Cochlear implants, a study of children implanted prelingually and postlingually: what age best facilitates oral language development

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Cochlear Implants: A Study of Children Implanted
Prelingually and Postlingually.

What Age Best Facilitates
Oral Language Development?

by
Lisa A. Stillwagon

A Thesis

Submitted in partial fulfillment of the requirements of the
Masters of Arts Degree in the Graduate Division
of Rowan University
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Approved by ____________________________ Professor

Date Approved ____________________________
The purpose of this study was to determine the most appropriate age for young hearing impaired children to receive a cochlear implant that would best facilitate oral language development. The study compared the oral language skills of five hearing impaired preschoolers, before and after implantation. Information was obtained through student case files including both formal and informal records and reports. Records included: progress reports, IEPs, audiological evaluations, and speech and language assessments.

The results of the study indicated that the development of oral language skills in hearing impaired preschoolers who received cochlear implants at ages 3 and 4, varies due to individual circumstances. A specific, ideal age for implantation cannot be pinpointed because there are many other aspects which affect success. Each subject must be looked at as a whole child, considering which aspects were positive and negative influences on successful communication growth. Age of implantation alone does not determine successful oral language growth.

Research has shown us that early amplification provides the best results for language development. This principal should apply to any mode of amplification. It
would seem logical to assume that the earlier the child is implanted, the better the success rate for learning to orally communicate. The amount of language before implantation must also be taken into account when determining how much more develops with an implant.

In the five subjects studied, two can be considered successful in that they were able to remain in oral programs for the hearing impaired or move into the mainstream after implantation, using oral language as their main mode of communication. Two other subjects continued to struggle with spoken language after implantation and moved from oral programs to total communication programs, using sign language. The remaining subject did not qualify as a candidate so did not receive a cochlear implant. This subject continues to use conventional hearing aids and has also moved into a total communication program due to slow oral language development.
The purpose of this study was to determine the most appropriate age for young hearing impaired children to receive a cochlear implant that would best facilitate oral language development. The study compared the oral language skills of five hearing impaired preschoolers, before and after implantation.

The results of the study indicated that the development of oral language skills in hearing impaired preschoolers who received cochlear implants at ages 3 and 4, varies due to individual circumstances. Age of implantation alone does not determine successful oral language growth.
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Chapter 1

Introduction

Among the vast array of new technologies that have appeared within the healthcare system in recent years, few have the power to change a recipient’s life as fundamentally as the cochlear implant. The power of this device to change a life is perhaps seen most dramatically when implants are used to give deaf children access to the world of sound (Radcliffe, 1994).

Hearing parents of deaf children often yearn for their children to function in a hearing society as normally as possible. Many are opposed to manual communication and hope for their children to communicate orally. If this does not occur with the use of conventional hearing aids, parents may look to the cochlear implant as a miracle cure for deafness. They believe an implant will improve their child’s hearing and in turn promote improved oral language. Unfortunately, the implant alone will not rectify all of the difficulties of a child who is deaf. Becoming implanted and having full use of the benefits of an implant is a complex process. Children must first qualify to become an implant candidate through a series of intense evaluations and then there must be follow through
with intense training and support from the school and family. Although implants are successful for many children, there is no guarantee that the implant will enhance speech and language skills even if all the necessary supports and training are in place. For some children, identifying and detecting environmental sounds will be the best that the implant can provide.

Brain development in the areas of speech and language must be considered when looking at the age of a cochlear implant candidate. If implanted at too late an age does the brain still have the ability to develop oral language at an appropriate pace? Are we doing children a disservice by implanting them at a late age with no language base and with no sign language support? Some experts state that a child must be implanted by age two to have the most speech and language benefit. Hearing impaired children who have minimal language skills may be implanted as late as age five.

There are many factors to be considered in determining if a child is a candidate for a cochlear implant: medical candidacy, audiological candidacy, educational candidacy, psychosocial candidacy and the role of the family (Cochlear, 1994). Teachers of the deaf, audiologists, speech-language pathologists, psychologists, social workers, surgeons and parents must decide together whether an implant is appropriate for a child. Guidelines should be followed closely, so as a team they can come to a decision based on facts. As professionals we must be sure that cochlear implants are being given to appropriate children for the appropriate reasons. The age of the candidate and the speech and language candidacy of children who have potential to benefit from a cochlear implant will be the focus of this study.
Statement of the problem

Young children must receive cochlear implants at an age prior to critical language learning years to receive the most benefit in promoting oral language development. Many children with severe language delays are receiving cochlear implants at four and five years old without the support of sign language and the expectation is that the implant will make them become oral communicators. Parents see the cochlear implant as an alternative cure when their children have not developed spoken language using conventional hearing aids.

The fact is that a cochlear implant is not a cure-all for deafness. The cochlear implant is being given to children who have passed their critical language learning years and are still expected to become oral communicators. The cochlear implant does not automatically enable children to understand speech. These children often struggle to communicate and at the same time may fall back in academics, social skills, and behavior due to their lack of communication skills. Many of these children are using the implant to detect environmental sounds, which they could not have heard with hearing aids, and with minimal use towards promote speech and language development. In these cases the children are being deprived of the right to communication due to this technological advance being misused.

Need for the Study

In working with preschool hearing impaired children in an oral school program, the author has found that parents of children who do not make satisfactory progress in the program have been looking to the cochlear implant as the cure for their child. There is a need for better understanding of who should receive a cochlear implant, for what reasons,
and what expectations should be.

**Value of the Study**

This study will provide educators of the hearing impaired useful information needed when recommending a child for a cochlear implant. Controversy surrounding cochlear implantation with children includes not only the age at which it should be performed, but also whether or not it should be used if one believes that children who are deaf are a cultural minority group and not disabled.

**Purpose of the Study**

The purpose of this study is to narrow down the age range of young children who would qualify as cochlear implant candidates, and at the same time consider the language level of the child as another aspect as candidacy. The child should be looked at as a whole, considering all qualities of the child and expectations of the parents before an implant is approved, which is not always done.

**Research Questions**

To accomplish the general purpose of this study, the data obtained is used to answer the following overall research questions:

1. What is the degree of success in acquiring oral language skills in a group of five deaf/hearing impaired children who received cochlear implants at ages 3 and 4?

The following sub-questions will be answered to determine if the cochlear implant promoted language development.

1A. What are the rates of growth in language development in a group of 5 and 6 year old children who received cochlear implants at age 3 and 4?
1B. Are there differential rates of progress in language development attributable to the age at which the child received a cochlear implant?

**Research Strategy**

In order to answer the Research Questions posed in this study baseline data will be obtained on the level of receptive and expressive language skills manifested by four profoundly deaf children including one at age 3 and three at age 4. The critical incident in promoting increased language development will be regarded as the cochlear implant and subsequent therapy provided by Children's Hospital of Philadelphia and Johns Hopkins University. Post implant data measuring the children's progress in receptive and expressive language will be obtained approximately two years after the implant. Expert judgment will be utilized to determine if rates of progress in language development are greater than would have been expected without the implant.

**Definition of Terms**

Several terms are used in the present study which have a specific meaning when used in connection with this study. They are defined here to establish a common framework.

- **cochlear implant**- An electronic device designed to provide sound information for individuals who have a profound sensorineural hearing loss (nerve deafness) in both ears and have minimal gain with hearing aids (Cochlear, 1994).
- **prelingual**- before language / **postlingual**- after language (Kretschmer, 1984).
- **oral language**- The use of the spoken word incorporated with speech and auditory skills (Kretschmer, 1984).
- **manual language**- The use of hand gestures and symbols to communicate, ex: sign language (Kretschmer, 1984).
- **simultaneous / total communication**- The use of signs and the spoken word simultaneously (Kretschmer, 1984).
degrees of hearing loss:  
mild: 0-20 dB loss  
moderate: 20-40 dB loss  
severe: 40-60 dB loss  
profound: 60-90 dB loss

Limitations of the Study

There are numerous factors that influence a child’s oral language performance, which will not be examined but were mentioned in chapter two. The study will not give conclusive information for all hearing impaired children, but will show the effects of a small population.

Overview of the Study

Throughout the study we will look at basic information regarding cochlear implants. The cases of five hearing impaired children with no other disabilities, who have been implanted at various ages will be examined. A comparison of their oral language development before and after implantation will be drawn. Also other case histories of implanted children will be examined as well as the role of brain development in language development and how age affects language learning.
Chapter 2

Understanding what a cochlear implant is and how it works is important background information needed for this study. A cochlear implant is a device that uses special technology to help profoundly hearing impaired people hear. It does not work like a hearing aid, which merely sends amplified sound to the impaired auditory system. It works by bypassing damaged inner ear structures to send electrical signals directly to the auditory nerve. Some of its components are surgically implanted inside the inner ear, or cochlea, and others are worn externally (Cochlear, 1994).

The implant system works in the following way to transmit sound information:

1. Sounds in the environment are picked up by the small directional microphone.

2. A thin cable sends the sound from the microphone to the speech processor.

3. The speech processor amplifies, filters and digitizes sound into coded signals.

4. These coded signals are sent from the speech processor to the transmitting coil via the cables.

5. The transmitting coil sends the signals across the skin to the implanted receiver/stimulator via FM radio signals.
6. The receiver delivers the correct amount of electrical stimulation to the appropriate electrodes on the array.

7. The electrodes along the array stimulate the remaining auditory nerve fibers in the cochlea.

8. The resulting electrical sound information is sent through the auditory system to the brain for interpretation.
The entire process happens in milliseconds so that the implant user may detect and process sounds as they occur (Cochlear, 1994).

A cochlear implant is an option for a profoundly hearing impaired child who receives little or no benefit from hearing aids. The specific criteria for candidacy are: age 2 years or older; profound sensorineural hearing loss in both ears; little or no benefit from hearing aids; no medical contraindications; enrollment in an educational program that emphasizes auditory skill development; and high motivation and appropriate expectations.

Post-implantation training is very intensive. The implant team will work with professionals in the child’s school to provide focused listening training. Several training sessions will be scheduled. The implant team will consult educators and parents regarding issues such as optimal classroom seating, minimizing noise, maximizing listening, and training the child to use the implant appropriately (Cochlear, 1994).

Being a successful implant users requires intensive training and dedication from everyone involved in the child’s life. Research with both adults and children shows that success with an implant is highly related to two factors: (1) the amount of exposure to meaningful sounds and (2) the amount of time each day that the device is used.

Most adult implant users who have lost their hearing postlinguistically are helped by the implant. They are still hearing impaired and may not hear very soft sounds or understand all speech, but they can better monitor their own speech and make it more intelligible. Like postlinguistically deaf adults, children who become deaf after acquiring oral language seem to be able to connect the sound from the implant with their memory of sound. They learn to identify meaningful sounds such as speech more quickly than
children who are prelinguistically deaf. However, prelinguistically deafened children may use an implant successfully if they are given the proper support and training for a sufficient length of time (Cochlear, 1994). Some benefits children may exhibit include:

- Children are able to detect conversational level environmental sounds, including speech, at comfortable loudness levels.
- Some children can identify everyday sounds such as car horns, doorbells, and birds singing.
- Many children can distinguish among different speech patterns.
- Many children can identify words from a set of alternatives without lip-reading.
- Some children exhibit improved lip-reading.
- A few children can recognize speech without lip-reading.
- After training and experience with the device, many children demonstrate improvements in speech (Cochlear, 1994).

Even the experts who have developed this device cannot guarantee improved oral language communication; instead, they say aspects of speech may be improved, but there is no mention of language development. Yet many parents choose to believe that a cochlear implant will result in their child's learning to speak and communicate orally.

No one can currently predict how much benefit a child will receive from a cochlear implant, but several factors appear to be significant contributors:

1. **Auditory memory.** Children who had some auditory experience before deafness may learn to use the sound information more quickly.
2. **The status of the cochlea.** Individuals with a greater number of functioning nerve fibers in the cochlea may benefit more from an implant.

3. **The motivation and commitment of the child as well as family members.** Commitment includes regular use of the implant, dedication to keeping appointments, careful maintenance of the device, and the use of educational/rehabilitation strategies.

4. **The rehabilitation and/or educational program in which the implant user is enrolled.** Therapists and teachers, family members and audiologists need to provide listening models and materials for the development of listening skills (Cochlear, 1994).

When considering the appropriate age for implantation in regards to oral language, we must consider the developmental ages of language development. There is evidence that infants may be processing language soon after (or even before) birth. Although young babies may appear to be passive recipients of language, in fact, they may actually be actively engaged in language processing (Kuder, 1997).

Most parents can remember the excitement of hearing their babies first words. But this remarkable achievement did not happen over night. In fact, the progression from the shrieking first heard in the hospital nursery to the controlled utterance of “da-da” or “ma-ma” is slow, systematic, and predictable for most children (Kuder, 1997). Babies born hearing impaired are missing all of this crucial language learning time.

Stark (1979) developed a framework for describing prelinguistic development shown in the following chart:
I Reflexive Crying
(0-8 wks)
Vegetative sounds
Sound discrimination

II Cooing and Laughing
(8-20 wks)
Vowel-like sounds
Cry more controlled

III Increased control over
(16-30wks)
speech
Prolonged vocalizations
Babble

IV Repeated syllable clusters
(25-50wks)
Jargon speech
Some Words

V Protowords
(9-18mos)
Transition to language

The following tables outline milestones for communication and mechanical aspects of language by Healy (1994):

<table>
<thead>
<tr>
<th>Stage</th>
<th>Form</th>
<th>Content</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (0-8 wks)</td>
<td>Reflexive Crying</td>
<td>Biological and Physical needs</td>
<td>Eye Contact</td>
</tr>
<tr>
<td></td>
<td>Vegetative sounds</td>
<td></td>
<td>Body movement</td>
</tr>
<tr>
<td></td>
<td>Sound discrimination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II (8-20 wks)</td>
<td>Cooing and Laughing</td>
<td>Differentiated crying</td>
<td>Games</td>
</tr>
<tr>
<td></td>
<td>Vowel-like sounds</td>
<td>Hunger, distress</td>
<td>Routines</td>
</tr>
<tr>
<td></td>
<td>Cry more controlled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III (16-30wks)</td>
<td>Increased control over speech</td>
<td>Beginning of semantic functions</td>
<td>Intent to communicate</td>
</tr>
<tr>
<td></td>
<td>Prolonged vocalizations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Babble</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV (25-50wks)</td>
<td>Repeated syllable clusters</td>
<td>Expansion of semantic functions</td>
<td>Illocutionary stage</td>
</tr>
<tr>
<td></td>
<td>Jargon speech</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Some Words</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V (9-18mos)</td>
<td>Protowords</td>
<td>Overextensions</td>
<td>Locationary stage</td>
</tr>
<tr>
<td></td>
<td>Transition to language</td>
<td>Underextensions</td>
<td></td>
</tr>
</tbody>
</table>

Ages for each stage are approximate:

Before birth: Receives intonation patterns from Mother’s voice.

By 2 months (possibly even at birth): Responds to Mother’s speech.

Birth-9 months: Cries, smiles, vocalized, laughs, reaches out makes gestures of giving, pointing, showing.

By 2-3 years: Can cooperate in communication; understands how to ask and answer, take turns in talking.

Can use language for different purposes (to get something, to talk about something, to relate to others”).

Responds to simple commands if phrased positively (say “Stop!” not “Don’t eat the spider”).

By 3 years: Gives related response to question.

By 4 years: Pretends conversation on toy telephone, waits for “answer.”

By 5 years: Talks to self to help control behavior or solve problems.

Age 5-6: Still blames listener when he’s not understood.

By age 10: Can stick to a topic.

Varies conversation according to listener.

Can use language to give “hints.”

Understands social “rules” for language use.

Because of individual differences among children these ages are only approximate.

First 4 months: Can distinguish between different sounds (one to two months), cooing.

4-8 months: Babbling (may use sounds not in English language).

9-12 months: First syllables (consonant-vowel: “ma,” “ma-ma”).

First consonants, usually p, m, t, and k.

First vowel, usually a, i, u.

Babbling may continue even after child acquires words.

By 3 years: Speech can be understood.

4-5 years: Can pronounce consonant clusters (e.g., sm, sp, tr, cl).

6 years: Can pronounce and distinguish between all vowel sounds.

8 years: Can pronounce and distinguish between all consonants sounds.

9 years: Can remember and repeat four and five numbers in a row.

Children who are congenitally deaf have missed out on the natural process of learning language which begins even before birth. These children must quickly become amplified in order to catch up on these missed years and to correct language deficits. The
greater the lag in providing a child access to sound the more difficult it is and longer it takes for the child to learn all they have missed, and to keep up with hearing peers.

The brain’s development in regards to language learning is another important aspect to consider when deciding the appropriate age for a deaf child to receive a cochlear implant. If the child has gone for several years without a language system, knowing if the brain will still have the same potential to learn at an older age is a consideration.

Maximum language growth apparently does occur normally during a critical period characterized by rapid development of neurological maturity, the so-called period of “resonance” between the ages of two and twelve years (Lenneberg, 1967). If a child exceeds this time period without mastery of some rudiments of a language system, the probability of adequate mastery of any language system is felt to be greatly reduced (Kretschmer, 1984).

Auditory skills at a young age are also important in development of the brain and language. Appropriate auditory stimulation promotes emotional, social and language development. Infants need to respond to sounds, building auditory pathways in the brain’s temporal lobe language areas. Although the mechanical aspects of the auditory system are in place at birth, the fiber links to the cortex are sparse and take a long time to reach adult capacity. Newborns can distinguish frequency and pitch and at one to two months infants can tell the difference between sounds and even perceive rhythm. Although auditory pathways continue to develop until seven to ten years, the first year is a critical period for learning the sounds of language and developing an interest in communicating with others (Healy, 1994).
The basis of language is learned from early experiences (Healy, 1994). A child deaf from birth, perhaps not diagnosed until a year old, and who has learned no formal language system by age four, has missed critical time in developing the brain for auditory skills and language. By this age hearing children can hold a basic conversation, and are preparing academically for kindergarten. It would make sense then to give the impaired child a manual mode of communication to assist in catching up in his/her missed years. Giving this child a cochlear implant, with no manual communication support, would be equivalent to beginning as though the child was an infant just learning to hear and process language. It would set this child farther behind in several areas of development such as auditory skills, language development, social skills and academics.

Within recent years, there has been a growing trend to lower the age of implantation below two years in children. The motivation for this trend is to provide children with access to auditory stimulation as early as possible, thereby taking advantage of critical periods for speech and language development (Osberger, 1997).

As of January 5, 1996, 79 children have received the Clarion implant in the United States. Of the 79 children, 30% were between the ages of two and three years at the time of implantation. Children between the ages of 18 and 23 months can undergo implantation (with the Clarion) if deafness is the result of meningitis and there is radiographic evidence of cochlear ossification (Osberger, 1997).

When determining the appropriate age for implantation, and considering if it is before or after a child acquires language, it is important to look at what research has told us. The results of a number of studies have shown significant improvements in the ability
of profoundly hearing impaired children to understand speech and language with a cochlear implant. There are however, large differences in the speech perception abilities among individual implanted children. Age of onset of deafness, duration of deafness before receiving an implant, and communication mode are variables that have been identified most often to account for the variance in speech perception performance among pediatric implant users (Miyamoto, Osberger, Robbins, Myers & Kessler, 1993).

The speech perception performance of 10 congenitally deaf and 3 postlingually deafened children who received cochlear implants was examined and compared. The children were tested pre-implant and at six month intervals up to 2 years using the Monosyllable-Trochee-Spondee test, the Word Intelligibility by Picture Identification test, and the Phonetically Balanced Kindergarten or Northwestern University List 6 Word List. The postlingually deafened children exhibited significantly improved performance on open- and closed-set tests of word recognition after 6 months of implant use, a pattern similar to that of postlingually deafened adult implant users. In contrast, the congenitally deaf children did not exhibit improved performance on speech perception tests until after 12 months or more of implant use. With as much as 18-24 months of use, however, some congenitally deaf children demonstrated limited open-set word recognition (Bertschy, Tyler, Kelsay & Gantz, 1992).

The research also observed that children with acquired deafness before 2 years of age, who receive an implant within 2 years of the onset of their deafness, tended to obtain higher scores on speech perception measures than did children who had congenital deafness.
Summary

These studies show that congenitally deafened children do have the ability to learn spoken language using a cochlear implant, but not as easily as those children who have language experience before deafness. Also, there is general agreement that it takes quite a long time before this language growth is seen. It can take 12 to 24 months of implant use before the child is exhibiting improved language and speech skills. If we do not give a severely language impaired child an implant until age four, they may be six year old before their oral language skills begin to improve. This could mean a six year old child would have the oral language abilities of a two or three year old. If given manual communication at age four, this same child at age six could possibly have the language skills of a four or five year old. We must consider which is more beneficial. Is it in the best interest of the child to persist with oral communication alone, perhaps causing frustration, low self confidence or academic and social struggles; or, is it better to provide a manual form of communication so the child can continue to develop at a rate more likely to help him quickly catch up to other signing peers and to better keep up with cognitive and social skills?
Chapter 3

Introduction

The following chapter describes the subjects of the study, the method of sample selection, the collection of data, the research design and the analysis of the data.

Sample

The sample for this study consists of five preschool and kindergarten age children with varying degrees of congenital hearing loss, who have no other disabilities. The children were diagnosed with hearing loss at varying ages and enrolled in oral programs for the deaf, also at varying ages. The study will look at what age they received a cochlear implant and what effects it had on their oral language skills.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Age</th>
<th>Degree of Hearing Loss</th>
<th>Age of Implantation</th>
<th>Participating Hospital</th>
</tr>
</thead>
<tbody>
<tr>
<td>subject 1</td>
<td>6</td>
<td>profound</td>
<td>4</td>
<td>*CHOP</td>
</tr>
<tr>
<td>subject 2</td>
<td>6</td>
<td>severe to profound</td>
<td>4</td>
<td>*CHOP</td>
</tr>
<tr>
<td>subject 3</td>
<td>5</td>
<td>severe to profound</td>
<td>3</td>
<td>Johns Hopkins</td>
</tr>
<tr>
<td>subject 4</td>
<td>5</td>
<td>profound</td>
<td>did not qualify</td>
<td>*CHOP</td>
</tr>
<tr>
<td>subject 5</td>
<td>5</td>
<td>severe to profound</td>
<td>3</td>
<td>Johns Hopkins</td>
</tr>
</tbody>
</table>

*Children’s Hospital of Philadelphia
Measures

The language skills of the five subjects, pre and post implantation, will be compared by using case files obtained through school or therapy settings. Tests administered include The Preschool Language Scale (PLS), The Brigance Inventory of Early Development, teacher observation, IEP information, and informal testing recorded on progress reports.

Method of Sample Selection

The students in the study were chosen from an oral school for the hearing impaired in Pennsylvania. Three of the children have cochlear implants and are current students. The fourth child is also a current student in the program and is in the process of being evaluated for a cochlear implant at Children’s Hospital of Philadelphia. The fifth student is a former student of the program with a cochlear implant who is now mainstreamed in his local district.

Collection of Data

The information used in this study was obtained through access to school files. Speech and language test results, case histories and IEP information was obtained with permission through student files.

Research Design

The design of the study is to determine if there is an ideal age for young children to receive a cochlear implant that will best facilitate oral language development. The oral language skills of five hearing impaired children will be examined before and after implantation. The age the children received the cochlear implant will also be considered.
This will determine if early implantation enhanced oral language communication in comparison to implantation at a later age.

**Analysis of the Data**

The information collected will be analyzed to see if the children’s oral communication skills were enhanced by the cochlear implant. Speech and language test results, case histories and IEP information will be reviewed and analyzed to determine oral skill development. The research will identify which children have remained successful in oral programs and those who have moved into Total Communication classrooms. The results of the study will determine ages of implantation that were successful and unsuccessful in promoting oral language development. It must be remembered that age alone will not determine implant success. There are multiple factors that influence a child’s oral language performance, which will not be examined but were mention in chapter two. The study will not give conclusive information for all hearing impaired children, but will show the effects of a small population.
Chapter 4

**Introduction**

The purpose of this study is to determine the most appropriate age for young preschool children to receive a cochlear implant that would best facilitate oral language development. Five subjects were studied to determine if receiving a cochlear implant improved their oral language and communication skills.

**Analysis and Interpretation of the data**

The study examined various records and reports, both formal and informal, regarding each of the five subjects. Records included: progress reports, IEPs, audiological reports and speech and language assessments. Each subject had varying reports and assessments in their records due to their specific educational backgrounds. Oral language skills were compared both before and after implantation to determine if skills improved due to the use of a cochlear implant. Results are summarized in Table 1.

**Results**

The following will summarize the case histories of the five subjects of this study. Language abilities with the use of conventional hearing aids and then with the cochlear implant will be discussed. Successful use of any amplification system depends upon
outside influencing factors which must be taken into consideration. Influences may include: the age of diagnosis and the age the child was aided, the degree of hearing loss, the support of the family, the intelligence of the child, the motivation of the child, consistent use of the amplification system, and the educational placement. All of these factors must be considered in the cases of the five subjects.

Subject 1:

Subject one received her implant at age 4. She has a profound hearing loss. Her implant was activated in January of 1996 while she was attending an oral day school for the hearing impaired. She is now 7 years old and has had three years of use with a cochlear implant.

Before she received her implant, evaluation reports clearly state that the subject was struggling to learn spoken language and that her parents were against the use of sign language. At this time the subject was wearing behind the ear hearing aids. An IEP written in March of 1995 by the school district of Philadelphia states the subject has, “minimal vocalizations at present and only uses a few words.” Under the IEP’s “Family Concerns” heading it states that the parents want the subject to, “participate in an oral program” and do not want their daughter to “be exposed to sign language.” Some examples of goals in this IEP include: to vocalize on demand by imitation using a telephone or microphone as prompts; to correctly produce vowel sounds when given a speech model; to look at a speaker; and to choose between two items through speech reading. The special needs coordinator states in her report that the subject, “relies on
gestures to communicate.” It is very clear that the subject had extremely low level oral language skills at age 3 when this IEP was written. It is also important to note that an audiological report from February 1995 shows that the subject showed an awareness to speech at 95dBHL. This shows a profound hearing loss.

The subject received her implant in January of 1996 and remained in the oral program until November of 1996 when it was decided that she needed sign language support in her communication. At this time she had been implanted for approximately 11 months. In the Total Communication program she began to learn signs as well as continue to work on spoken language. Her response to speech sounds greatly improved as reported in an audiological evaluation by the Children’s Seashore House in June of 1996. It showed her awareness to speech at 25 to 40 dBHL. Although her awareness to speech was much improved, her development of oral language was still very weak while using the cochlear implant. An IEP written by her classroom teacher in June of 1997 reports, “Due to severe language delays, and her age, placement in a Total Communication setting was recommended.” In a 1998 IEP, at age 7, language goals continue to be basic, extremely below her age level. Examples of goals include: to understand simple questions such as, “Where is the…?”; to recognize names for common objects; to describe feelings; and to imitate various words and syllables. The teacher states the subject is, “beginning to use her voice to vocalize her wants and needs”, “she approximates most of the words she is taught,” and “her speech is unintelligible most of the time.” At present, sign language has become this subject’s main mode of communication. It should be noted that this child has factors in her life that most definitely have affected her success in language development,
using hearing aids or a cochlear implant. Various reports state that family counseling and parenting classes were recommended but the family never followed through. The parents are reported as being, "concerned about their child’s education, but not consistent with discipline or follow through of teacher recommendations concerning amplification use and teaching language at home.” Speech homework was often incomplete as reported by the speech therapist and the child was often brought to school up to an hour late. Characteristics of subject 1 are summarized in Table 1.

Subject 2:

Subject 2 received her implant at age 4. She has a severe to profound hearing loss. Her implant was activated in October of 1996 while she was attending an oral day school for the hearing impaired. She is now 6 years old and has had 2 ½ years of use with her cochlear implant.

This subject experimented with amplification devices before being implanted. She was first fit with behind the ear hearing aids at 18 months of age. At age 3 she was fit with the Transonic Hearing System which is a speech transposition device. It transfers speech sounds into the speech range of hearing. With only minimal benefit and slow developing oral language skills, the subject’s mother looked to the cochlear implant. It was believed by both her teachers and her mother that the subject still had the potential to learn spoken language.

Before implantation, the subject’s language skills were on a basic level far below her age level. Samples of her IEP goals from 1995 include: “The student will receptively
recognize vocabulary from monthly language topics, ex: Halloween vocabulary,” or the subject will, “spontaneously use classmates and teachers names.” The teacher reported in the present education level that the subject, “relies on gestures for receptive and expressive communication.”

The subject was evaluated by Children’s Hospital of Philadelphia and named a candidate for a cochlear implant. Her family decided it was worth the try with hopes it would help develop her oral communication. The subject received her implant and it was activated in October of 1996. She remained in a the oral program for approximately 10 months giving her a chance to adjust to the implant and to learn how to benefit from it. It was decided she was not progressing fast enough and was falling farther behind in language development as well as in academics. Her teachers reported they were concerned about her age. She was 41/2 years old and cognitively ready for kindergarten, but did not have the language abilities to complete kindergarten level skills. The subject’s behavior was also beginning to change. She went from being a pleasant and cooperative child, to having tantrums which were uncharacteristic. It seemed, “her lack of communication abilities were becoming frustrating” as reported by her classroom teacher and speech therapist. At this point she moved into a Total Communication program. Here her oral skills would still be a priority, but she would have sign language support to her communication.

The subject is presently 6 years old and continues to be in the TC classroom. Her communication has progressed tremendously using signs and she is now able to complete academics close to her age level. Her oral language skills remain below age level, but are
improved. A 1998 progress report notes that she has much more awareness to both linguistic and nonlinguistic sounds and her spoken language is much more intelligible. Her classroom teacher reports in a 1998 IEP that she “uses 3-4 words when expressing herself in sign” and “uses her voice consistently when signing although not always intelligible.” It also states that, “when she is expressing herself using words and phrases that she has internalized, her speech is very clear.” She is able to imitate a variety of speech sounds but she only transfers them into spontaneous speech when the language is familiar to her. Goals in this 1998 IEP include: to recognize her name as well as family names and classmates name through audition alone; use pronouns “I”, “he”, and “she” expressively; and understand a two step command.

As well as attending the TC program five days a week, the subject also receives speech therapy twice a week at school and is scheduled to return to CHOP once a month to check the implant functions. Speech therapy is also offered at CHOP. The subject’s family is often unreliable. She has missed several days of school as well as scheduled appointments with teachers and professional at CHOP.

Although the Cochlear implant has had some positive affect on this subject, it has not at this point enabled the child to be an oral communicator as her family had hoped. It seems the combination of the cochlear implant along with sign language has been very beneficial to her. The subject continues to learn auditory and oral language skills and at the same time uses signs to communicate more efficiently. Characteristics of this subject can be found in Table 1.
Subject 3:

Before being implanted this subject wore behind the ear hearing aids. He has a severe to profound hearing loss. He was attending a preschool handicapped class specifically for children with hearing impairment, using Total Communication. His parents are very supportive of his education and attend parent meetings and therapies consistently.

Audiologist from Temple University scored his speech detection at 80dBHL unaided and at 40 dBHL aided. The reports indicate “appropriate benefit” from the current amplification system. The subject’s parents decided that although he was benefiting with his hearing aids, it was not enough and his oral language skills were weak. In December of 1996, at age 3 the subject received his cochlear implant at Johns Hopkins. It was activated in January 1997. He attended rehabilitation therapy at Johns Hopkins/The Listening Center, once a week immediately after implantation. He remained in the Total Communication program.

At age 4 years and 5 months, having approximately 16 months of use with his implant and American Sign Language as support, the Preschool Language Scale was administered by his home school district. This was to determine his skills for expressing and understanding language. This test is normed on children with normal hearing. The following scores were obtained: auditory comprehension (receptive language)-age equivalent 2 years, 3 months; verbal ability (expressive language)-age equivalent 2 years, 0 months; total language score-age equivalent 2 years, 1.5 months. The results indicated that the subject was severely language delayed compared to hearing peers. However, test results and behavioral observation indicated that his language was progressing in a normal
sequence of development. The therapist noted in her report that the growth of the subjects language skills, “appear to be consistent with cochlear implant research that indicates a 12 to 18 month ‘waiting period’ after the child is implanted before noticeable speech and language development is seen.”

For the 1998-1999 school year, the subjects parents decided to pull their son from the TC classroom and enroll him in an oral program. They felt that submerging him in oral language by surrounding him by those who used only oral language, would better help him develop these skills. This meant the use of sign would be ended while in school because communication philosophies can not be crossed. It also meant in the home signing would need to stop to provide the child consistency.

A December 1998 progress report written by the oral classroom teacher states that in the Fall the subject, “relied on gestures to assist his understanding and signed with unintelligible speech.” She also states that the subject currently, “rarely signs to express himself,” and “has a greater understanding of spoken language.” Her report indicates that the subject’s speech continues to be unintelligible, with the exception of isolated words. He has learned much of the vocabulary taught in school. He continues to receive speech therapy twice a week at school and returns to Johns Hopkins once a month to have his implant checked.

Characteristics of subject 3 can be found in Table 1.
Subject 4:

This subject was diagnosed with a profound hearing loss at age 18 months. She was fit with conventional hearing aids and enrolled in parent-infant classes in an oral day school for the hearing impaired. The family attended these classes for approximately 10 months, meeting once a week. The subject then moved into the toddler class of the program which met four half days a week. She continued to move through the program and at age 4 entered the preschool. At the end of this school year it was decided that a second year in the preschool was needed.

This subject has a history of behavior problems. It is stated in various reports that she is prone to tantrums and has a difficult time conforming to school routines and rules. Her parents are not consistent with behavior management which has affected the child's social skills. She does not consistently wear her hearing aids, which is also a behavior issue. Her hearing aids have also spent a great amount of time out for repair leaving her unaided and shut off to oral language. It has been felt by her teachers throughout the years that much of her behavior is due to her frustration in communicating with others.

By age 4 the subject's language skills were extremely below age level. A 1998 IEP report states that the subject, "relies on visual clues to aid her receptive language." For example, when the teacher stands in the classroom doorway and says, "time to line up," she shows her understanding of the command due to the position of the teacher but could not understand the command with the isolated words alone. She is reported as using a few words and phrases spontaneously and consistently such as, "no," "stop," "bye bye," and "help me." She receptively understand and expressively uses, "mommy" and
“daddy” but does not do the same for her own name. The speech teacher in the program
stated that, “she has difficulty imitating words with more than two syllables.”

During the subject’s first year in the preschool the teacher reported in both
progress reports as well as in the child’s IEP, that there were concerns about her oral
language development. It seemed the child was aging but her language skills were not
progressing. The child’s behavior also continued to be an issue and was only getting
worse. Her teacher felt that something needed to be done. Options were discussed with
the family including a cochlear implant or moving into a Total Communication
environment. If she was a cochlear implant candidate she could remain in the oral
program and be closely monitored with her implant for appropriate progress. If the family
decided against an implant, or if she was not a candidate, it was suggested she move to a
TC class. The family was slow to decide and it was not until the start of her second year
in the preschool that the decision was made to peruse a cochlear implant. After months of
evaluations at the Children’s Hospital of Philadelphia, it was determined that this subject
was not a candidate for a cochlear implant. During audiological testing her hearing fell
within the speech range, meaning it was too good for an implant. Although the child does
not use this hearing outside of the testing booth, she still did not qualify.

In November 1998 the subject moved into a Total Communication class with
children her age, where she continues to be presently. Her teacher reports that they are
working on her wearing her hearing aids consistently and making progress. Her behavior
changed immediately. The TC teacher has never seen a tantrum and said she is a “shy and
very cooperative child.” She is picking up sign quickly and is expected to progress nicely. Her oral language skills remain a priority.

Characteristics of subject 4 can be found in Table 1.

Subject 5:

Subject 5 has a severe to profound hearing loss. He was diagnosed at 12 months of age and soon after aided with behind the ear hearing aids. He was enrolled in an early intervention program for handicapped children which he and his mother attended together. The subject and his mother also simultaneously attended parent infant education sessions at an oral program for the hearing impaired. After a year of these therapies the child was enrolled in the toddler class of the oral school which he attended four half days a week. The subject was now two years old.

Before receiving his cochlear implant, a progress report from the toddler teacher of the oral school states that the child, “has great potential to become an oral communicator.” She also states that the child can, “identify his name through speech reading as well as through audition alone.” He is recorded as understanding basic commands such as, “sit down,” “open.” and “come here.” The teacher notes that he spontaneously uses a few words such as, “stop,” “help me,” “no,” “thank you,” “bye bye,” “hot,” “cookie,” “mommy,” as well as his name. An IFSP written by the parent educator notes that the subject’s mother is “dedicated to her child’s education” and “attends all scheduled sessions.”
Audiological reports from the Children's Hospital of Philadelphia, began showing that the subject was losing hearing at age two. It was determined that the subject had a progressive hearing loss and it could not be known how much or at what rate his hearing would decline. A cochlear implant was pursued and the subject received his implant in 1995 at age three.

Upon receiving his cochlear implant the subject returned to his home school district and was enrolled in a handicapped preschool class with a teacher of the hearing impaired as his one on one assistant. The subject was integrated into the regular classroom for kindergarten and is currently in first grade. He continues to have the support of the teacher of the hearing impaired as a resource and tutor.

A 1998 IEP report notes that the subject remains slightly below his peers in language skills. It also states that his speech is very intelligible and he communicates well with peers. He often relies on speechreading, but gains a great deal of information through audition. The report states that the subject, "functions very well in the regular classroom."

Characteristics of subject 5 can be found in Table 1.
Table 1: Characteristics of subjects studied

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age of Implantation</th>
<th>* Adequacy of oral language development using a c.i.</th>
<th>**mode of communication after implantation</th>
<th>Degree of family support</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>adequate</td>
<td>TC</td>
<td>adequate</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>adequate</td>
<td>TC</td>
<td>poor</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>adequate-very good</td>
<td>oral</td>
<td>very good</td>
</tr>
<tr>
<td>4</td>
<td>did not</td>
<td>poor</td>
<td>TC</td>
<td>adequate</td>
</tr>
<tr>
<td></td>
<td>qualify for implant</td>
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</tr>
<tr>
<td>5</td>
<td>3</td>
<td>very good</td>
<td>oral</td>
<td>very good</td>
</tr>
</tbody>
</table>

*poor, adequate, very good

**TC= Total Communication

Research Questions

1. What is the degree of success in acquiring oral language skills in a group of five deaf/hearing impaired children who received cochlear implants at ages 3 and 4?
The degree of success in acquiring oral language skills in a group of five deaf/hearing impaired children who received cochlear implants at ages 3 and 4 varies in each individual case. Of the five subjects, two can be considered successful in that they are presently in oral programs and use spoken language as their main mode of communication. Two subjects can be considered mildly successful in that they continue to learn oral language skills, but now use sign language as their main mode of communication. The remaining subject was found to not be a candidate and did not receive a cochlear implant.

1a. What are the rates of growth in language development in a group of 5 and 6 year old children who received cochlear implants at ages 3 and 4?

The rates of growth in language development vary depending on the individual circumstances of each subject. It is difficult to determine a general rate of growth specific for all children from a small amount of subjects. The study does show that the rate of growth cannot be determined by the age of receiving a cochlear implant alone. The whole child must be looked at to decide what is best regarding amplification, remediation techniques and mode of communication.

1b. Are there different rates of progression in language development attributable to the age which the child receives a cochlear implant?

Studies have shown throughout the years that the sooner a child receives intervention, the better the chances for success. The earlier a child is identified as being hearing impaired and amplified, the better the chances of developing appropriate oral language skills. This principle should apply to any system of amplification. It is difficult
to determine from this study if a cochlear implant is more beneficial than conventional hearing aids, but we do know that the two systems are very different. We also know that the earlier a child is exposed to oral language the better the chances of learning language. It would seem that early implantation would result in most appropriate oral language skill development.

**Summary**

The results of this study indicate that the development of oral language in hearing impaired preschoolers who received cochlear implants at ages 3 and 4, varies due to the individual circumstances of each child. In two of the five subjects studied, the child was able to either remain in an oral program for the hearing impaired or move into the mainstream. These two subjects now use oral language as their main mode of communication. Two other subjects continue to struggle with the use of spoken language and have moved into Total Communication settings, relying on sign language as their main mode of communication. It seems for these children that the combination of signs with the use of the cochlear implant has been most beneficial. They are better communicators, better in academics, as well as having positive personality changes. The remaining subject did not qualify for a cochlear implant and continues to use conventional hearing aids. She has moved from an oral setting to a Total Communication setting.

In all five subject cases there are varying factors which may have affected the child’s success in developing oral language skills. These factors may include: the age of diagnosed hearing loss and age amplified, degree of hearing loss, the support of the family,
the intelligence of the child, the motivation of the child, consistent use of the amplification system, and the educational placement.

It is important to see each of the five subjects as individuals and consider their circumstances in deciding if the cochlear implant was successful in their oral language development. The implant alone may or may not have been the deciding factor in their success. We can look at what research tell us about early amplification for success, but we must also look at all other influences on the child.
Chapter 5

Summary

The purpose of this study was to determine the most appropriate age for young hearing impaired children to receive a cochlear implant that would best facilitate oral language development. The study compared the oral language skills of five hearing impaired preschoolers, before and after implantation. Information was obtained through student case files including both formal and informal records and reports. Records included: progress reports, IEPs, audiological evaluations, and speech and language assessments.

The results of the study indicated that the development of oral language skills in hearing impaired preschoolers who received cochlear implants at ages 3 and 4, varies due to individual circumstances. A specific, ideal age for implantation cannot be pinpointed because there are many other aspects which affect success. Each subject must be looked at as a whole child, considering which aspects were positive and negative influences on successful communication growth. Age of implantation alone can not determine successful oral language growth.
Research has shown us that early amplification provides the best results for language development. This principal should apply to any mode of amplification. It would seem logical to assume that the earlier a child is implanted, the better the success rate for learning to orally communicate. The amount of language before implantation must also be taken into account when determining how much more develops with an implant.

In the five subjects studied, two can be considered successful in that they were able to remain in oral programs for the hearing impaired or move into the mainstream after implantation, using oral language as their main mode of communication. Two other subjects continued to struggle with spoken language after implantation and moved from oral programs to total communication programs, using sign language. The remaining subject did not qualify as a candidate so did not receive a cochlear implant. This subject continues to use conventional hearing aids and has also moved into a total communication program due to slow oral language development.

**Conclusions**

It can be concluded that a child must have positive, influencing characteristics to gain maximum benefit from a cochlear implant. Age of implantation alone does not determine successful oral language growth.

**Discussion**

Future studies on this topic may benefit from a larger group of subjects. It may also be useful to examine subjects with similar case histories, for example: similar hearing loss, diagnosed at the same age, implanted at the same age, and from supportive families.
These factors may make it easier to determine if the age of implantation directly affects the development of language. It may also be beneficial to examine children with more extreme differences in implantation age. For example: a child implanted at age two versus a child implanted at age 5.

There is a need for future studies on this topic. It is crucial for parents to be provided appropriate information and statistics regarding the effects of implantation. Parents must be well informed before making such a critical decision for their child. Cochlear implants are invasive and are life changing. Appropriate candidates who are expected to have appropriate benefit with realistic expectations should only be implanted. Implants should not be given to every child who’s parents want a miracle cure for deafness.

Early amplification has been proven to facilitate oral language skills. It has also been stated that many other factors influence a child’s success. The following case studies are examples of how these theories apply to cochlear implants.

Lucy was diagnosed before a year of age. She began therapy at 12 months old. She was fitted with a frequency transposition hearing aid to give her maximum hearing for speech sounds. Nearing her second birthday she was using a few words such as, “ow,” “more,” “no,” “uh-oh,” and “bye bye.” Lucy underwent surgery for a cochlear implant on her second birthday. She responded to it instantly and asked to wear it within days of her hookup.

Lucy had all of the characteristics for a good prognosis for receiving maximum benefit from the implant. Her hearing loss was diagnosed before a year of age; she was fit
with appropriate technology; her mother assumed the role of teacher of listening and verbal development; they attended therapy consistently; and the principals of the oral philosophy were applied from infancy forward. Sign language was not used and she was raised as a hearing and speaking child by her parents. At age 3 1/2 she talks freely using many two and three word phrases. Her voice quality is normal and she loves to sing. In just 1 1/2 years of implant use she has acquired the receptive and expressive language skills of a 2 to 2 1/2 year old (HEAR in Dallas, 1996).

Micky was adopted at six months and at the time weighed only eight pounds. His deafness was discovered at one year of age. Audiologists told his parents that he would never talk. His mother was determined to teach him to speak and he began speech therapy at 18 months of age. Micky’s progress was slow. In addition to having a severe hearing loss he also had continuous ear infections making him profoundly deaf most of the time. He had very little spoken language at this point. His hearing aids were of little benefit. Micky received a cochlear implant at age 4 1/2.

Micky is now a different child. He is seven years old and getting straight A’s in first grade. He loves to read and write. His mother reports that he is speaking more clearly everyday and learns new words on his own. Micky’s family is from a small town and have only met one other hearing impaired child. They are very pleased that Mickey will be able to function in the hearing world, in the regular classroom and not be an outcast (HEAR in Dallas, 1996).

Tyler was implanted at 5 1/2 years old. He was communicating in sign language and attending a kindergarten for the deaf. He began oral therapy immediately after
implantation. Initially Tyler could imitate vowel sounds and vocal play. His therapist recommended that he be moved from the kindergarten for the deaf into a regular kindergarten for the second semester of the year. She also suggested he repeat kindergarten to give him nearly two years to learn to talk before entering first grade.

The therapist noted that Tyler was the hardest working child she had ever met. He was determined to hear and talk and be like other children. Now 10½ years old, Tyler has had the implant for five years. His mother says that with the implant Tyler wants to talk all of the time. He no longer uses sign language. Tyler is now in fourth grade and reads on a sixth grade level. He goes to regular school, talks on the phone, can hear cars, dogs barking, rain and birds (HEAR in Dallas, 1996).

Each of these cases are success stories. Although they are each different, they are examples of how the entire child must be considered when determining how oral language successfully develops using a cochlear implant.


In Their Own Words…Deaf Children Who Now Hear and Talk. (1996). HEAR in Dallas.
