Team Approach to Determining Cochlear Implant Candidacy in Early Infancy

Jean Thomas, M.S., CCC-A
Kristin Lutes, M.S., CCC-SLP
Mary Willis, M.S., CCC-SLP
Carle Foundation Hospital, Urbana, Illinois
Early Intervention

• Critical periods for language development
• Spoken language and auditory skill development requires auditory input
• Delay in EI result in gap in language and listening skills
CDC Goals for EHDI

“1 – 3 – 6 Rule”

- Newborn hearing screening completed by 1 month of age
- Diagnostics completed by 3 months of age
- Follow up and intervention should be in place by 6 months of age
## Infant Demographics

<table>
<thead>
<tr>
<th>Age grouping</th>
<th>n=</th>
<th>NHS 1 mo</th>
<th>Avg. age of diagnosis</th>
<th>Avg. age fit with HA 6 mo</th>
<th>Avg. age at CI surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤12 mo</td>
<td>14</td>
<td>93% screened, majority failed (1 pass)</td>
<td>2 mo range .5-5 mo</td>
<td>3 mo range 1-7 mo</td>
<td>9 mo range 6-12 mo</td>
</tr>
<tr>
<td>13-18 mo</td>
<td>13</td>
<td>38% screened, all failed</td>
<td>7 mo range 1-14 mo</td>
<td>9 mo range 2-15 mo</td>
<td>15 mo range 13-18 mo</td>
</tr>
</tbody>
</table>
CI Candidacy

♦ FDA guidelines:
  ♦ 12 months of age or older
CI in Infancy Leads To Positive Outcomes

- Hammes et al 2002
- Robbins et al 2004
- Schauwers et al 2004
- Sharma et al 2004
- Colletti et al 2005
- Kishon-Rabin et al 2005
- Tomblin et al 2005
- Waltzman & Roland 2005
- Dettman et al 2007
CI Candidacy

♦ FDA guidelines:
  ♦ 12 months of age or older
  ♦ Profound hearing loss in both ears (≥90dB)
  ♦ Little or no benefit from appropriately fit hearing aids
  ♦ Lack of auditory progress
  ♦ Family motivation to improve hearing
  ♦ Appropriate expectations
  ♦ No medical contraindications
<table>
<thead>
<tr>
<th>Pediatric CI Evaluation</th>
<th>Infant CI Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete behavioral audiologic assessment</td>
<td></td>
</tr>
<tr>
<td>Verification of hearing aid fitting</td>
<td></td>
</tr>
<tr>
<td>Measure of aided speech recognition, with appropriate open/closed set materials</td>
<td></td>
</tr>
<tr>
<td>Speech language evaluation using formal test measure</td>
<td></td>
</tr>
<tr>
<td>Medical evaluation</td>
<td></td>
</tr>
<tr>
<td>Pediatric CI Evaluation</td>
<td>Infant CI Evaluation</td>
</tr>
<tr>
<td>-------------------------------------------------------------</td>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>Complete behavioral audiologic assessment</td>
<td>Objective test measures, with behavioral audiometric evaluation when developmentally appropriate</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Verification of hearing aid fitting</td>
<td>Verification of hearing aid fitting</td>
</tr>
<tr>
<td>Measure of aided speech recognition, with appropriate open/closed set materials</td>
<td>Evaluation of auditory skill development</td>
</tr>
<tr>
<td>Speech language evaluation using formal test measure</td>
<td>S/L eval incorporated in diagnostic therapy over several months</td>
</tr>
<tr>
<td>Medical evaluation</td>
<td>Medical evaluation</td>
</tr>
</tbody>
</table>
Pediatric Cochlear Implant Team

♦ Family
♦ Audiologist
♦ Otologist
♦ Speech language pathologist
♦ Child development specialist
Pediatric Cochlear Implant Team

♦ Family
♦ Audiologist
♦ Otologist
♦ Speech language pathologist
♦ Child development specialist
Team Approach in Determining CI Candidacy in Infants

Coordinated effort
Lengthy process making early referral important
Begins when family and professionals enter the education and evaluation process together
Family on the CI Team

- Family supported in grieving process
- Family encouraged to be active participant in decision making process
  - Family education and training
  - Parent/Caregiver support groups
Supporting Parents in the Decision Making Process (Duncan 2009)

♦ Provide parents time to deal with their feelings. Do not rush the decision making process
♦ Discover parent aspirations for their child
♦ Professionals must provide families with impartial information that respects the family’s needs
Team Approach in Determining Cochlear Implant Candidacy in Infants

♦ Family
♦ **Audiologist**
♦ Otologist
♦ Speech language pathologist
♦ Child development specialist
Audiologic Assessment

- Objective measures
  - ABR
  - ASSR
  - OAE
  - Tympanometry
Hearing Aid Fitting and Verification

♦ Fitting formula used to calculate targets for the gain and output of the hearing aid (DSL, NAL)
♦ Ensures that the hearing aid is amplifying speech to be comfortable and audible to maximize speech understanding
Hearing Aid Fitting and Verification

♦ Probe microphone measurements
♦ Individualize fitting with RECD
Assess Auditory Skill Development

Parent Questionnaires

♦ IT-MAIS assesses emergence of auditory skills in everyday situations
♦ LittLEARS assesses preverbal auditory behavior up to 2 years of age
Team Approach in Determining Cochlear Implant Candidacy in Infants

- Family
- Audiologist
- Otologist
- Speech language pathologist
- Child development specialist
Medical Reports

- Young 2002
- James & Papsin 2004
- Miyamoto et al 2005
- Waltzman & Roland 2005
- Colletti et al 2005
- Birman 2009
Surgical Considerations

- Radiologic evaluation
- Overall health of the infant
- Anesthesiologist experienced with infants
- Physiological differences
  - Blood loss
  - Head size
Team Approach in Determining Cochlear Implant Candidacy in Infants

♦ Family
♦ Audiologist
♦ Otologist
♦ Speech language pathologist
♦ Child development specialist
Developmental and Speech / Language Evaluation
Evaluation

Question #1

Given the infant’s chronological age (adjusted if applicable),

How does he seem to be developing apart from skills affected by hearing loss?

For example, If the child is 3 mos old, is he doing the kinds of things that you would expect most 3-month old babies to do?
Evaluation

- Developmental Information *not* dependent upon hearing
  - Sleeping & Feeding Patterns
  - Reflexes
  - Gross & Fine Motor Skills
  - Visual Skills
  - Non-verbal cognition
  - Play & Socialization using facial cues, gestures, actions, props
Evaluation:
Question #2

In comparison to the infant’s overall functioning level for skills not affected by hearing loss (Result #1) –

How does he seem to be developing skills that are affected by hearing loss?
Evaluation

- Developmental Information that is dependent upon hearing
  - Auditory Responses
  - Auditory Cognition
  - Types of Sound Production
  - Speech Sound Development
  - Comprehension of Language
    - Spoken w/o Visual Cues
  - Social Initiations & Responses
    - Using Spoken Language
      - without visual cues
Evaluation Results

Evaluation details provide developmental starting points for exploring an infant’s candidacy for cochlear implantation through diagnostic therapy.
Diagnostic Therapy: Continuation of the Speech Language Evaluation Process
Diagnostic Therapy

- Begins as soon as possible following initial evaluation
- Infants generally seen weekly
- Necessarily involves family members
- Necessarily involves audiologists
- Helps ensure appropriateness of early cochlear implantation
Diagnostic Therapy

- Observations of the child’s communication behaviors in a play environment
- Parent education and training
- Develop auditory skills needed for behavioral assessment
Diagnostic Therapy

- Recording infant’s vocalizations
- Pre-lexical vocalizations provide a window into what the child is hearing
- Ongoing formal assessment of speech language and listening skills
Team CI Evaluation Process

- Ongoing collaborative process
  - Bring parental priorities, expectations and goals to team meetings
  - Providers update team on evaluation findings and therapy status
  - Deliberate prognosis for achieving family’s goals with HAs vs. CIs
  - Team recommendations made with knowledge of how timely intervention impacts outcomes
CI in Infancy Leads To Positive Outcomes

- Hammes et al 2002
- Robbins et al 2004
- Schauwers et al 2004
- Sharma et al 2004
- Colletti et al 2005
- Kishon-Rabin et al 2005
- Tomblin et al 2005
- Waltzman & Roland 2005
- Dettman et al 2007
Recent Studies

♦ Geers et al 2009
  ♦ Study of 153 children enrolled in oral communication programs. Testing completed at 5-6 yrs of age
  ♦ Identified four predictors of spoken language skills
    ♦ Nonverbal intelligence
    ♦ Parent Education
    ♦ Age at CI stimulation
    ♦ Gender
  ♦ Optimum age of CI varied depending on language domain being tested
  ♦ Regression analysis indicated that age appropriate development of *complex* language skills requires early CI (12 mo of age)
Dettman et al. 2007

- Children who received CI younger than 12 mo achieved mean rates of language growth comparable to normal hearing peers.
- Rates were significantly greater than rates of children implanted between 12-24 mo.
- When data from children with cognitive delays were removed, the difference in rates remained statistically significant.
Children who were implanted by 18 months of age have smaller gaps in language abilities than do children implanted after 18 months of age.
Purpose

- To provide update on connected language progress of 4 groups of children (n=66) who ranged in age from 7 – 48 months at the time of implantation.

- To compare outcomes of those implanted by 12 months of age to that of children implanted between 13 - 18 months.
Subjects
Subjects

Age Group Comparisons

9 - 18 months (n=19)
19 - 30 months (n=23)
31 - 40 months (n=12)
41 - 48 months (n=12)
Demographics
Results

Connected Language
Language Age vs. Chronological Age

- <18 mos. (n=19)
- 19 - 30 mos. (n=23)
- 31 - 40 mos. (n=12)
- 41 - 48 mos. (n=12)

Chronological Age in Months

Language Age (in months)
Language Quotient by Age at Implantation

Groups by Age at Implantation

- 18 mos. or under (n=16) - Language Quotient: .95
- 19 –30 months (n=20) - Language Quotient: .67
- 31 –40 months (n=11) - Language Quotient: .59
- 41–48 months (n=10) - Language Quotient: .55
Young Group Break Down

7 - 12 months (mean=9.25)

vs.

13 - 18 months (mean=15)
Young Group Break Down

The Groups

12 months or under (n=8/10)
13 - 18 months (n=7/12)

Exclusions: <12 months of CI experience (n=2); Substantial secondary disabilities (n=5)
## Language Quotients with CI by 12 Months vs. CI at 13 - 18 Months

<table>
<thead>
<tr>
<th>Age at Implant/Test Interval</th>
<th>Lang. Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Implanted by 12 mos.</strong></td>
<td></td>
</tr>
<tr>
<td>most recent (n=8)</td>
<td>1.020</td>
</tr>
<tr>
<td>1.5 year post</td>
<td>0.969</td>
</tr>
<tr>
<td>1 year post</td>
<td>0.944</td>
</tr>
<tr>
<td><strong>Implanted at 13 - 18 mos.</strong></td>
<td></td>
</tr>
<tr>
<td>most recent (n=7)</td>
<td>0.923</td>
</tr>
<tr>
<td>1.5 year post</td>
<td>0.796</td>
</tr>
<tr>
<td>1 year post</td>
<td>0.916</td>
</tr>
</tbody>
</table>
Summary of Study Findings

- Comparing the performance of 66 children implanted at Carle Foundation Hospital, the highest overall performance was seen in children implanted by 18 months of age.

- Implantation by 12 months resulted in an even smaller average gap than at 13-18 months.

- In all groups, the children who progressed most slowly were those with secondary disabilities, poor parental follow through, or inconsistent device use.
Summary

♦ Early detection and diagnosis is critical to achieving implantation in early infancy

♦ In cases of severe to profound HL, referral for CI evaluation needs to be made soon after diagnosis - before 6 months of age

♦ A cooperative effort between families and an experienced pediatric CI team can lead to cochlear implantation by 12 months of age

♦ Cochlear implantation is desirable in infancy to maximize outcome
Contacts

Mary.Willis@carle.com
Jean.Thomas@carle.com