Learning to Listen with Hearing Technologies: An interdisciplinary perspective on aural rehabilitation

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Optimal Access to Sound

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Learning Objectives

• Discuss the variety of audiological options available for individuals who have hearing loss, whether the hearing loss is mild, profound, unilateral or bilateral.

• Discuss resources for evaluation and intervention of children or adults with hearing loss who are learning to listen with hearing technologies.

• Discuss key principals in evaluation and intervention for children with hearing loss who are learning to listen and use spoken language, whether an infant starting an IFSP or an elementary-aged child who has nearly met all IEP goals.
Options

- FM system and other assistive technologies
- Hearing aids
- Bone and magnetic anchored devices
- Middle ear implants
- Cochlear implants
- Hybrid implants
- Auditory brainstem implants
## Why It Matters

<table>
<thead>
<tr>
<th>Age at Diagnosis</th>
<th># of Children Diagnosed at Lions Clinic in 2012 - year to date (% of column)</th>
<th># Children Diagnosed elsewhere but seen at Lions Clinic (diagnosed in 2012 - year to date)</th>
<th>Total # of children diagnosed or seen at Lions clinic (diagnosed in 2012 – year to date)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-30 days</td>
<td>2 (5%)</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>31-91 days (0-3 months)</td>
<td>15 (37%)</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>92-730 days (4-24 months)</td>
<td>10 (24%)</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>731-1825 days (25-60 months)</td>
<td>9 (22%)</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>&gt;1826 days (5-10 years old)</td>
<td>5 (12%)</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>41 (100%)</strong></td>
<td><strong>2</strong></td>
<td><strong>43</strong></td>
</tr>
</tbody>
</table>

Information obtained from Minnesota Department of Health
• Hearing loss affects 12,000 children born in the United States each year, making it the most common sensory birth difference.
• ~2 to 3 out of every 1,000 children in the United States are born deaf or hard-of-hearing.
• Nine out of every 10 children who are born deaf are born to parents who can hear (~90%).
It takes a team

- Parents and family
- MN Dept. of Health
- MN Help Me Grow
- MN Hands and Voices
- ENT
- Clinical Audiologist
- Speech-language pathologist (aural rehabilitation specialist)
- Educational Audiologist
- Educators/Early Intervention team
- Physical therapist
- Occupational therapist
- Child psychologist
- Genetics
- Ophthalmology
- Infectious Disease
- Many others!
Hearing Loss Diagnosis

• After diagnosis of hearing loss by audiologist, referral made to pediatric otolaryngologist (ENT)
  – ENT evaluates structures, middle ear status, gives clearance for amplification if appropriate

• Referral to early intervention (Help Me Grow MN) to prepare Individualized Family Service Plan (IFSP) or Individualized Education Plan (IEP)
Goal of Amplification

• Assist them in hearing conversation at average and soft listening levels in both quiet and in competing noise

• Maximize their auditory functioning to enable children to fully participate in aspects of communication that occur in their daily lives if family chooses spoken language communication

• Amplify sounds into audible range, in order to hear and thus develop speech-language skills
Hearing Aids

- Unilateral hearing loss (mild to severe)
- Bilateral hearing loss (mild to severe)
Hearing Aids

• Hearing aids provide amplification at frequencies where there is hearing loss, making speech sounds audible

• After earmolds taken, hearing aids and earmolds ordered

• Child returns several weeks later for hearing aid fitting
Hearing Aid Features

- Digitally programmable standard
- Verification measures used
- Advanced features such as frequency compression used when appropriate
Bone anchored candidacy criteria

- conductive hearing losses
- mixed hearing losses
- single sided deafness
Osseointegrated Devices

- BAHA: bone anchored hearing aid
- Used for those with microtia/atresia, or otherwise blocked/damaged middle ear systems
- Also used for single-sided deafness (SSD), where one ear has normal hearing
- Can be surgically implanted or worn on soft headband for pediatrics (surgery can be performed after age 5)
Bone anchored device mechanisms

- The sound is transferred from the processor through a tiny percutaneous penetrating abutment connected directly into the titanium implant.
- The outer and middle ear are bypassed as sound is directly transferred from the acoustic environment to the cochlea via the skull bones.
Osseointegrated Outcomes

- Quality of life
- Performance in quiet
- Performance in noise
- Localization?
Middle ear and other implants

- Maxum – middle ear implant: magnet implanted on ossicles and processor worn in the ear canal or behind the ear
- Vibrant Soundbridge – middle ear implant: converts sounds into mechanical vibrations, stimulating middle ear structures
- Lyric – hearing aid left in the ear canal 24/7
- Soundbite – uses bone conduction transmitting sound via teeth
Cochlear Implants
CI History

• 1970 – First commercially available device (3M single electrode)
  – Age 18 and older
• 1984 – Multi-channel devices introduced
• 1985 - FDA approved for adults
• 1990 - FDA approval for children
  * (at time for age >24 months)
  – Criteria lowered to 18 months in 1998
  – Criteria lowered to 12 months in 2002
Cochlear Implants

• An implantable medical device

• Electrically stimulates auditory nerve of those patients with severe to profound sensorineural hearing loss

• Has potential to give sound perception to those who are unable to derive benefit from hearing aids (for variety of reasons), by bypassing damaged portion of hearing system
Electrode Arrays

- Advanced Bionics – 16
- Cochlear – 24 (22 in cochlea)
- Med-El – most have 12 pairs of electrode contacts, but varies by internal device
Components

- Microphone – captures sounds from environment
- Speech processor – processes sound
- Transmitter/external magnet – information sent across skin via radio waves to internal receiver
- Receiver/stimulator – converts transmitted information into electrical signals
- Electrode/electrode array – delivers signals to nerve for stimulation
Candidacy by Manufacturer

• Advanced Bionics
  – Adults - Severe to profound, bilateral, sensorineural hearing loss (>70 dBHL). Postlingual onset. 50% or less on a test of open-set sentence recognition (HINT Sentences).
  – Children - 12 months through 17 years of age. Profound, bilateral, sensorineural hearing loss (>90 dBHL). Little or no benefit from appropriately fitted hearing aids. Motivation to improve hearing, realistic expectations.

• Cochlear
  – Adults – Severe to profound sensorineural hearing loss bilaterally. 50% or less on sentence recognition tests in the ear to be implanted and 60% or less in the non-implanted ear or bilaterally.
  – Children – 12 months to 2 years – profound loss; 2 years to 17 years – severe to profound loss. Lack of progress in the development of auditory skills. High motivation and realistic expectations from family

• Med-El
  – Speech monosyllable score should be ≤60% at 65dBSPL in the best aided condition.
Clinical CI Candidacy for Evaluation - Adult

- Sensorineural hearing loss approximately 70 decibels (dB) or greater bilaterally
- Pre or post-lingual deafness
- Unaided word recognition <40-50% in each ear
- Fit with bilateral hearing aids (loaner hearing aid can be fit for evaluation in one ear if only utilizing one hearing aid)
- Willing and medically stable to undergo surgical procedure
- No age limitation

➢ Medicare: 40% or less in the best aided condition
Clinical CI Candidacy for Evaluation – Pediatric

• **FDA criteria**
  – Children 12-24 months with bilateral profound sensorineural hearing loss
  – Children 2-17 years with bilateral severe to profound sensorineural hearing loss with limited benefit from bilateral hearing aids

• **Clinical criteria**
  – Evaluate moderate to severe sensorineural hearing loss (or worse) bilateral sensorineural hearing loss or
  – Child with any hearing loss for which hearing aids cannot provide adequate benefit (i.e. steeply sloping hearing loss)
Evaluation Process

• Team Approach
• Referral initiated; patient meets with Cochlear Implant Team
• Full audiological evaluation and history
  – Team approach critical (input from speech-language pathologists, educators, early intervention team, parents, etc.)
  – Behavioral assessment and/or electrophysiologic testing (i.e. ABR)
• Aided assessment—Soundfield
• Tympanometry and acoustic reflexes
• Auditory brainstem response evaluation if needed
• OAEs
• Aided Speech Perception
• Aural Rehabilitation evaluation
Team Involved in Decision-Making

– Parents and family
– Surgeon
– Clinical Audiologist
– Speech-language pathologist (aural rehabilitation specialist)
– Educators/Early Intervention team
– Child psychologist
– Genetics, Ophthalmology, Infectious Disease, other specialists as appropriate
Important note

- Cochlear implants are a team decision, but most importantly a family choice. As CI’s are an elective surgery, no matter what communication modality they choose, it is important to have auditory training to maximize its function.
Hybrid implants

• Electric and acoustic stimulation combined

• Available outside the US and in trials throughout the country
Auditory Brainstem Implants (ABIs)

• Initially developed at the House Research Institute in 1979

• Current model made by Cochlear Corporation
  – Nucleus 24 Auditory Brainstem Implant (ABI) System

• Designed to give sound awareness to people who become deaf when surgery to remove auditory nerve tumors damages the nerves
  – Neurofibromatosis type 2
ABI’s

- Implanted during acoustic neuroma removal
- Array placed in patient’s cochlear nucleus
- FDA approved (in 2000) for ages 12 and older
  - Neurofibromatosis type 2 diagnosis
- January 2013 update: pediatric FDA trial approved
- Approximately 15-20 per year in United States (300 in US overall)
- Approximately 1500 adults implanted worldwide
ABI Clinical studies

• 82% of the patients implanted with the Nucleus 24 Auditory Brainstem Implant System were able to detect certain familiar sounds, such as honking horns and ringing doorbells
• 85 % were able to hear and understand conversation with the aid of lipreading
• About 20-25% of ABI recipients are able to understand some speech without lip-reading
• Pediatric ABI trial approved by FDA in January 2013
ABI’s
Fairview Aural Rehabilitation

- Four Systemwide Aural Rehabilitation Specialists
- Miranda Davis (Fairview Burnsville)
  - Pediatric and adults
- John Henry (Fairview Southdale)
  - Adults
- Erika King (Fairview Southdale and University of Minnesota Amplatz Children’s Hospital)
  - Pediatric and adults
- Sara Oberg (University of Minnesota Medical Center, Fairview and University of Minnesota Amplatz Children’s Hospital)
  - Pediatric and adults
University of Minnesota Amplatz Children’s Hospital

- World-class care in more than 50 pediatric specialties
- All private patient rooms – 65% larger than national average
- New Pediatric Emergency Department and Trauma Center
- Minnesota’s first “green” children’s hospital
Lions Children’s Hearing & ENT Clinic

- Pediatric Audiologists
  - Melissa Ferrello, Au.D.
  - Barbara Friedman, Au.D.
  - Kristin Musser, Au.D.
  - Jennifer Ward, Au.D.

- Aural Rehabilitation Specialists
  - Erika King, SLP
  - Sara Oberg, SLP

- Pediatric Otolaryngologists
  - David Hamlar, M.D.
  - Tina Huang, M.D.
  - Abby Meyer, M.D.
  - Frank Rimell, M.D.
Thank you!
References available upon request
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