Critical Review: In children with cochlear implants, is an oral communication approach more effective than a total communication approach at improving speech and language skills?

Kailey Leroux
M.Cl.Sc SLP Candidate
Western University: School of Communication Sciences and Disorders

This critical review compares the effectiveness of two interventions to improve speech and language skills in children with cochlear implants by comparing communication outcomes in an oral communication (OC) intervention and a total communication (TC) intervention. A literature search through computerized databases was conducted and yielded seven, nonrandomized clinical trials that met inclusion criteria. Overall, the evidence is somewhat conflicting on which approach is more beneficial; however, the evidence did support the use of an OC intervention with regards to speech intelligibility. Recommendations for future research and clinical practice are provided.

Introduction

Cochlear implantation has become standard clinical practice for children with severe-profound hearing loss since the mid-1980's (Yanbay, Hickson, Scarinci, Constantinescu, & Dettman, 2014). A cochlear implant is a small, electronic device that consists of an external portion that fits behind the ear, and an internal portion that is inserted surgically under the individual's skin. The cochlear implant is able to bypass any damaged areas of the ear and stimulate the auditory nerve directly. Individuals fitted with a cochlear implant are thus able to hear a variety of sounds from the environment and eventually learn or re-learn to hear and develop their speech (Jiménez, Pino, & Herruzo, 2009). Children who do receive a cochlear implant at a young age may rely on speech and language intervention services to achieve success in developing and improving their linguistic skills. However, speech and language outcomes for children with cochlear implants are highly variable and researchers have studied numerous predictors that may impact these outcomes, one of them being mode of communication used (Yanbay et al., 2014).

There are a variety of methodologies offered to develop and improve speech and language skills for children with hearing loss. Two different modes of communication, both encompassing a broad range of methodologies, have been implemented. These include a total communication (TC) approach and an oral communication (OC) approach. The OC approach includes auditory-verbal and aural/oral approaches, which only uses the auditory channel as the means for the development of linguistic skills. It is expected that the child's output will be speech in this approach. The rationale for this approach is to enable the child to grow and learn in a living environment that is predominantly hearing, and become independent, contributing citizens, in a largely hearing society (Martin & Clark, 2006). The TC approach combines aural and sign systems (e.g., Signed English) to help the child learn language and communicate. The rationale for the TC approach is that it provides opportunities to communicate in all modes, allowing the child to choose the form that is best suited for their individual needs (Martin & Clark, 2006).

Parents and educators wish to provide children with the best opportunities to achieve age-appropriate speech and language skills, and therefore they may seek the guidance of a Speech-Language Pathologist to assist in determining which program will be most effective at improving linguistic skills. Thus, this critical review consists of a literature search of the available evidence comparing these two methodologies in children with cochlear implants. Both speech and language outcomes are of interest and will be evaluated in this article.

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the effectiveness of an OC versus a TC intervention program for promoting speech and language skills in children with cochlear implants.

Methods

Search Strategy

Computerized databases, including PubMed and Scholars Portal were searched using the following search strategy: ((Mode of communication) OR (oral communication) OR (total communication) OR (sign language) AND ((Cochlear implants)). Articles were also selected from reference lists of research papers previously read and reviewed.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to examine the effectiveness of TC and OC approaches on developing speech and language

skills of children with cochlear implants. Outcome measures included a variety of speech and language tests. Research studies exclusively focusing on speech perception outcomes were not included. No limits were set on the demographics of research participants or their socio-economic status.

Data Collection

Results of the literature search yielded seven non-randomized clinical studies in accordance with the previously mentioned selection criteria.

Results

Non-randomized clinical trials

Non-randomized clinical trials are a type of quasi-experimental design, in which the participants have not been assigned to treatment groups by chance. The researchers have either used natural groups or have assigned participants to groups using a non-random procedure, due to various practical reasons. The ability to control for confounding variables determines the strength of these studies (Axelrod & Hayward, 2006).

Connor, Hieber, Arts, and Zwolan (2000) conducted a longitudinal cohort study to compare consonant production accuracy and vocabulary development of children using cochlear implants that were enrolled in OC and TC education programs. A total of 147 children met inclusion criteria and participated in this study. Children were assigned to either the OC group or the TC group dependent upon the school they had attended for the first three years they had used their implants. There were 66 participants in the TC group and 81 participants in the OC group. Participants were further divided into groups based on the age they received their cochlear implant: preschool (under 5.0 years), early elementary (5.0 to 6.9 years), and middle elementary (7.0 to 9.9 years). Certified speech-language pathologists conducted assessments using familiar standardized tests to obtain results in consonant-production accuracy, receptive vocabulary and expressive vocabulary.

Appropriate two-level hierarchical linear modeling (HLM) revealed that over time, children in the OC group improved more quickly and achieved higher scores in consonant-production accuracy than those in the TC group, however no significant differences were found if the child was implanted before the age of five. When comparing expressive vocabulary in both groups, results revealed children in the TC group achieved significantly higher scores than the OC group if they received their cochlear implant in preschool or early elementary school. Upon visual inspection of graphs, the TC group did demonstrate higher scores over time than the OC group, but the difference between the two groups scores did not change over time. No statistically significant differences were found between the two groups in regards to receptive vocabulary scores.

The procedures and participants of this study were described in great detail and the authors attempted to control for a variety of variables that may influence outcomes. However, there are a few limitations in this study. Children who responded to picture targets in sign language may not have been understood correctly by the examiner; thus, the expressive vocabulary results should be interpreted with caution. Moreover, the authors obtained information regarding educational placement by parent report or school visit observations, and participants were placed in programs at different sites that were run by different professionals. It is difficult to conclude how and when sign language was being implemented in these various settings and whether programs were delivered uniformly. Overall, the results of this study provide highly suggestive evidence for positive speech intelligibility outcomes for the OC group, positive expressive vocabulary outcomes for the TC group, and no differences in receptive vocabulary. Importantly, however, age of implantation impacted both speech and language results.

Tobey et al. (2007) implemented a non-randomized clinical trial to investigate phoneme accuracy in children with cochlear implants using two different communication modes: OC and TC. A total of 173 participants were included in the study. Intelligibility measures were appropriate and well-detailed, and included blinding of speech-language pathology raters. Appropriate ANOVAs were used to analyze percent correct scores for vowel, consonant and total sounds. Results showed phoneme accuracy (total sounds) was significantly higher for children using OC modes than children using TC modes. They concluded children using OC had more accurate articulatory productions of place and manner features due to the linguistic advantage of being in a setting with ample opportunities to practice listening and speaking.

The results of this study revealed significantly higher speech intelligibility for children using an OC approach. A large sample size, baseline similarities of participants, as well as the use of standardized procedures to collect data on phoneme accuracy should be considered strengths of this study. The researchers reported on inter-rater reliability and described the methodology, procedures, and results of this study in detail. Although Tobey et al. (2007) used parent questionnaires to determine the communication mode of the child, the researchers determined an average of the rankings over five time frames: pre-implant, each of

the first three years' post-implant, and current participation. This provides more validity to determine which mode of communication the child had been exposed to most. Overall, the results of this study provide highly suggestive evidence for positive speech intelligibility outcomes for the OC group.

Geers et al. (2000) conducted a preliminary study in which they hypothesized that children who communicate using speech and hearing will achieve higher levels of speech perception, speech production, language and reading skills than children using both speech and sign language to communicate. A total of 20 children were enrolled in an OC setting and a total of 23 children were enrolled in a TC setting. Well-established assessment tools were used to examine the four outcome variables. Appropriate *t*-tests revealed that participants in the OC setting performed significantly higher on speech perception tasks and had significantly higher scores for speech production intelligibility. There were no statistically significant differences between the two groups in reading or language scores. The authors concluded that these results suggest that children in an OC setting receive more auditory benefit from their implant, leading to better linguistic outcomes.

The purpose of this study was to focus exclusively on effects of a communication mode (OC or TC) on outcome measures. Strengths of this study include the use of standardized, valid assessment tools, and that the researchers made attempts to control for possible influencing variables. In addition, selection criteria, participant characteristics, as well as the administration and test descriptions were reported in detail. However, the OC and TC settings were not described in detail. Similar to Connor et al.'s (2000) study, it is difficult to know if all TC programs used equivalent amounts of sign language with spoken language. Moreover, the participants differed in mother's education and the amount of intervention hours received in the first three years after implantation. The OC group averaged double the amount of therapy, as well as mothers in this group averaged double the years of college education. Statistical analysis was not conducted to determine whether these between group differences could interact with the outcome variables. Overall, the results of this study provide suggestive evidence that an OC approach may lead to superior speech production and speech intelligibility outcomes.

Geers (2002) also conducted a longitudinal cohort study examining how the type and amount of educational intervention influences five specific variables: speech perception, speech production, language, and reading in children with cochlear implants. A total of 136 participants were seen over a four-year period. A parental rating scale determined classroom communication mode, with 67 children in an OC setting and 69 children in a TC setting. A battery of well-established tests was administered and performance on the dependent variables was reduced to a single score by using principal component analysis. A series of multiple regression analyses was also conducted. Analysis of the results revealed that an OC approach had statistically significant results in performance on speech perception, speech production, spoken language and reading outcome measures individually; however, there was no significant contribution to the total language performance from either educational group.

Information on child, family, and implant characteristics were well reported in this study, and participants were similar at baseline. However, methods of data collection, as well as the study's results, were not clearly explained. While Geers (2002) did use well-known standardized tests to assess outcome measures, no reliability or validity was documented for the independent variables (child's therapy, class placement, and communication mode). Despite these limitations, the results provide somewhat suggestive evidence that there are no statistical differences between the OC group and the TC group for overall speech and language performance.

A study conducted by Cullington, Hodges, Butts, Dolan-Ash, and Balkany (2000) compared the language abilities of children using cochlear implants in an OC setting and a TC setting. This study included 12 children in the TC setting and 12 children in the OC setting. Four well-established, standardized language tests were administered to assess expressive and receptive language abilities. In order to control for scoring bias, an individual blinded to the study also scored the assessments. Appropriate 2-tailed *t*-tests and Mann-Whitney U tests revealed that children in the OC group demonstrated significantly less language delay on the Expressive Vocabulary Test (EVT) than those in the TC group. Children in the oral group performed better on the other language tests, however the results were not statistically significant.

Cullington et al. (2000) provided sufficient participant details accompanied by visuals of participant characteristics. The classification of the two groups appears to be a strength for this study, as the children were chosen from either a public school that uses a TC approach or a public school that focuses on oral programs or auditory-verbal therapy. However, the study's sample size was small, and there was no information on whether baseline differences were

accounted for, thus posing a possible threat to the internal validity of the study. The methodology and procedures of this study were also not reported in great detail, making it difficult to critically appraise these sections. Overall, the results of this study provide somewhat suggestive evidence for positive expressive language outcomes for children in an OC setting.

More recently, Jiménez et al. (2009) conducted a non-randomized clinical trial to compare speech development in 18 pre-lingual deaf children with cochlear implants who had been educated using two different modes of communication. Participants were divided into groups based on their environment—a group that used both sign language and spoken language (G1) and a group that used only spoken language (G2). The authors used chi-square statistical analyses to determine the equivalence of participant characteristics. The lead author of the paper conducted the speech and language examinations using four valid, standardized assessments. Appropriate statistical analyses (ANOVAs) were completed to compare group scores of speech intelligibility, receptive vocabulary, psycho-linguistic skills, adaptive behavior and behavioural problems. The results revealed that the TC group performed significantly better in manual expression and verbal fluency, and the OC group performed significantly better in oral comprehension, pronunciation, and use of grammar rules. There were no statistically significant differences found for receptive vocabulary, social and communicative skills, or sub-tests relating to visual and auditory processing.

When critically appraising the design of this study, there are several limitations. The selection criteria of the participants, the two intervention settings, and the procedures of this study were not reported in great detail. Furthermore, the tests administered were not described, rather they were listed, making it difficult to determine the specific skills each test was examining. Generalizability of findings is also a limitation, as the study consisted of a small sample size. Despite these limitations, inter-observer reliability of assessment results was reported to be 100%, and the authors used appropriate statistical analysis to show equivalence of participant groups.

Jiménez et al. (2009) concluded that children in the TC group should be able to evoke a greater number of words than children in the OC group, due to their higher scores in verbal fluency. However, the limitations of this study reduce the clinical application of these results. Overall, the results of this study provide somewhat suggestive evidence for positive manual expression and verbal fluency outcomes for the TC group, positive oral comprehension, speech intelligibility, and use of grammar for the OC group, and no differences in receptive vocabulary, social communication skills, or sub-tests relating to visual and auditory processing.

Using a nonrandomized clinical trial, Percy-Smith, Cayé-Thomasen, Breinegaard, and Jensen (2010) examined the effect of several factors on language outcomes for prelingual children with cochlear implants. They also estimated the effect-related odds ratio of each factor, relating to a participant's speech and language abilities. A total of 155 children participated in the study, with 40 participants using only spoken language in the home, 85 participants using spoken language and supportive signs, and 30 participants using spoken language and sign language together. Each participant completed a different battery of tests dependent on their hearing age. The authors looked at receptive language, phonological speech production, vocabulary, auditory awareness, auditory capacity and speech intelligibility. Appropriate logistic regression analysis revealed that the only factor having statistically significant effects on all outcome measures was communication mode used in the home. Odds ratio estimates revealed that children in spoken language environments had greater odds of performing higher in all tests when compared with children exposed to spoken language with sign support, or solely exposed to sign language.

The participants and descriptions of possible associated factors on speech and language outcomes were well described in this study. However, phonological productions and vocabulary skills were assessed with unknown Danish tests. It is unclear whether these are standardized, however this study was performed on a Danish population, and therefore one may speculate with caution that they were used appropriately. Furthermore, mode of communication was determined by parent report, and this may have caused children to be included in a group that does not accurately reflect their mode of communication. Moreover, the Reynell test and vocabulary test each had particularly high odds ratio estimates (>100), and should therefore be interpreted with caution. This may be due to the smaller sample size, as only 88 of the children were tested on the Reynell test and only 61 children on the vocabulary test. Overall, the results of this study provide somewhat suggestive evidence for positive auditory awareness and capacity, speech production and intelligibility, receptive language, and vocabulary outcomes for children in an OC setting.

Discussion/Recommendations

The studies included in this critical review looked at both speech and language outcome measures. Overall, the critical appraisal of available research provides conflicting evidence regarding the benefits of one intervention over another for improving the language skills of children with cochlear implants. When considering all of the studies, there appears to be a general finding that there are no differences in language outcomes in regards to an OC approach versus a TC approach. Furthermore, findings that examined speech intelligibility were consistent and found that children enrolled in an OC setting performed significantly better on speech intelligibility measures (Connor et al. (2000), Geers (2000), Jiménez et al. (2009), Percy-Smith et al. (2010), Tobey et al. (2007), and Geers et al. (2002)).

There are several methodological reasons that could account for some of the differences between studies. These include pre and post implant characteristics, control of confounding variables, the samples studied, the assessments that were administered, and the particular tools used to measure language outcomes. In particular, differences can be seen between the studies, such as the age of diagnosis of hearing loss, age at hearing aid fitting, age at cochlear implant, amount of hearing loss, duration of implant use, length of intervention, and child and family characteristics, such as socio-economic status and family involvement. These factors have the potential to affect performance levels of the participants. While several studies attempted to control for potential confounding variables, no study controlled for all of them. Not controlling for confounders may reduce the internal validity of the studies and must be considered when drawing conclusions. Additionally, all studies included two groups that differed in mode of communication; however, there were significant differences in the descriptions of the two interventions. There appears to be a lack of standardization on the definitions of an OC approach and a TC approach. The methodologies used to develop a child's language ranges on a spectrum from completely visual to completely auditory, with many programs in between that differ in the amount and type of sign or spoken language used. Moreover, a lack of uniformity exists on how researchers obtain information on a child's true mode of communication, and how long a child had been using that particular mode of communication. While some of the studies suggest that one approach is more beneficial than the other, the fact that studies found statistically significant findings in different linguistic outcomes, as well as the limitations in all of the studied included, makes it difficult to draw conclusions.

Future recommendations for research might include increasing sample sizes to increase power, thus providing researchers and readers with increased confidence in the results. Moreover, if a more standard definition could be applied to the participant groups, and participants were chosen who have exclusively been enrolled in an OC program and a TC program, future research endeavors may be able to provide more accurate results. Longitudinal studies may also have particular benefit in future research when studying the linguistic abilities of children with cochlear implants in different educational settings, as this may provide important information on how their speech and language skills are developing and improving over time in connection with different intervention programs. Furthermore, future research could examine how increasing the amount of speech therapy for children enrolled in a TC approach may alter the findings that children in an OC approach perform better in regards to speech intelligibility.

Clinical Implications

Based on the current quality of evidence, caution should be applied when suggesting to a family whether an OC or a TC approach is more effective at developing the speech and language skills of a child with a cochlear implant. It is in the child's, family of the child, and clinician's best interests to consider all approaches to intervention. Family members of the child receiving the intervention may have a particular style or attitude towards a given intervention technique. Until further studies and research have been conducted, it is important to understand that the clinician's and family's joint goal is speech and language proficiency and meaningful exchange between individuals, no matter the methodology or modality employed.

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