Critical Review:
Is it beneficial for children awaiting a cochlear implant to be taught sign language prior to implantation?

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This critical review examines the efficacy of teaching sign language to children awaiting cochlear implantation. A holistic approach to development is utilized so children's later mode of communication, speech characteristics and psychosocial development are considered. Study designs include: prospective or retrospective cohort studies (3), within group repeated measures (1), and expert opinion (1). Based on the evidence provided, pre-implant sign language use does not provide a measurable advantage or determent to cochlear implant users. Parents should be advised to choose the pre-implant mode of communication they are most comfortable and proficient with, as this will allow them to provide their child with a rich language environment prior to cochlear implantation.

Introduction

It has been reported that 58% of parents receive conflicting information about the best method of communication to use with their child prior to cochlear implantation (Christiansen, 2004). Some clinicians argue that teaching children sign language prior to implantation allows them to develop a foundational understanding of symbolic language off which oral language skills can later be built. Once children receive their cochlear implant, auditory stimuli can be mapped onto the existing sign concepts. Sign language also utilizes children's non-impaired visual system, so it provides them with a reliable mode of communication that can supplement spoken language (Koch, 2002). In addition, knowledge of sign language may facilitate children's interactions with other member of the Deaf community (Christiansen, 2004).

In opposition to pre-implant sign language use, some clinicians argue that children should receive maximal exposure to oral language prior to implantation, and access to sign language post-implant may make children less motivated to improve their listening and oral language skills. With the advent of new technology, the average age of hearing loss identification and treatment has declined. Hearing aids are often fitted in infancy and children are receiving cochlear implants earlier in development. This allows children to receive some early meaningful auditory stimulation, which some argue makes pre-implant sign language use unnecessary (McConkey Robbins, 2006).

Making decisions that will affect their child's hearing and language development can be distressing for parents. The presentation of conflicting information regarding pre-implant modes of communication contributes to this stress and leaves parents feeling unsure about the appropriateness of their decisions (Christiansen, 2004). It is important that best practice guidelines be developed so that speech-language pathologists (SLP) can provide parents with knowledge to make informed decisions.

Objectives

The primary objective of this review is to critically evaluate existing literature on the efficacy of sign language use prior to cochlear implantation in order to develop recommendations for best clinical practice.

Methods

Search Strategy

Several computerized databases, including CINAHL, PubMed, PsycInfo and SCORPUS were searched using the terms (cochlear implant) AND (sign language). References from relevant articles were examined for inclusion. The search was limited to articles published in English, but not limited by year of publication.

Selection Criteria

Studies were selected for evaluation if they included data on children (birth to 17 years) who used sign language prior to cochlear implantation. No limitations were set on the demographics of research participants or outcome measures.

Data Collection

The search strategies yielded five studies that met the selection criteria. The research design of these studies included: prospective or retrospective cohort studies (3), within group repeated measures (1), and expert opinion (1).

Results

Cohort Study

Cohort design studies are appropriate for assessing children with cochlear implants since a randomized design is not possible due to the nature of the population. The available population is also limited due to the relatively small number of children who receive a cochlear implant each year. In addition, blinding of participants and assessors is not feasible. The level of evidence provided by a cohort study is classified as level two (b), with level one representing a randomized control trial. In cohort studies, participants share common characteristics but are not individually matched. This is an inherent limitation of the research design.

Watson, Archbold, and Nikolopoulos (2006) conducted a longitudinal retrospective cohort study in order to examine the relationship between age of cochlear implantation and later mode of communication. Participants' mode of communication was classified as either oral or sign, and noted pre-implant, one-, three-, and five-years post-implant. Participants were divided into three cohorts based on age at implantation: younger than three years of age (n=26), between three and five years of age (n=85), and greater than five years of age (n=61). Results indicated that most children's mode of communication changed during the first five-years post-implant, with the majority of children transitioning from sign to oral language. Children implanted before three years of age were most likely to successfully make this transition.

The design of this study addresses its proposed research question. A plausible rational for the study was provided. Participants were selected from the client pool of the Nottingham Cochlear Implant Program. At the time of the study, 191 children had received a cochlear implant from this program and had being using the device for a minimum of five-years. Of this group, 175 were included in the study. Outcome measures were not available for the remaining 16 children due to emigration or device failure. Participants were reported to be from a variety of geographic areas, linguistic backgrounds, education settings, and hearing loss etiologies. The large sample size and diverse participant demographic allowed the researchers to gather a representative sample of the available population.

The researchers provided references to empirical evidence supporting their division of participants into cohorts based on age of implantation. Criteria used for classifying participants' mode of communication were also clearly described and are used in other empirical studies, such as Archbold (2000). Data for language classification was collected through parent and teacher report, as well as direct observation of participants at home and school. These are valid and reliable outcomes measures as data was collected from a variety of sources.

One limitation of this study is it does not directly examine children's language proficiency five-year post-implant. However, the researchers acknowledged this limitation and stated that the transition from sign to oral communication within the educational setting indicates children's increased language proficiency.

Descriptive statistical and the Chi-Squared test were used for statistical analysis of the data. Results were considered significant when $p<0.05$. These tests are appropriate for the research question and type of data collected (i.e. test of association, categorical data). The statistical significant of all relationships was stated and all statistical manipulations were valid. The study's statistical power was not reported, but considering the large sample size it is believed to be adequate.

The validly of this study is compelling due to its large and representative sample, diverse outcome measures, and appropriate statistical analysis. The researchers concluded that children's mode of communication prior to implantation is not a significant factors in determining communication mode five-years post-implant. This finding is of great clinical importance since it directly impacts the counseling of parents. This study will be heavily weighted when considering guidelines for best clinical practice.

Archbold et al. (2000) conducted a prospective cohort study in order to examine the relationship between mode of communication, speech perception and speech intelligibility in children who received cochlear implants. For the purposes of this review, only the relationships found between pre-implant mode of communication and later speech perception and intelligibility will be examined. The researcher looked to determine if differences exist in the speech skills of children who used oral versus sign language prior to implantation. All participants were followed from time of implant. Those participants who were using oral communication at three-years post-implant were divided into two groups based on parent report of pre-implant mode of communication: sign language (n=12) or oral communication (n=10). Participants' mode of communication and speech performance was then assessed at three-, four- and five-years post-implant. The performance of children who used sign language pre-implant was not found to be significantly different than that of children who communicated orally.

The design of this study addresses its proposed research question. A plausible rational for the study was provided. Participants were consecutively selected from a group of children who received cochlear implants before the age of seven from a specialized pediatric hospital. As previously mentioned, randomized

selection is not possible in this population. At the time of the study, 46 children were available for analysis, of which 22 were using oral communication. This small sample size is a limitation of the study as it may not adequately represent the diversely of the cochlear implant population. Participants were reported to be from a variety of social backgrounds, education settings, and hearing loss etiologies.

The methods of assessment used in this study were clearly outlined. Speech perception was measured using the IOWA Closed-Set Sentence Test, Connected Speech Discourse Tracking, and the Categories of Auditory Performance Scale. All of these tools were found to be valid and reliable when assessing children with cochlear implants. Speech intelligibility was rated using the Speech Intelligibility Rating Measurement, which is a valid and widely used assessment tool. Participants' primarily mode of communication was classified as oral or sign, and criterion for this classification was provided.

One limitation of this study is it only examines children's speech abilities; it does not consider their vocabulary or language development. Connor, Hieber, Arts, and Zwolan (2000) found that children who were educated using total communication (use of both sign language and oral communication) achieved significantly higher receptive spoken vocabulary scores when compared to children who were educated using solely oral communication. These findings cannot be directly compared to those of Archbold (2000) as different factors were controlled for and examined in each study. However, they indicate that further research is necessary to determine if pre-implant mode of communication affects other areas of linguistic development.

Appropriate statistical tests were utilized in this study. The researchers considered the distribution of the data and used t-tests and the Mann-Whitney U test when appropriate. Results were considered significant when $p<0.05$. The statistical significant of all relationships was reported and all statistical manipulation were valid. The statistical power of this study is limited due to its small sample size. This leaves the study vulnerable to Type II errors.

The validly of this study is suggestive due to its small same size. The researchers concluded that pre-implant sign language use does not provide a disadvantage to cochlear implant users. This finding has compelling clinical significance as it directly impact counseling of parent prior to cochlear implantation. This study will be moderately weighted when considering guidelines for best clinical practice.

Dammeyer (2009) used a prospective cohort study to examine the presence of psychosocial difficulties in children who are Deaf, hard-of-hearing, or have a cochlear implant. For the purposes of the review, only data related to children with cochlear implants will be examined. Participants' speech intelligibility, auditory perception, sign language expression, sign language reception, and psychosocial functioning were examined. A significant difference in psychosocial functioning was not found between children using sign language versus oral language.

The design of this study addresses its proposed research question. A plausible rational for the study was provided. Participants were recruited from schools for the Deaf and hard-of hearing. Data was collected from 334 students, which accounted for 50% of all children in Denmark with moderate to severe hearing loss. This allowed the researchers to collect a representative sample of the available population. However, it should be noted that children enrolled in mainstreams schools were not included in the study.

Participants' language performance and psychosocial functioning was assessed by means of teacher report. Measures of expressive and receptive communication included the Speech Intelligibility Rating Scale, Categories of Auditory Performance, the Sign Language Production Scale, and Sign Language Understanding Scale. Participants' psychosocial functioning was assessed using the Strengths and Difficulties Questionnaire (SDQ). The administration and scoring of each assessment tool was explained in detail. In addition, the inter-rater reliability of each tool was evaluated and found to be adequate (>0.783). One limitation of this study, which was acknowledged by the researchers, is that some empirical evidence suggests that teachers may rate students' psychosocial functioning too high and may not be aware of psychosocial difficulties that exist outside the classroom.

The logical regression model was used to determine the probability of psychosocial difficulties in children using cochlear implants. This statistical test is appropriate for the research question and type of data collected (i.e. test of association, continuous data). The statistical significant of all relationships was stated and all statistical manipulations were valid. The study's statistical power was not reported, but considering the large sample size it is believed to be adequate.

The validly of this study is compelling due to its large sample size, reliable outcome measures, and appropriate statistical manipulations. The researchers concluded that children's mode of communication does not significantly affect their psychosocial well-being as long as they are proficient in their chosen mode. This finding is of compelling clinical significant. However, it should be noted that the study examined post-implant, not pre-implant, mode of communication. Caution must be used when applying this finding to recommendations for pre-implant mode of communication. This study will

be moderately weighted when considering guidelines for best clinical practice.

Within Group Repeated Measures

A within group repeated measures design is appropriate for assessing the given population as randomization and blinding are not possible. The level of evidence provided is classified as level two (c). Limitations of the design include a lack of control group for comparison, and reduced variability between participants.

Tait, Lutman, and Nikopolous (2001) conducted a within group repeated measures design study in order to examine the relationship between pre-verbal language skills and later speech perception in children with cochlear implants. Participants were video-recorded while interacting with a researcher who was familiar to them. Recordings were made prior to cochlear implantation and at six- and twelve-months post-implant. Four areas of preverbal development were examined: turn-taking, communicative autonomy, eye contact, and auditory awareness. Participants communicated using their preferred mode(s) of communication (i.e. sign and/or oral language). Measurements of speech perception were collected at three-years post-implant. Results indicated a positive correlation between pre-verbal autonomy and later speech perception skills, regardless of pre-implant mode of communication.

Participants were recruited from the Nottingham Cochlear Implant Program. At the time of the study, 33 children were available for analysis. No data on participant demographics was provided. This is a limitation of the study since it is unclear if the participant sample is representative of the total cochlear implant population.

The methods used for video recording, transcribing and analysis were clearly outlined and could easily be reproduced. The researchers provided some evidence supporting the validity of the video-recording technique in capturing pre-verbal communication in children with hearing impairment. Participants' speech perception skills were assessed using the IOWA closed-set sentence test and the Connected Speech Discourse Tracking. These are valid and reliable measures of speech perception in children with cochlear implants.

Although the researchers reported a significant correlation between pre-verbal autonomy and later speech perception skills, they did not state the statistical test used to find this relationship or the strength of the correlation. This is a significant limitation of the study.

The validity of this study is equivocal due to its small sample size and unexplained statistical analysis. The researchers found that the quality of children's pre-implant communication, regardless of mode, affects later speech perception skills. This has compelling clinical importance. Since children acquire language through exposure in their environment, this finding suggests that parents should choose the pre-implant mode of communication they are most comfortable and proficient with. This study will be minimally weighted when considering guidelines for best clinical practice.

Expert Opinion

Expert opinions provide a unique perspective and often capture trends that are difficult to document in empirical research. This type of research design is appropriate for the given population. The level of evidence provided is classified as level three. Expert opinions are vulnerable to bias, and therefore their conclusions must be interpreted with caution.

Moeller (2006) outlined several advantages and disadvantages of pre-implant sign language use that should be considered when counseling families. In addition, she described several factors that may influence a recommendation for pre-implant mode of communication. For example, if the child is not expected to receive a cochlear implant until after 18 months of age, pre-implant sign language use should be recommended. No empirical evidence is provided to support these recommendations, which limits their reliability. However, they are of compelling clinical significance. The researcher's recommendations are based on several years of clinical experience and expertise, and do not contain any obvious biases. As a result, they are of great value to other clinicians working in the field. This study will be given moderately weight when considering best practice guidelines.

Discussion

Overall, the examined research provides consistent evidence regarding the efficacy of teaching sign language to children awaiting cochlear implantation. Although the articles varied in their level of evidence, they each arrived at a similar conclusion. The articles considered a variety of outcome measures, including children's later mode of communication, speech characteristics, and psychosocial development. This allowed for a holistic examination of the impact of pre-implant communication mode. Based on the evidence provided, pre-implant sign language use does not provide a measurable advantage or determent to cochlear implant users. None of the articles found a significant difference between children who used sign versus oral language prior to implantation. In addition, Watson, Archbold, and Nikolopoulos (2006) provided compelling evidence that parents' decision regarding pre-implant communication mode is not always a permanent decision. The majority of children were found to change communication mode during the first five-years post-implant. This finding taken in

conjunction with that of Dammeyer (2009) suggests that parents should chose the pre-implant mode of communication they are more comfortable and proficient with. Children develop speech and language by receiving exposure to it in their environment. Therefore, it is important that parents provide complete and meaningful language models to their child prior to cochlear implantation. Encouraging parents to choose the pre-implant communication mode they are most proficient with will ensure they provide their child with the best possible language environment. In turn, this will optimize their child's speech, language, and psychosocial development.

Although best practice guidelines can be made based on the evaluated evidence, application of these guidelines should be made on an individualized basis. Children awaiting cochlear implantation are a highly heterogeneous population and a variety of factors can impact their speech and language development. Therefore, the needs and desires of each child and family must be considered when counseling parents regarding pre-implant mode of communication.

Despite some methodological limitations, the majority of evaluated research had highly suggestive validly and compelling clinical significant. However, the current body of literature is limited. Future research should continue to employ cohort design studies as they provide the highest possible level of evidence, since randomized control trials would not be morally or ethically feasible with this population. It would also be valuable for future research to examine if children who used sign language versus oral language prior to cochlear implantation differ in their vocabulary or grammatical development five years post-implant. This is an area that has not yet been adequately examined and may impact the developmental efficacy of pre-implant sign language use.

Clinical Implications

Current research indicates that pre-implant sign use does not provide a measurable advantage or determent to cochlear implant users. In most cases, parents should be advised to chose the pre-implant mode of communication they are most comfortable and proficient with. This will allow parents to provide their child with a rich language environment prior to implantation, which will facilitate optimal speech and language development pre- and post-implant.

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