing loss
  • Permanent mild-severe hearing loss PTA 25-75 dB (500, 1k, 2k, 4k)

• 150 children with normal hearing

• Ages 6 months to 6 years 11 months at entry to study

• English spoken in the home by at least one parent

• No significant disabilities
Accelerated Longitudinal Design
Domains of the Study

- **Audiological Information**
  - Tympanometry
  - Audiogram
  - Speech Perception
  - Hearing aid verification

- **Speech Production**
  - Articulation
  - Speech Intelligibility

- **Language**
  - Understanding and use of
    - syntax
    - vocabulary
    - narrative discourse
    - morphological use
  - Social reasoning (Theory of Mind)

- **Academic**
  - Spelling
  - Reading comprehension
  - Word recognition
  - Math
  - Verbal reasoning

- **Psychosocial behavioral/cognitive**
  - Cognitive reasoning
  - Social behavior
  - Teacher reports

- **Family outcomes**
  - Parenting
  - Quality of life/ Family Life
  - Satisfaction of service delivery
Complexity of Interactions

- Background characteristics of the child and the family
- The nature of interventions
  - who provides services
  - how much experience with children who have had mild-severe hearing loss have they had
  - what is their case load
  - how frequently does the child receive services
- Hearing and speech perception/audibility
- Language environments
- Academic environments
- Psychosocial and behavioral influences

How do all these factors interact?
## Test Battery 1 yr 9 mos To 2 yrs 3 mos

**Age First Seen:** 1YR 9MOS TO 2YRS 3MOS AND CHILDREN AGES 1YR 9MOS-2YR 3 MOS AT LATER VISITS

All batteries for hearing loss subjects; Batteries also assumed for control subjects are highlighted

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Test Name</th>
<th>Given To</th>
<th>How Given</th>
<th>Time</th>
<th>Primary Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speech Production:</td>
<td>Ertmer Open and Closed Set Test (O &amp; C)</td>
<td>Child</td>
<td>Elicited</td>
<td>15 min</td>
<td>SLP; Audiologist</td>
</tr>
<tr>
<td></td>
<td>CASPP</td>
<td>Child</td>
<td>Elicited</td>
<td>15 min</td>
<td>SLP; Audiologist</td>
</tr>
<tr>
<td>Hearing Function:</td>
<td>Hx, Audiogram (VRA) + Tymps</td>
<td>Child</td>
<td>Elicited</td>
<td>30 min</td>
<td>Audiologist</td>
</tr>
<tr>
<td></td>
<td>Electroacoustic Analysis 60/90</td>
<td>Child</td>
<td>Elicited</td>
<td>5 min</td>
<td>Audiologist</td>
</tr>
<tr>
<td></td>
<td>Aided Speech Intelligibility Index (Verifit SII)</td>
<td>Child</td>
<td>Elicited</td>
<td>15 min</td>
<td>Audiologist</td>
</tr>
<tr>
<td></td>
<td>ESP lo-verbal</td>
<td>Child</td>
<td>Elicited</td>
<td>15 min</td>
<td>Audiologist</td>
</tr>
<tr>
<td></td>
<td>Hearing Aid Checklist</td>
<td>Parent</td>
<td>Given Checklist</td>
<td>20 min</td>
<td>Audiologist</td>
</tr>
<tr>
<td></td>
<td>Little Ears Questionnaire</td>
<td>Parent</td>
<td>Given Questionnaire</td>
<td>15 min</td>
<td>Audiologist</td>
</tr>
<tr>
<td>Language:</td>
<td>Mullen Scales</td>
<td>Child</td>
<td>Elicited</td>
<td>15 min</td>
<td>SLP</td>
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<td></td>
<td>MBCDI + Upper Extension</td>
<td>Parent</td>
<td>Given Checklist</td>
<td>15 min</td>
<td>SLP</td>
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<tr>
<td>Psychosocial, Behavioral, and Family:</td>
<td>Vineland Adaptive Behavior Scales</td>
<td>Parent</td>
<td>Interviewed</td>
<td>20 min</td>
<td>SLP; Audiologist</td>
</tr>
<tr>
<td></td>
<td>Child Behavior Checklist</td>
<td>Parent</td>
<td>Given Checklist</td>
<td>20 min</td>
<td>SLP; Audiologist</td>
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<tr>
<td></td>
<td>Infant Behavior Questionnaire</td>
<td>Parent</td>
<td>Given Questionnaire</td>
<td>20 min</td>
<td>SLP; Audiologist</td>
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<tr>
<td></td>
<td>Beach Center Family Survey</td>
<td>Parent</td>
<td>Given Checklist</td>
<td>20 min</td>
<td>SLP; Audiologist</td>
</tr>
<tr>
<td></td>
<td>OCHL Family Interview</td>
<td>Parent</td>
<td>Phone Interview following the visit</td>
<td>60 min</td>
<td>SLP; Audiologist</td>
</tr>
<tr>
<td></td>
<td>OCHL SPS Audiology</td>
<td>Service Provider</td>
<td>Online Survey</td>
<td>30 min</td>
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<td></td>
<td>OCHL SPS 0 to 3 Years</td>
<td>Service Provider</td>
<td>Online Survey</td>
<td>30 min</td>
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### Test Battery: 4 yrs 3 mos To 4 yrs 9 mos

**AGE FIRST SEEN: 4YRS 3MOS TO 4YRS 9MOS**
All batteries for hearing loss subjects; Batteries also assumed for control subjects are highlighted

<table>
<thead>
<tr>
<th>Test Type</th>
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<tbody>
<tr>
<td><strong>Academic:</strong></td>
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<td>TOPEL</td>
<td>Child</td>
<td>Elicited</td>
<td>30 minutes</td>
<td>SLP</td>
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<td></td>
<td>WPPSI</td>
<td>Child</td>
<td>Elicited</td>
<td>30 minutes</td>
<td>SLP; Audiologist</td>
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<tr>
<td><strong>Language:</strong></td>
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<tr>
<td></td>
<td>Morphological Elicitation Procedure</td>
<td>Child</td>
<td>Elicited</td>
<td>45 minutes</td>
<td>SLP</td>
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<td>CASL Core 3-4</td>
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<td>Elicited</td>
<td>45 minutes</td>
<td>SLP</td>
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<td><strong>Hearing Function:</strong></td>
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<tr>
<td></td>
<td>Hx, Audiogram (CPA) + Tymps</td>
<td>Child</td>
<td>Elicited</td>
<td>30 minutes</td>
<td>Audiologist</td>
</tr>
<tr>
<td></td>
<td>Electroacoustic Analysis 60/90</td>
<td>Child</td>
<td>Elicited</td>
<td>5 minutes</td>
<td>Audiologist</td>
</tr>
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<td></td>
<td>Aided Speech Intelligibility Index (Verifit SII)</td>
<td>Child</td>
<td>Elicited</td>
<td>15 minutes</td>
<td>Audiologist</td>
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<td><strong>Psychosocial, Behavioral, and Family:</strong></td>
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<tr>
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<td>LNT/MLNT</td>
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<td>Elicited</td>
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<td>Audiologist</td>
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<td></td>
<td>Hearing Aid Checklist</td>
<td>Parent</td>
<td>Given checklist</td>
<td>20 minutes</td>
<td>Audiologist</td>
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<td></td>
<td>SSQ Revised</td>
<td>Parent</td>
<td>Given checklist</td>
<td>15 minutes</td>
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<td></td>
<td>Child Behavior Checklist</td>
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<td>Vineland Adaptive Behavior Scales</td>
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<td>Family Activities Checklist &amp; Parent Issues Checklist</td>
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<td></td>
<td>OCHL SPS Audiology</td>
<td>Service Provider</td>
<td>Online survey</td>
<td>30 minutes</td>
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<td>OCHL SPS Preschool</td>
<td>Service Provider</td>
<td>Online survey</td>
<td>30 minutes</td>
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<td></td>
<td>Teacher Report Forms</td>
<td>Teacher</td>
<td>Sent forms</td>
<td>20 minutes</td>
<td>SLP; Audiologist</td>
</tr>
</tbody>
</table>
# Test Battery: 5 yrs 9 mos To 6 yrs

**AGE FIRST SEEN: 5YRS 9MOS TO 6YRS**

All batteries for hearing loss subjects; Batteries also assumed for control subjects are highlighted

<table>
<thead>
<tr>
<th>Test Type</th>
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<tr>
<td><strong>Academic:</strong></td>
<td>WRMT-R: Word Attack Subtest</td>
<td>Child</td>
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<td>5 minutes</td>
<td>SLP</td>
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<tr>
<td></td>
<td>WRMT-R: Word Identification</td>
<td>Child</td>
<td>Elicited</td>
<td>5 minutes</td>
<td>SLP</td>
</tr>
<tr>
<td></td>
<td>WRMT-R: Passage Comprehension</td>
<td>Child</td>
<td>Elicited</td>
<td>15 minutes</td>
<td>SLP</td>
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<tr>
<td></td>
<td>WASI</td>
<td>Child</td>
<td>Elicited</td>
<td>30 minutes</td>
<td>SLP</td>
</tr>
<tr>
<td></td>
<td>Head to Toes</td>
<td>Child</td>
<td>Elicited</td>
<td>5 minutes</td>
<td>SLP</td>
</tr>
<tr>
<td><strong>Language:</strong></td>
<td>CASL Core 5-6</td>
<td>Child</td>
<td>Elicited</td>
<td>60 minutes</td>
<td>SLP</td>
</tr>
<tr>
<td></td>
<td>Spontaneous Language Sample</td>
<td>Child</td>
<td>Elicited</td>
<td>20 minutes</td>
<td>SLP</td>
</tr>
<tr>
<td><strong>Hearing Function:</strong></td>
<td>Hx, Audiogram (Conventional) + Tymps</td>
<td>Child</td>
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<td>Audiologist</td>
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<tr>
<td></td>
<td>PBK</td>
<td>Child</td>
<td>Elicited</td>
<td>15 minutes</td>
<td>Audiologist</td>
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<td></td>
<td>Hearing Aid Checklist</td>
<td>Parent</td>
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<td></td>
<td>SSQ Revised</td>
<td>Parent</td>
<td>Given checklist</td>
<td>15 minutes</td>
<td>Audiologist</td>
</tr>
<tr>
<td><strong>Psychosocial, Behavioral, and Family:</strong></td>
<td>Friendship Interview</td>
<td>Child</td>
<td>Interviewed</td>
<td>15 minutes</td>
<td>Speech Pathologist; Audiologist</td>
</tr>
<tr>
<td></td>
<td>Child Behavior Checklist</td>
<td>Parent</td>
<td>Given checklist</td>
<td>20 minutes</td>
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</tr>
<tr>
<td></td>
<td>Family Activities Checklist &amp; Parent Issues Checklist</td>
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<td>Given checklist</td>
<td>20 minutes</td>
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</tr>
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<td></td>
<td>Children's Behavior Questionnaire</td>
<td>Parent</td>
<td>Given Questionnaire</td>
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<td>SLP; Audiologist</td>
</tr>
<tr>
<td></td>
<td>Beach Center Family Survey</td>
<td>Parent</td>
<td>Given Questionnaire</td>
<td>20 minutes</td>
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</tr>
<tr>
<td></td>
<td>OCHL Family Interview</td>
<td>Parent</td>
<td>Phone interview following the visit</td>
<td>60 minutes</td>
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<tr>
<td></td>
<td>OCHL SPS Audiology</td>
<td>Service Provider</td>
<td>Online Survey</td>
<td>30 minutes</td>
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<td></td>
<td>OCHL SPS School-Age</td>
<td>Service Provider</td>
<td>Online Survey</td>
<td>30 minutes</td>
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<tr>
<td></td>
<td>Teacher Report Forms</td>
<td>Teacher</td>
<td>Sent forms</td>
<td>20 minutes</td>
<td>SLP; Audiologist</td>
</tr>
</tbody>
</table>
Data Collection and Management

- Family Intake Questionnaire at first visit
- Telephone Interview of Parents (annual)
  - One individual conducts all the interviews
- Online Services and Provider Survey (annual)
  - Birth-to-Three
  - Preschool
  - School Age
- Teacher Survey - Online
  - Preschool
  - School Age
- Teacher questionnaires - Paper
- Medical Records
  - Birthing hospital
  - Pediatrician
  - ENT
Data Collection and Management

• Centralized Data Entry Access
  • For all service providers and teachers
  • For entry of annual parent telephone interview
  • Each of the three research teams
    • Enrollment data
    • Scheduling and tracking information
    • Item level entry for test data collected at each site

• Sharepoint site for research teams
  • Discussion forum
  • Shared documents
  • Team calendars
Family Intake Interviews

- Information about the children
  - 207 children included thus far
    - Male: 107 (51.7%)
    - Female: 100 (48.3%)

- Age at entry into the study
  - Range: 6 - 86 months
  - Mean: 43 months
  - Median: 43 months
All the OCHL Team Members

- **The Univ of Iowa**
  - Bruce Tomblin Co-PI
  - John Knutson
  - Ruth Bentler
  - Lenore Holte
  - Sandie Bass-Ringdahl
  - Connie Ferguson
  - Elizabeth Walker
  - Marcia St. Clair
  - Wendy Fick
  - Rick Arenas
  - Jacob Oleson
  - Jane Pendergrast
  - Marlea O’Brien  Project Coordinator

- **BTN RH**
  - Mary Pat Moeller Co PI
  - Pat Stelmachowicz
  - Mark Van Dam
  - Meredith Spratford
  - Emlie Sweet
  - Laura Kreigshauser
  - Lauren Berry
  - Sophie Ambrose
  - Amelia Schuster
  - Lisa Burton

- **The Univ of North Carolina**
  - Melody Harrison
  - Patricia Roush
  - Shana Jacobs
  - Thomas Page
  - Aneesha Pretto
Because the data presented at the EHDI IFSC meeting reflects only a small part of the first year of data collected, and are potentially misleading, all data slides have been deleted.