Individuals with Cochlear Implants: An Introduction

PowerPoint Slides to be used in conjunction with the Facilitator’s Guide
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Session Agenda

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Session Agenda, continued

• What are the Limitations of a Cochlear Implant?
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Introduction

• Consider:
  – You are getting a new student in your special education class who has a cochlear (koe-klee-er) implant.
  – Your friend who teaches first grade has a transfer student who also has a cochlear implant.
  – You have had hearing impaired children in your classroom before but never a child with a cochlear implant.
Introduction, continued

• Can we help them? YES, WE CAN!
• It can be overwhelming for a teacher to find out that there will be a child with a cochlear implant (CI) in his/her classroom.
Introduction, continued

• This introductory module provides information for teachers and other educators about:
  – hearing, 
  – hearing loss, 
  – what a cochlear implant is, 
  – which hearing impaired students may receive one, and 
  – what strengths and challenges a child with a cochlear implant may present.
Session Goal and Objectives

• The goal of this module is to help prepare teachers in regular and special education to obtain basic knowledge of a cochlear implant and to feel more confident in providing for the educational needs of a child with a cochlear implant.
Objectives: Participants will be able to:
1. Identify a description of normal hearing.
2. Identify the components of a cochlear implant (CI).
3. Identify who is a pediatric cochlear implant candidate.
4. Identify the benefits and challenges of a cochlear implant.

5. Identify how age of implantation may affect a child’s performance in the classroom.
Set the Course

• These slides will address the basics of hearing, hearing loss, and cochlear implants.
• Cochlear implants are changing how we educate children who are deaf to use spoken language.
• We have a long history with teaching the deaf to speak.
Set the Course, continued

• In the following video clip, note the long and laborious process involved in teaching Helen Keller, a deaf and blind individual, to speak.

• The process begins with training Helen Keller to make individual sounds using her hand to feel how the sound is made and progressing to producing a sentence.
Set the Course, continued

• Helen Keller, the American author, political activist and lecturer and her instructor and lifelong companion, Anne Sullivan, appear in a newsreel from 1928. In this footage Sullivan shows the way how Helen Keller learned to talk.

• In this rare footage of Helen Keller, you will observe the perseverance and tenacity on the part of Helen and her teacher, Ann.
Set the Course, continued

- Play the video at http://mast.ecu.edu/modules/ici_intro/lib/media/vid_1.html.

- As this video aptly portrays it was hard work to learn to speak. Even with development and refinement of hearing aids in the 20th century, teaching children who were deaf required a lot of hard work by the child, the parent, the teacher, and therapists.
Set the Course, continued

• Some children learned spoken language well. Others who worked just as hard did not fare as well. Many were frustrated in their efforts.

• Along the way, technology has developed amplification methods which helped some deaf individuals to hear sound.

• Over the years, these innovations included:
Set the Course, continued

• Ear trumpets
Set the Course, continued

- Bulky body worn hearing aids
Set the Course, continued

• Bar level hearing aids
Set the Course, continued

• All leading to today’s innovation: the cochlear implant!
Set the Course, continued

• With the recent advancements in technology, deaf education has changed markedly and has introduced new challenges.

• As a renowned philosopher wrote, “We must welcome the future, remembering that soon it will be the past; and we must respect the past, remembering that it was once all that was humanly possible” (George Santayana, 1863-1952).
How Do We Hear?

• Let’s step back for a moment and review HOW we hear.
• This occurs in a sequence of steps that converts the sound waves into different kinds of energy.
• A sound is produced by voice or a noise, creating sound waves that travel through the air.
How Do We Hear? continued

• These sound waves are collected by the outer ear, move through the ear canal, and vibrate the ear drum.

• Sound is converted to mechanical energy and moves across the three bones of the middle ear which amplifies the sound.
How Do We Hear? continued

• At the oval window this movement activates the fluid in the inner ear (cochlea) which stimulates many small hair cells –sensory cells of hearing.

• Thousands of tiny hair cells create electrical impulses that go to the auditory nerve and brain for interpretation and we HEAR the sound.
How Do We Hear? continued

• The following video demonstrates how the ear works; how the sound is being transmitted to the brain through different parts of the ear and the nerves.

• Play the video at

http://mast.ecu.edu/modules/ici_intro/lib/media/vid_2.html
How Do We Hear? continued

• Damage to many hair cells in the cochlea results in limited or no sound reaching the nerve of hearing and the brain.
• This is what happens in a sensorineural hearing loss.
• Think about what different levels of hearing loss may mean to a student in your class by considering that conversational speech is about 60 decibels (dB).
How Do We Hear? continued

- A severe sensorineural hearing loss is when the sound reaching the brain is attenuated by 70dB to 90dB (a sound intensity that is equal to the sound of a loud dog barking or a telephone ringing near you).

- A profound sensorineural hearing loss is classified as a loss of hearing of 90dB and above (a sound intensity that is equal to a lawnmower or airplane sound near you).
How Do We Hear? continued

• Such peripheral hearing loss eventually results in central auditory damage in the brain in children.
How is a Cochlear Implant Different from a Hearing Aid?

- A hearing aid amplifies sounds – it makes sounds louder. Hearing aids cannot make sounds loud enough for children with severe to profound hearing loss to acquire language.

- A cochlear implant is an electronic device that bypasses the damaged parts of the inner ear to stimulate the nerve of hearing. Parts of it are surgically implanted.
CI vs. Hearing Aid, continued

Parts of cochlear implant

- The cochlear implant is an electronic device that has both external and internal parts.
CI vs. Hearing Aid, continued

External Parts of a CI and how they function:

• **A speech processor** which sits behind the ear and connect to the processor by a wire.

• **A transmitter** (coil) that attaches above the ear to a magnet, which is surgically placed under the skin.

• **A microphone** on the processor collects the sound that the speech processor converts to a digital signal.
CI vs. Hearing Aid, continued

- The signal is passed to the internal device of the implant through the transmitting headpiece or coil.

Internal Parts of a Cochlear Implant and how they function

- **A receiver** which is implanted just under the skin (slightly above and behind the external ear).
CI vs. Hearing Aid, continued

• **An electrode array** which is placed in the cochlea. The **receiver and electrode array** are surgically implanted.

• Sound is transmitted from the external processor to the receiver just below the skin to the electrode array.

• The electrodes pass the signal to different places on the nerve of hearing and to the brain.
CI vs. Hearing Aid, continued

• The brain perceives the signal as sound but this sound is not perceived as normal hearing.
• The brain has to be taught to understand the signal.
CI vs. Hearing Aid, continued

Cochlear Implant Manufacturers

- There are three major cochlear implant manufacturers. These links contain information on their products as well as training information and research.
  - Advanced Bionics  
    [http://www.advancedbionics.com](http://www.advancedbionics.com)
  - Cochlear Americas  
    [http://www.cochlearamericas.com](http://www.cochlearamericas.com)
  - MED-EL  
CI vs. Hearing Aid, continued


It reviews the steps of the sound processing, first with normal hearing, then how the cochlear implant processes the sound and sends it to the brain for interpretation.
Who is Eligible for a Cochlear Implant?

• Children who are considered candidates for cochlear implants fall into four descriptions:
  1) Those with profound bilateral sensorineural hearing loss ages 12 to 24 months are the prime candidates.
Who is Eligible for a CI, continued

2) Children with severe to profound hearing loss at 25 months through 17 years who demonstrate limited benefit from hearing aids. These are children who demonstrate slow progress and limited listening and speech and language skills and become eligible for a CI at 25 months.

3) Children with sensorineural hearing loss and auditory neuropathy who have better hearing levels but do not benefit from hearing aids are also candidates for implantation.
Who is Eligible for a CI, continued

4) Children with progressive hearing loss may become candidates at a later age. To date, 26,000 children have been implanted, most between 1 and 6 years of age (National Institute of Deafness and other Communication Disorders, 2010).
Who is Eligible for a CI, continued

• At what ages do children receive cochlear implants?
  – The age at which a child can be considered for a cochlear implant is regulated by the FDA.
  – In the United States deaf children ages 1 through 17 yrs are approved by the FDA to receive CI’s.
  – Deaf children under 1 yr may receive a CI if it is medically necessary (e.g., conditions where the damage in the cochlear is progressing).
Who is Eligible for a CI, continued

– Somewhat older children with progressive hearing loss who are no longer benefitting from hearing aids become eligible for CI’s.

– However, for children with early significant hearing loss the younger the age of implantation the better the speech and language outcomes!
Who is Eligible for a CI, continued

• CI Surgery Basics
  – Surgery generally lasts from 2 to 4 hours.
  – The surgeon implants the receiver and electrode array. The magnet is also implanted just under the skin.
  – The cochlear implant audiologist is present and checks for device functioning during surgery.
Who is Eligible for a CI, continued

– The child typically goes home within 24 hours and the ENT surgeon monitors the child for several weeks.
– When site is healed, the CI is activated. This is the point when a child is first able to hear sounds with the CI.
– Activation is not just pushing a button and turning the unit on. It is a complex process called MAPping.
Who is Eligible for a CI, continued

• Cochlear Implant Activation – MAPping
  – Each child will need a specialized program for their CI called a MAP. MAPs are created by an audiologist via a computer program.
  – Children respond differently to the experience of hearing sound often for the first time.
  – Initial MAPs are usually set to soft levels.
Who is Eligible for a CI, continued

- MAPping is completed every few weeks to gradually increase intensity and check programming of electrodes.
- Parents, teachers, therapists monitor a child’s listening progress and provide the CI audiologist with information vital to each MAPping visit.
Who is Eligible for a CI, continued

• What does a cochlear implant sounds like?
  – It is a digital signal with electrical stimulation: NOT LIKE NORMAL HEARING!!!!!
Who is Eligible for a CI, continued

– The quality of the sound varies with the number of electrodes that can be connected in the cochlea.

– The goal is to have a complete insertion of the electrode array, but depends on the condition of the cochlea. Complete insertion is not always possible.
Who is Eligible for a CI, continued

• Importance of an appropriate CI MAP
  – Optimal language development is dependent on an appropriate CI MAP
  – Development of an appropriate program - MAP - is an ongoing process. Initial MAPping begins about 2 weeks after implantation.
  – MAP checks are completed initially at frequent and then longer intervals as the MAP becomes more stable.
Who is Eligible for a CI, continued

• Eventually MAP checks are completed as needed or yearly. Yearly monitoring of an established MAP is a minimal standard.
  – The MAP is an essential piece of the therapeutic intervention for a child with a cochlear implant.
  – Teachers should notify parents if there is a change in listening behavior in the classroom - a MAP check and adjustment may be needed.
What are the Limitations of a Cochlear Implant?

• Fitting a child with a CI and completing a successful MAP are important, but … a cochlear implant provides improved access to sound, however, this does not mean the child hears normally.

• The child has to be taught to obtain meaning from the CI signal – it does not happen naturally.
Limitations of a CI, continued

• The child will likely require extensive training in listening, language, and speech (e.g. articulation, rhythm, rate, pitch).

• The cochlear implant device requires regular maintenance and troubleshooting. The manufacturers provide troubleshooting guides for the parents and the teacher or designated person at the school who monitors the CI daily.
Limitations of a CI, continued

- While the cochlear implant is a marvelous device, not all deaf children can benefit from a CI.
- Also remember that a CI involves a surgical procedure and as with any surgical procedure, there are limited but inherent risks.
Limitations of a CI, continued

• Children come with a variety of CI combinations

• The variety of CI configurations include:
  – Unilateral CI – one ear
  – CI and hearing aid (on the opposite ear)
  – Simultaneous CIs - on both ears and implanted at the same time
Limitations of a CI, continued

– Sequential CI – on both ears but implanted at different times which can vary from a few months to a number of years

– Cochlear Implant/s and an FM system (provides a direct link from the teacher or speaker’s voice via a lapel microphone for the teacher/speaker and the FM receiver connected directly to the child’s CI. This link increases the child’s distance listening and reduces background classroom noise).
Limitations of a CI, continued

- One configuration is not necessarily better than the other.
- The cochlear implant team and audiologist generally work to provide the best configuration for a particular child.
Activity - Limitations of a CI

• It is important that peers have a basic understanding of cochlear implants and why their classmates have them.

• Consider how to share developmentally-appropriate information with your students.

• Using the information about how hearing and CIs work from the video and module content, create a simple lesson plan.
Activity – Limitations of a CI, continued

• Describe activities and materials that would be helpful in sharing this information.

• Review your lesson with a partner, asking the partner to consider the appropriateness of the content and approach for the target audience.
Hearing Impaired Brain, continued

• The child’s brain is constantly developing and changing.
  – Auditory development begins in utero at 20 weeks gestation and continuing during all waking and sleeping hours in hearing children.
  – Auditory development in the brain does not stop with the birth of the child.
Hearing Impaired Brain, continued

– Normal hearing infants who develop discrimination skills specific to their language as early as 7-8 months of age demonstrate accelerated language development at 12, 18, and 24 months.

– The child will continue to develop auditory skills but with diminished capacity for change as they become older.

– Brain plasticity is said to be greatest in the first 3½ years of life, giving us an opportunity to teach a child to hear and develop language.
Hearing Impaired Brain, continued

– Skills mastered as close as possible to the time that a child is biologically intended to do so, results in developmental synchrony (Robbins, et al., 2004). This has major implications for deciding when to implant a child with a CI.

– If a cochlear is possible, the general rule of thumb is: Sooner is better than later!!!
Hearing Impaired Brain, continued

• Watch the video at
  http://mast.ecu.edu/modules/ici_intro/lib/media/vid_4.html

  This features Naomi, who is making good progress with a late implant. Naomi was profoundly deaf since birth and now has 2 cochlear implants, left ear done in February 2008 and the right ear done in November 2008. She has exceeded the doctor's and audiologist's expectations.
Hearing Impaired Brain, continued

- Now watch a second video clip of two profoundly deaf kindergarten friends, AJ and Gibson, at http://mast.ecu.edu/modules/ici_intro/lib/media/vid_5.html. Notice the differences in listening ability, clarity of speech and voice quality between Naomi in the first video clip and the two boys in the second video clip.
Hearing Impaired Brain, continued

• Delayed auditory development results in delayed spoken language development.
  – If a child does not hear until age 2 or 3, he/she will demonstrate delayed spoken language development.
  – Language is an auditory based skill for most of us, essential for communication and learning.
  – Implanting the child early in life gives the best opportunity for learning language efficiently through natural interactions.
Hearing Impaired Brain, continued

– This is the most efficient means of mastering oral language (incidental listening).

– This also means that the later the age of implantation the greater the need for didactic instruction (direct teaching).

– Remember that repetition is necessary for language learning. “Mastery of any developmental skill depends on cumulative practice” (Robbins et al., 2004).
Hearing Impaired Brain, continued

- In the next video at http://mast.ecu.edu/modules/ici_intro/lib/media/vid_6.html, a therapist interacts with a child, Logan, who has a cochlear implant.
  - The therapist is attempting to check the functioning of the device by eliciting discrimination of the Ling sounds (m, ah, u, e, s, sh).
  - The child has his own agenda and the therapist follows his lead.
Hearing Impaired Brain, continued

– Logan demonstrates an instance of **incidental learning** by using a novel word that was not formally taught to him and announcing, “I just try clown around.”

– The therapist acknowledges the behavior and expands his utterance to include “ing”, stating, “You are clowning around.” The child is brought back to the activity and identifies the “sh” sound with a gesture.
Hearing Impaired Brain, continued

• Children Aren’t Little Adults – Some common sense reminders about normal hearing development:
  – The child is not an undersized adult. The rate at which he/she can process an auditory signal is age dependent.
  – We recognize that a small child cannot fully process adult language so we use “baby talk” or adjust our language to the small listener.
Hearing Impaired Brain, continued

– We speak slower, louder, and use simpler language to the young child so that he/she can process the auditory signal correctly.

• The following points should be recognized when interacting with any child, but especially with a hearing impaired child:

  – All children require an increased signal to noise ratio (10X louder) to develop language and literacy skills.
Hearing Impaired Brain, continued

– An adult is able to fill in the missing parts of an unclear message/information precisely because they already have language and experience with language.

– When learning language, a child needs all of the parts of the message/information to be clear and louder than the background noise.

– When listening and learning in the classroom, all children require the signal to noise ratio to be 10 times louder than the background noise.
Hearing Impaired Brain, continued

– Children require longer processing times (a minimum of 7 seconds).
– Higher auditory brain centers are not fully developed until a child is approximately 15 years of age. At this age the teen’s brain is functioning more like an adult, although they continue to learn vocabulary and additional information.
– Children with hearing loss need even longer processing time and environmental accommodations.
Hearing Impaired Brain, continued

• Auditory Brain Development
• In addition to problems with the ear processing sound, children with hearing impairments and CIs face other challenges.
  – The auditory cortex is directly involved in speech perception and language processing. Normal maturation of the central auditory pathways is a precondition for the normal development of speech and language skills.
Hearing Impaired Brain, continued

– Children who do not hear well during the early critical years will not develop normal speech and language skills. Significant hearing loss in the early critical years and reduced language skills will make learning in the classroom difficult.

– Peripheral hearing loss can result in central auditory damage which will impact how the child learns and communicates.
Hearing Impaired Brain, continued

- Early implantation lessens central auditory damage thereby resulting in greater auditory ability.

- Children with cochlear implants follow a developmental sequence of auditory, speech and language skill acquisition similar to that of children with normal hearing but at different rates and ages.
Activity - Hearing Impaired Brain

• Access to the information about classroom acoustics at http://www.classroomhearing.org/acoustics.html.

• Consider their individual classrooms or a classroom with which you are familiar.

• List and then share at least three strategies you can implement to improve classroom acoustics.
Hearing vs. Listening

• Hearing and listening are not the same. They are two interrelated skills.
  – Hearing: Auditory access to the brain (made available by CIs and/or hearing aids)
  – Listening: Attending to auditory events with intentionality
  – “Hearing” must be made available before “listening” can be taught. Listening needs to be established in order to develop spoken language.
Hearing vs. Listening, continued

• CI Sequence of Skill Development

• This sequence of skill development in children with CIs was developed at Cincinnati Children’s Hospital for use by the CI team to determine level of auditory and speech language development.

• This helps determine a child’s progress and set goals to be worked on by the family, therapists, and teachers.
Hearing vs. Listening, continued

– Startles to loud sounds and shows awareness of soft environmental sounds.
– Becomes aware of voice.
– Detects the “Ling 6 Sounds” (m, ah, oo, ee, sh, s). These are sounds that cover the listening spectrum that is required to understand speech.
– Establishes a “conditioned response.” This means that a child gives a trained response every time they hear a specific sound.
Hearing vs. Listening, continued

- Increases vocalization and taking turns vocalizing back and forth with the caregiver.
- Detects the main signal from other background noise (e.g., Responds to daddy’s voice in a noisy room).
- Detects high frequency sounds (e.g., f, s, sh).
- Uses voice to gain attention.
- Discriminates durational differences (e.g., bah-bah-bah-bah, moooooo by looking at sheep or cow).
Hearing vs. Listening, continued

– Responds to name and to “No.”
– Imitates inflection within vocal productions (e.g., Wheeeeee, Ah OOOh!).
– Demonstrates perception and production of vowels (imitate a variety of vowel sounds).
– Produces an approximation of visible speech sounds made on the lips (e.g., b, m, p).
– Imitates the correct number of syllables produced by the communication partner. (Ability to do this skill is a good predictor of future language progress).
Hearing vs. Listening, continued

- Increases communicative interactions.
- Demonstrates comprehension of stress patterns (anger, fear, excitement).
- Discriminates singing from talking. The child may begin to move his/her body to singing.
- Identifies environmental sounds (e.g., turns to the door bell, the microwave, dog barking).
- Identifies family members’ voices (e.g., looks towards, mom’s, dad’s. or sibling’s voice).
Hearing vs. Listening, continued

- Demonstrates word approximations (e.g., “ba”/ball, “u ee”/cookie, “o”/go).
- Identifies commonly used words and phrases (e.g., come here, bath-time, eat, ball).
- Associates own name with self.
- Identifies Ling 6 sounds (m, ah, oo, ee, sh, s). This means they can hear these sounds and can point to an object or picture that represents the sound.
- Identifies familiar songs/rhymes (e.g., Pat-a-Cake, Happy Birthday, Wheels on the Bus).
Hearing vs. Listening, continued

– Decreases dependence on sign/gestural support.

– Increases complexity of word approximations including high frequency sounds.

– Responds appropriately to common verbal commands (e.g., sit down, put on your coat, open the door, stop, get your shoes, time to go).

– Uses word approximations to spontaneously label, request and comment about objects and actions.
Hearing vs. Listening, continued

– Discriminates minimal pair words/phrases with the support of contextual cues (two/blue, feet/meat, tight/fight).

– Rapid growth in the comprehension of new words and increases direction following skills.

– Begins to acquire information incidentally (overhearing). Picks up vocabulary words and information that has not been taught.
Hearing vs. Listening, continued

– Improves as a communication partner (begins to ask questions).
– Increases growth in expressive vocabulary and language skills.

(Cincinnati Children’s Hospital, 2010)
Hearing vs. Listening, continued

• How quickly a child with a CI learns to communicate depends on many factors.
• While an implant can do amazing things, it should not be assumed that a child with a CI will develop oral speech and language.
• There may be other issues that make learning language difficult. The cochlear implant is the beginning of a language and learning process.
Hearing vs. Listening, continued

• Many factors that may impact progress. Foremost among these are:
  – The child must wear the device consistently. The CI(s) should be on whenever the child is awake (unless they are doing something that could damage the device).
  – The CI needs to be in good working order with an appropriate program (MAP).
Hearing vs. Listening, continued

– Ideally, the child receives the implant at a young age: Recent research that examined 5 year old children who were implanted before age 18 months showed language skills similar to normal hearing peers.

– Children implanted after 18 months showed more variability in language skills.

– Finally, those implanted after 36 months demonstrated poorer language skills (Niparko, 2010).
Hearing vs. Listening, continued

• Other factors identified as contributing to rate of progress with the CI are:
  – Quality of child/caregiver interactions and parent’s verbal responsiveness to children’s communication attempts is most important. Children, at age 4 years, whose parents responded to their communications (rather than directing the communication), demonstrated better language skills (Nitterour, 2009).
Hearing vs. Listening, continued

– Intensity of listening, language, and speech training

– Residual hearing and prior hearing aid usage before implantation. The more access to sound before the CI, the better!

– The number of other challenges that a child with hearing loss may experience. It has been demonstrated that ~30-40% of children with hearing loss exhibit additional disabilities (e.g., learning, vision, motor difficulties) (Wiley, Jahnke, Meinzen-Derr, & Choo, 2005).
Activity- Hearing vs. Listening

• Identify a student who has a CI or who has a hearing impairment.
  – Evaluate where he/she falls on the Cincinnati Children’s Hospital progression:
    • How does this compare to his or her age peers? Are there implications for the classroom setting or instructional design where there is a delay or lag between the individual and most other students?
    • Share the descriptions and strategize how the needs of all students can be met.
Summary

• Children are being identified with hearing loss at much earlier ages.
• This has led to many deaf children receiving improved access to auditory information at early ages through use of cochlear implants.
Summary, continued

• We know that early access to sound promotes improved listening, language, speech, and literacy skills.
• Children with CIs are more likely to have language levels that allow them to be educated in the mainstream.
Focus and Reflection Questions

1. Ask the participants if anyone has had experience with someone with a cochlear implant. Was it before or after MAPping? Why is the MAP an essential piece of the therapeutic intervention for a child with a cochlear implant?
Focus and Reflection Questions, continued

2. Discuss the statement: “For children with early significant hearing loss the younger the age of implantation the better the speech and language outcomes!” How does it relate to an adult being able to fill in missing parts of an unclear message?

3. What experience do you have with students in a classroom that includes a classmate with a cochlear implant?
Application and Extension Activities

1. Return to any of the group activities in the previous sections for ideas for further discussion as time allows
Self-Assessment

• A self-assessment with response feedback is available at http://mast.ecu.edu/modules/ici_intro/quiz/. Participants may take this assessment online to evaluate their learning about content presented in this module.
Session Evaluation

• A form for participants to evaluate the session is available in the Facilitator’s Guide.