Introduction to Cochlear Implant Technology

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UTAH SPEECH AND HEARING ASSOCIATION

History of Cochlear Implants

- Concept of electrical stimulation has been around since 1950’s.
- Djourno and Eyries teamed together in 1957 in France but discontinued work due to equipment failure and due to personality conflict.
- Reports of benefits of electrical stimulation were lost for several years due to translation.

History of Cochlear Implants

- Work in United States began with William House in CA.
- Several US scientists continued exploration of electrical stimulation.
- The Bilger Report was a pivotal moment in cochlear implant history.
  - Patients could not understand speech with implant alone
  - Ability to lip-read improved
  - Quality of life improved
  - Speech production improved

How Does a Cochlear Implant Work?

- Basic parts and functionality are similar across the implant companies
- Internal Components
- External Components

Outline of lecture

- How does a cochlear implant work?
- Who is a candidate for a cochlear implant?
- Introduction to Mapping
- How well do cochlear implant recipients do?
- The team approach to cochlear implantation.
- Case Studies
External Components

- Microphone
  - Gathers sound

- Sound Processor
  - Digitizes and analyzes incoming sounds

- Cords
  - Delivery of electrical data

- External Transmitter
  - AKA – Transmitter
  - AKA – Headpiece
  - AKA – Coil
  - Purpose is to deliver data to the internal receiver (antenna) via radio frequency

- Power Source
  - Rechargeable or disposable batteries

- Magnet
  - Only purpose is to locate and maintain connectivity between external and internal components
Internal Components
- Magnet
  Maintain connectivity with external hardware

Internal Components
- Antenna
  Receives data delivered by external transmitter via radio frequency

Internal Components
- Receiver Stimulator
  Decodes and analyzes data — delivers data to electrode array

Internal Components
- Electrode Array
  Stimulation of auditory nerve fibers in the cochlea

Our Past

X-Ray Image of implanted Cochlear Implant
How does a cochlear implant work?

- External sound processor captures sound and converts it into digital signals.
- Processor sends digital signals to internal implant.
- Internal implant converts signals into electrical energy, sending it to an electrode array inside the cochlea.
- Electrodes stimulate hearing nerve, bypassing damaged hair cells, and the brain perceives signals as sound.

How Does a CI Work?

- External sound processor captures sound and converts it into digital signals.
- Processor sends digital signals to internal receiver via the transmitting coil.
- Internal implant converts signals into electrical energy, sending it to an electrode array inside the cochlea.
- Electrodes stimulate hearing nerve, bypassing damaged hair cells, and the brain perceives signals as sound.

Three CI Manufacturers in the US

- Advanced Bionics ‘Hi Res 90K’
- Cochlear Corp. ‘Nucleus 5’
- MedEl ‘Sonata’
Three CI Manufacturers in the US
The External Hardware

- Advanced Bionics
  ‘Harmony’
- Cochlear Corp.
  ‘Nucleus Freedom’
- MedEl
  ‘Opus 2’

Pediatric Candidacy

- Candidacy Evaluations consist of:
  - Medical Evaluation
  - Audiologic Evaluation

Pediatric Candidacy

- Medical Evaluation
  - Status of cochlea
  - General health of the patient

Pediatric Candidacy

- Audiologic Evaluation
  - Evaluation of degree of hearing loss
  - Evaluation of speech perception
  - Evaluation of hearing aid

Candidacy for Children

- Age 12 months
- Family’s desire to be part of hearing world
- High motivation & appropriate expectations
- Hearing aid use for at least 6 months
- Little success with hearing aids
- Commitment to spoken language
- Appropriate educational placement
- No medical contraindications
### Children Audiologic Evaluation 12-24 Months

<table>
<thead>
<tr>
<th>Audioligic Test</th>
<th>Cochlear Implant criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABR/ASSRs</td>
<td>Profound range</td>
</tr>
<tr>
<td>Immitance Audiometry</td>
<td>Normal middle ear function</td>
</tr>
<tr>
<td>Otoacoustic Emissions</td>
<td>No response</td>
</tr>
<tr>
<td>Unaided thresholds</td>
<td>Profound hearing loss</td>
</tr>
</tbody>
</table>

#### ABR/ASSR

**Auditory Brainstem Response**

**Auditory Steady State Response (ASSR)**

- Sounds produced by the cochlea, usually in response to sound
- Presence of OAE suggests normal functioning cochlea/normal hearing
- Must be absent to qualify for implantation

#### Immittance Testing

**Tympanogram**

- Normal tympanogram and absent reflexes are criteria for candidacy

**Acoustic Reflex**

- Aided thresholds
- Lack of progress in auditory skill development

### Children Audiologic Evaluation 12-24 Months Criteria

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Threshold (dB)</th>
</tr>
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<tbody>
<tr>
<td>125</td>
<td>0</td>
</tr>
<tr>
<td>250</td>
<td>0</td>
</tr>
<tr>
<td>500</td>
<td>0</td>
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<td>8000</td>
<td>0</td>
</tr>
<tr>
<td>10000</td>
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</tr>
</tbody>
</table>

#### Otoacoustic Emission (OAE)

- Sounds produced by the cochlea, usually in response to sound
- Presence of OAE suggests normal functioning cochlea/normal hearing
- Must be absent to qualify for implantation

#### Children Audiologic Evaluation 12-24 Months

- Aided thresholds
- Outside of speech range in high frequencies
- MAIS (Meaningful Auditory Integration Scale)
**MAIS - 42-48 Months Criteria**

Does the child spontaneously recognize auditory signals that are part of his/her everyday routines?

1. Ask the parent: When _____ hears the _____ signal, _____ does one of the following?

   - Always
   - Frequently
   - Occasionally
   - Rarely
   - Never

2. Ask the parent: How many times does _____ hear the _____ signal on a daily basis?

   - Always
   - Frequently
   - Occasionally
   - Rarely
   - Never

**Speech Perception Testing**

- **Outside of speech range in high frequencies** ≤ 30% MLNT
- **Aided thresholds**

**Children Audiologic Evaluation - 2-5 Years**

- Aided thresholds
- Outside of speech range in high frequencies
- Speech Perception Testing

**MAIS - 5 Years Criteria**

- Aided thresholds
- Outside of speech range in high frequencies
- Speech Perception Testing

**MAIS - 5 Years**

- Aided thresholds
- Outside of speech range in high frequencies
- Speech Perception Testing

**Children Audiologic Evaluation - 2-5 Years**

- Aided thresholds
- Outside of speech range in high frequencies
- Speech Perception Testing
Children Audiologic Evaluation
5 - 18 Years

Aided thresholds

- Outside of speech range in high frequencies

Speech Perception testing
- Words
- Sentences

≤ 30% on LNT

CI SELECTION CRITERIA IN CHILDREN

Potential Candidates

- Length of use of appropriate amplification
- Powerful behind-the-ear hearing devices
- 60-65-70 peak gain
- 55-60 dB gain at 4000 Hz
- Appropriate max power output

- Appropriate ear molds
- Hold gain of HD without feedback
- High frequency emphasis if necessary

- Language level both oral and sign language
- Response task needs to be in the mode taught to the child, otherwise you may not be assessing what the child can hear.
CI Programming

Topics of Discussion
- Definition of mapping
- Basic Parameters of Mapping
- Methods of mapping
- Is the map right?
- Important information to provide in preparation for mapping session
- Important information to know from the mapping session

BASIC MAP PARAMETERS

What is a Map?
- What is a Map?
  - It is not an acronym
  - It does not stand for anything
- A map is an individual’s specific listening program
  - A map is designed for the specific user

A Map consists of:
- Minimum Levels of Audibility
- Maximum Levels of Comfort
- Programming Strategy
- Other Associated Programming Options

Basic Map Parameters
- Minimum Levels of Audibility
  - Called T levels by all implant companies
  - Cochlear recommends measuring them while Advanced Bionics and MedEl do not recommend measuring them
- Defined: The lowest level of electrical stimulation required at each electrode to provide audibility
- T levels allow the recipient to hear the softest sounds of speech and the environment
Basic Map Parameters

- Maximum Levels of Comfort
  - Called “C” levels by Cochlear and “M” levels by Advanced Bionics and MedEl
    - C = comfort level
    - M = most comfortable level
  - Definition: The maximum electrical stimulation level of sound that the recipient can comfortably tolerate at any given time
  - C levels prevent sounds in the environment from being uncomfortably loud

Things to keep in mind about mapping:

- There is no “target” threshold or comfort level
- T & C/M levels are measured in current units, not in decibels
  - There is no relationship between current units and decibels on the audiogram
  - There is no relationship between current units and pre-operative unaided/aided thresholds

Programming Strategies

- Each company has proprietary programming strategies that analyze speech/sound and deliver a systematic electrical stimulus to each of the electrodes
  - The goal of each programming strategy is to represent the complexities of speech and sound as faithfully as possible
  - Keep in mind:
    - The human cochlea consists of thousands of nerves that process speech and sound
    - A cochlear implant is only stimulating a fraction of those nerves

- MedEl
  - FSP
  - CIS

- Cochlear
  - ACE
  - Speak
  - CIS
  - In the new system 5, ACE is the only option
  - Within ACE there are different rates to choose from, although 900 Hz and 1200 Hz are the most commonly used in adults

- Hi-Resolution
- Fidelity 120 – Not FDA approved for use in children
Programming Strategies

- There are many options in basic programming strategies.
- In children it is recommended to begin by using programming strategies that have proven to be the most beneficial to the adult population, then attempt other strategies if benefit is not achieved despite appropriate intervention.

Other Associated Programming Options

- Examples of options – too many to list, but be aware that there are options that can affect the end map:
  - Cochlear
    - Is the sensitivity fixed or enabled?
    - Pulse width (the amount of time the electrode is firing)
    - Gains
  - Advanced Bionics
    - IDR (input dynamic range)
    - The manipulability of the volume control
  - MedEl
    - How is the volume adjusted
    - Are there differences in MapLaw

Methods of Mapping

- Objective Measures
  - Measureable thresholds
- Subjective Measures
  - The user provides input about preferences
- Goals vary depending on the company
  - Cochlear – must measure T levels
  - ABC/MedEl – do not measure T levels, set M levels

Methods of Mapping – Objective Measures

- Techniques are similar to those used for traditional audiology hearing tests
- Methods used to measure T levels
  - Based on development level of child
  - Visually Reinforced Audiometry (VRA)
    - Kids age 6 months – 18/24 months
  - Conditioned Play Audiometry (CPA)
    - Kids age 24/36 months/5/6 years
  - Counting Conditioned Play
    - Kids age 36 months, up
  - Counting
    - Kids age 6-8 to adults
Methods of Mapping - Objective Measures

- Conditioned Play
  The child is presented with a sound stimulus. The response task requires the child to perform some kind of task when they hear a sound.

Methods of Mapping - Objective Measures

- Counting Conditioned Play
  The response task is to perform a task every time they hear a stimulus.

Methods of Mapping - Objective Measures

- Other tests can be used to estimate levels when a child is unable to participate in testing
  - NRT – Neural Response Telemetry (Cochlear)
    - Estimates the T levels
  - NRI – Neural Response Imaging (Advanced Bionics)
    - Estimates the M Levels
  - eSRT – stapedial reflex threshold

Methods of Mapping – Subjective Measures

- Input from the individual is used for establishing levels of comfort
- Children may have a difficult time judging loudness
- The age of the child may determine if you use observation or direct input
- Observation: does the child fuss or blink in response to sounds
- Direct input: the child provides a judgment of loudness
Methods of Mapping – Subjective Measures

Is the Map Right?

- What does it mean, “Is the map right?”
- The map allows the user to access to quiet spoken language while not exceeding levels of comfort

Performance Expectations

- Why do we care so much about Ling sounds?
- Ling sounds represent the entire spectrum of speech frequencies, assuring you that the child has access to all speech sounds.

User should be able to hear ≤ 30 dB HL.
- User should be able to detect/repeat all Ling sounds (e.g., /ah/ /oo/ /ee/ /sh/ /s/ /m/)
- User should be able to hear to at least 30 feet (Carol Flexer)
- Expect user to be able to overhear (incidental listening)
- User should be able to tolerate loud sounds
There's been a change in performance

- Asking for repetitions
- Not wearing equipment
- Turning down volume/sensitivity
- Negative behavior
- Increase in articulation errors
- Not responding to auditory stimuli
- Speech is more slurred
- Cannot repeat Ling
- Voice quality has changed

WHAT INFORMATION DOES THE AUDIOLOGIST NEED FOR THE MAPPING APPOINTMENT?
Information to provide for mapping

- Which program and settings has the user been wearing
- Ling sounds/words that the user is not hearing/discriminating
- Equipment problems
- Performance progress/lack thereof
- Use of the equipment
  - Number of hours, how is equipment tolerated, etc.
- Any problems user may be having
- Any new inappropriate behaviors

WHAT HAPPENED AT THE MAPPING APPOINTMENT?

Information to obtain from mapping

- Changes made to the map
- What should be the settings on the processor
  - Which program, what volume/sensitivity
- Audiogram
- Speech discrimination test results

Information to obtain from mapping

- Processor settings – what’s the difference, what’s the purpose?
- Important to understand what each map does so that the user is wearing the correct map

Information to obtain from mapping

- Program options
  - Everyday listening
  - Noise
  - Music
  - FM
- Processors contain multiple program options
  - Are all programs the same?
  - What’s the difference between the programs?
  - How do I know?
    - Communication is critical because there’s no other way for anyone to know the contents of the processor.

Information to obtain from mapping

- Processor notes
- Next appointment scheduled for
- Need to schedule an appointment in:

AUDIOLOGIST: 
_Cache Pitt, AuD, CCC-A    

COMMENTS: 
COMMENTS: 
Cochlear Implant Follow-up Programming Summary 
Patient Name:      Parents:      
Date of birth:      Date of service:    
Address:      Phone number:  

EQUIPMENT CHECK

- Equipment functioning properly.
- Equipment not functioning properly and the following action was taken:
  - Equipment was replaced using stock
  - Equipment was replaced through the implant company and will arrive.

PROGRAMMING

- No significant changes in programming
- Slight changes in programming
- Significant changes in programming
  - Comments:

AUDIOMETRIC TESTING

- Aided thresholds are within expected ranges (20-30 dB HL) from 250-6000 Hz.  Average:  
- Aided testing could not be completed at this time:
  - An appointment was scheduled for
  - An appointment needs to be scheduled.

SPEECH PERCEPTION TESTING

- Aided speech perception was completed (see audiogram for details)
- Aided speech perception testing was not completed:
  - An appointment was scheduled for
  - An appointment needs to be scheduled.

PROCESSOR CONFIGURATION/USER SETTINGS

P1
P2
P3
P4

Processor notes

Next appointment scheduled for
Need to schedule an appointment in:
Information to obtain from mapping

- Controls on the processor
  - Program
    - Contains the individualized map
  - Volume
    - Modifies the C/M levels (upper limits of loudness comfort)
  - Sensitivity
    - Controls the softest level of sound allowed in the processor
    - Controls the "size of your listening world"

When’s my next mapping appointment?

- How often should I plan to go in for mapping?
  - Key point to keep in mind:
    - The goal of having a cochlear implant is to have access to spoken language.
    - It is the adult’s responsibility to make sure that the child is accessing the spoken language.
    - The less capable a child is to communicate their lack of accurate hearing, the more frequently their map should be checked.

When should I expect mapping?

- Dr. Pitt’s preferences
  - Hook-up
    - Two days – within same week
    - One month follow-up
    - Three month follow-up
  - Routine follow-ups
    - For kids linguistically up to age 3
      - Every 3 months
    - For kids linguistically up to age 5
      - Every 6 months
    - For kids developmentally over age 5
      - Annual

SoundWave NRI
Recipient Outcomes & Expectations

Factors of Success

- Status of the cochlea
- Appropriate mapping
- Consistent use of implant
- Child’s potential
- Therapy
- Educational placement
- Parental involvement and carry-over

Outcome Predictors: Children

- Age at time of implantation
- Parental support
- Educational placement
- Strong emphasis in auditory and oral speech input
Auditory Training for Children

- Children will not do well with just a well placed electrode or just a good map.
- Must be placed in an educational program which has a very strong auditory, oral component.
- Cochlear implants are a tool for children to develop better communication skills, not just hear environmental sounds.

How Well do Kids Do

- What expectations should I have for a child with a cochlear implant who is implanted early enough?

Performance Expectations

- Child should be able to hear ≤ 30 dB HL
- Child should be able to hear to at least 30 feet (Carol Flexer)
- Expect child to be able to over hear (incidental listening)

Performance Expectations

- Expect child to be language equivalent by age 5 (if identified early and no complications)
- Expect child to be mainstreamed by Kindergarten
- Expect normal speech intelligibility

<table>
<thead>
<tr>
<th>Test</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Set Speech</td>
<td>Range from 36% to 100%</td>
</tr>
<tr>
<td>Understanding</td>
<td></td>
</tr>
<tr>
<td>Speech Intelligibility</td>
<td>All scored 90% or better</td>
</tr>
<tr>
<td>Language &amp; Reading</td>
<td>65% within average range</td>
</tr>
<tr>
<td>Reading</td>
<td>70% within average range</td>
</tr>
</tbody>
</table>
Performance Expectations

- Child with hearing aids or cochlear implant who hears at expected levels does not hear the same as a child who has normal hearing.
- Significant therapy is required for successful achievement of outcomes.

Outcome Predictors

- Length of auditory deprivation
- Pre-lingual vs. post-lingual
- Etiology (ossification, Mondini)
- Electrode insertion length
- Patient motivation
- Family support

Industry Standard for Performance
Transdisciplinary teams

- **Surgeon**
  - The role of the surgeon is to evaluate the candidate medically to determine the following about the child:
    - Is a surgical candidate
    - The status of the cochlea
    - Any need for specific electrode types based on anatomy
  - Because of the medical model, ultimately the surgeon is responsible for the burden of candidacy, so they have to apply all findings and considerations before making a final decision.

- **Audiologist**
  - The role of the audiologist is to evaluate the child's hearing and assess auditory function
    - Testing includes:
      - Hearing assessment
      - Assessment of appropriateness of amplification
      - Assess benefit of amplification

- **Speech-Language Pathologist/Auditory-Verbal Therapist**
  - The role of the therapist is to assess spoken language development
    - Is the child meeting linguistic developmental milestones?

- **Educator**
  - May not be present on most teams, but an educator can report appropriateness of educational setting and if the child is meeting educational milestones

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Transdisciplinary teams

- Transdisciplinary – across disciplines
- The goal of working as a cochlear implant transdisciplinary team is to determine cochlear implant candidacy for an individual child based on his/her multiple facets that influence successful cochlear implant use.
- Each team member has a significant role in assessing the child from their discipline's point of view while applying their findings to those of other team members.
Transdisciplinary Teams

- Psychologist/Social Worker
  - The presence of a psychologist or social worker is not consistent across most teams, but the information or services that they offer can be invaluable
  - Psychological readiness of both the child and the family can be evaluated
  - Families can be prepared not only for the surgery but for the process of implantation and follow-up

CANDIDACY

CANDIDACY CASE STUDIES

Candidacy

- First FDA guidelines required that the patient have a profound loss (≥100 dB HL)
- 0% Speech understanding with the use of hearing aids
- ≤ 60 dB aided thresholds

Candidacy

- Current FDA guideline indicates a bilateral severe to profound hearing loss with limited benefit from hearing aids
- Limited benefit from hearing aids (adults):
  - ≤ 50% sentence recognition in the ear to be implanted and/or ≤ 60% sentence recognition in the best aided condition, i.e. binaural.
  - Medicare’s criteria is more strict at ≤ 40%
- Most common test pre-implant is the HINT performed in quiet with 60 dB SPL (47 dB HL) as the industry standard
Candidacy

Audiometric data alone do not determine candidacy
Must see the whole picture

Case Study 1

BW born in 1947
Began wearing hearing aids in 1992 at age 45
Case Study 1

- BW born in 1947
- Began wearing hearing aids in 1992 at age 45
- Noticed in about 2006 that hearing aids weren't helping as much for understanding speech

Case Study 1 11/07

<table>
<thead>
<tr>
<th>Test</th>
<th>Right Ear</th>
<th>Left Ear</th>
<th>Both Ears</th>
</tr>
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<tbody>
<tr>
<td>HINT</td>
<td>90%</td>
<td>90%</td>
<td>60%</td>
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</table>

Case Study 1 8/09

- Had cochlear implant consultation in 2007 (no recommendation from managing audiologist), but chose to wait because of fear of “losing hearing”
- Had cochlear implant surgery in December 2008/hook-up in January 2009
  - Cochlear Nucleus Freedom, left ear
- Function as of August 2009

Case Study 1

<table>
<thead>
<tr>
<th>Test – performed at 40 dB SPL (47 dB HL)</th>
<th>Two Week Post</th>
<th>One Month Post</th>
<th>Three Month Post</th>
<th>Six Month Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>HINT Sentences</td>
<td>76%</td>
<td>99%</td>
<td>DNT</td>
<td>DNT</td>
</tr>
<tr>
<td>ASU Sentences</td>
<td>DNT</td>
<td>DNT</td>
<td>DNT</td>
<td>97% quiet</td>
</tr>
<tr>
<td>37% +5 SNR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNC Words</td>
<td>48% words</td>
<td>78% words</td>
<td>84% words</td>
<td>86% words</td>
</tr>
<tr>
<td>Phonemes</td>
<td>75% phonemes</td>
<td>87% phonemes</td>
<td>93% phonemes</td>
<td>92% phonemes</td>
</tr>
</tbody>
</table>

Case Study 2

- GF born January 2007
- Hearing loss identified through newborn hearing screening
- Cause of hearing loss: large vestibular aqueduct
  - Results in progressive hearing loss, often associated with blows to the head
- Parents very interested in pursuing cochlear implant
- Had cochlear implant surgery August 2008
  - Cochlear Nucleus Freedom, left ear
Case Study 2

- Had progression in loss in the right ear
- Had cochlear implant surgery in the right ear July 2009
  - Cochlear Nucleus Freedom

Who do I refer?

- Cochlear Implant candidates are not nearly as obvious to recognize as I thought they were. How do I know which of my patients to refer to a cochlear implant center?
  - Difficult-to-fit patients
  - Patients who consistently seek multiple repetitions in quiet
  - Patients for whom you may consider an FM system in addition to their hearing aids as a way of improving communication
  - Patients using frequency transposition/frequency compression aids.
  - Patients who score about 30% or less on aided word testing
  - It’s better to err on the side of “refer” than “not to refer”

At what point should I refer my patient to a CI center?

- For adults
  - At any point that they are not understanding speech in quiet as well as expected after maximizing their hearing aid settings and eliminating a medical condition.
- For kids
  - As soon as severe/profound hearing loss is identified because of the many other factors included in pediatric candidacy an immediate referral usually results in timely implantation whereas referral at 12 months usually results in delayed implantation
**Am I a cochlear implant candidate?**

- **When using hearing aids ...**
  - Do you or your child have to ask people to repeat themselves in one-on-one conversations, even in a quiet room?
  - Do you only understand relatives or close friends on the telephone?
  - Do you or your child depend upon lipreading to understand a conversation?
  - Do you watch only closed-captioned television programs?
  - While dining in restaurants, do you or your child have difficulty following the conversation?
  - Do you avoid social activities because you do not know what is being said and are afraid you may respond incorrectly?
  - Are you or your child exhausted at the end of the day because communication requires such a high degree of concentration?


**How do I refer to a CI center**

- Cochlear Corporation website has a list of centers throughout the world that work with cochlear implants.
  - Click on “Find a Clinic”

**Trends in cochlear implants**

- Totally implantable device
- Bilateral Implants
  - Same benefits as bilateral hearing aids versus unilateral
- Hybrid cochlear implant

**Hybrid Device**

- 10 mm Hybrid CI electrode / 6 electrodes
- Use CI and ITE Hearing Device (knee point around 1.5 - 2 kHz)
- Function in noise
- Music
THE EFFECT OF COCHLEAR IMPLANTS ON PROFESSIONAL EDUCATION

Impact of CI on education of professionals

- The success of cochlear implants affects the education of
  - Audiologists
    - Age of identification and amplification affect education of pediatric audiologists
  - Speech/language pathologists
  - Teachers of the Deaf
  - Other associated professionals, e.g. auditory verbal therapists

Impact of CI on education of professionals

- Cochlear implant education was previously limited to discussions within courses and exposure to cochlear implants occurred offsite.
- US News and World Report, top 25 ranked Audiology programs in US informally polled about CI exposure
  - Of respondents:
    - 100% have a dedicated CI course
    - 100% offer exposure to cochlear implants in a clinical setting

Many Education Programs teaching individuals to work with Children with Hearing Loss are "Out-of-Sync" with current needs

- Most programs for young deaf children were developed 30+ years ago when:
  - The majority of deaf children were identified at 2-3 years of age
  - Sign language was the principle communication option
  - 95% of all newborns with hearing loss have parents with normal hearing.
  - In one research study when parents were given a choice
    - In 1995: 60% chose sign-language options; 40% chose spoken-language options
    - In 2005: 15% chose sign-language options; 85% chose spoken-language options
- The number of cochlear implants for children under age 5 has quadrupled in the last 4 years (to 2000+ implants per year)

Primary Emphasis of University Training Programs for Teachers of Deaf and Hard of Hearing Children

- Graduate Studies Program in Auditory Learning & Spoken Language
- For Speech Pathologists, Audiologist, Teachers of the Deaf
- Focus is to teach university students who will work with deaf children an auditory/oral approach to developing and using spoken language
- on-site practicum
- Multi-disciplinary courses

Utah State University

- Utah State University
  - Graduate Studies Program in Auditory Learning & Spoken Language
  - For Speech Pathologists, Audiologist, Teachers of the Deaf
  - Focus is to teach university students who will work with deaf children an auditory/oral approach to developing and using spoken language
  - on-site practicum
  - Multi-disciplinary courses
Review

- Discussed:
  - History of CI's
  - Candidacy criteria
  - Current benefit/expectations
  - Impact of CI's on education of audiologists