

Critical Review: The Effects of Intrathecal Baclofen Therapy on Speech in Individuals with Cerebral Palsy

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This critical review examines the effects of intrathecal baclofen (ITB) therapy on speech in individuals with Cerebral Palsy (CP). Several studies were evaluated to determine if ITB is effective in improving speech within this population. Overall, the research provides some weak evidence that ITB may improve speech in some individuals with CP. However, this evidence should be viewed as preliminary evidence, and further research is recommended

Introduction

Cerebral Palsy (CP) is a nonprogressive neurological condition resulting from brain damage that takes place before cerebral development is complete. This brain damage can occur before, during, or after birth, up to the age of two (Kriger, 2006).

Cerebral Palsy can be classified as spastic, dyskinetic, ataxic, hypotonic or mixed. Spastic CP accounts for 70-75% of all cases (Chitra & Nandini, 2005). Albright, Barry, Shafron and Ferson (2001) estimated that approximately 1/3 of individuals with CP have dystonia. Spasticity and dystonia may co-occur in an individual.

Cerebral Palsy can affect all four limbs (quadriplegic), two limbs on one side (hemiplegic), or just the legs or just the arms (diplegic). Up to 60% of individuals with CP have some form of mental impairment (Chitra & Nandini, 2005).

Cerebral Palsy is the most common physical disability in childhood. It affects 2-2.5 children in every 1000 live births (Kriger, 2006). Chitra et al. (2005) reported that 38% of children with CP have impaired speech and/or articulation disorders. Others have reported that dysarthria occurs in 28% to 52% of children with CP (Ingram, 1964; as cited in Bjornson McLaughlin, Loeser, Nowak-Cooperman, Russel, Bader & Desmond, 2003). This dysarthria is caused by the effects of spasticity on respiration, phonation, resonance, articulation and prosody (Yost & McMillan, 1983; as cited in Bjornson et. al, 2003).

Intrathecal Baclofen (ITB) is a pharmacologic treatment for spasticity and/or generalized dystonia. Spasticity results from the failure of the brain to send messages down to the spinal cord to release GABA. GABA is an important chemical which works to relax the muscles. Without its release as needed, spasticity occurs. Spasticity can affect any muscle making movements stiff, difficult and awkward (Albright, 1996). Baclofen works as a GABA agonist in order to decrease this spasticity (Koman, Paterson Smith & Shilt, 2004). The mechanism through which ITB

works to decrease dystonia is unknown (Albright et al., 2001).

Baclofen can be given orally but must be given in high doses in order to make a difference due to difficulty with crossing the blood brain barrier. High doses result in negative side effects (Disabato & Ritchie, 2003). Baclofen can be given in lower doses if it is injected directly into the intrathecal space of the spine, and this is the basis of ITB therapy (Disabato & Ritchie, 2003).

ITB involves the insertion of a catheter into the intrathecal space. This catheter is attached to a pump which is surgically implanted in the abdomen. This pump is programmed to continuously release a prescribed amount of baclofen, either at a steady rate, or in various quantities throughout the day (Rawlins, 1998; as cited in Disabato & Ritchie, 2003), thereby reducing spasticity or dystonia. All pump-implantations are preceded by a trial injection to test for responsiveness and possible negative side effects.

Several authors have subjectively reported that ITB therapy improves, or may improve speech. For example, Koman et al. (2004) reported that intrathecal baclofen, "anecdotally, is reported to improve speech." Disabato and Ritchie (2003) reported that decreased tone in the respiratory system can lead to improvements in speech skills, but did not provide evidence to support this claim. A study by Concalves, Garcia-March, Sanchez-Ledesma, Onzain & Broseta (1994) was completed and they reported that "speech problems were ameliorated", but failed to provide outcome measures.

Objectives

The primary objective of this paper was to critically evaluate the existing literature pertaining to the effects of ITB on speech in individuals with CP. The secondary objective was to propose evidence-based recommendations for future practice and research regarding ITB and its effects on the speech of individuals with CP.

Methods

Search Strategy

The following computerized data bases were searched; AMED, Embase, CINAHL, Medline, PubMed and Proquest Nursing.

Keywords used include:

(Intrathecal Baclofen) AND ((Speech) OR (Intelligibility)) AND (Cerebral Palsy)

The OVID Databases (AMED, Embase, CINAHL and Medline) were useful in obtaining articles that were relatively specific to the topic at hand. PubMed and Proquest Nursing databases were useful in obtaining more general articles addressing the different treatments for CP. These articles only briefly and subjectively mention the possible effects of ITB on speech and do not attempt to support this claim through means of outcome measures.

Selection Criteria

The studies included in the critical review were required to investigate the effects of ITB on speech in individuals with CP, using some form of outcome measure. Articles that did not use any form of outcome measure were excluded from the review.

Data Collection

Results of the literature search yielded two abstracts and three articles pertaining to ITB therapy and its effects on speech. Other articles not meeting the above criteria were used for informational purposes only. Three of these articles obtained subjective evidence through the administration of an interview or questionnaire and looked at speech outcomes as a subcomponent of the study. The other two studies obtained objective evidence through the administration of the Assessment of Intelligibility of Dysarthric Speech (AIDS) (Yorkston & Beukelman, 1981). Both of these studies employed a single-subject design and focused mainly on speech outcomes.

Results

For a brief outline of articles with regards to speech, see Appendix A.

Studies that Administered a Subjective Measure of Speech Outcome

Albright, Barry, Shafron and Ferson (2001), sought to "evaluate the effects of intrathecal baclofen on patients with severe generalized dystonia." This study looked at several outcomes, including speech. With regards to speech, a telephone questionnaire was administered. Sixty-two out of seventy-seven participants were contacted and responded. The

participants were asked several questions including whether speech had improved, been unchanged or worsened. Thirty-three percent reported an improvement in speech, 63% reported no change, and 4% reported that their speech had worsened. No specific conclusions regarding speech were made by the researchers.

Motta, Buonaguro, Stignani, and Conurso (2004) assessed the efficacy of ITB therapy in treating dystonia in children with CP. The study included 22 participants obtained from a convenience sample, and focused on any resulting changes in the dystonia. With regards to speech, a subjective patient's questionnaire was administered following pump implantation. Fifty percent of participants reported speech improvements as a result of the reduced dystonic movements. Again, no specific conclusions regarding speech were made by the researchers.

Bjornson, McLaughlin, Loeser, Nowak-Cooperman, Russel, Bader and Desmond (2003) sought to clarify what issues, if any, related to oral motor control are affected by ITB. Thirty children and their families were part of a convenience sample for this study. An interview tool containing 33 questions was designed for this study. At the time, it had not yet been tested for validity, reliability or responsiveness. The interview was administered in person, to the child and parent, at a mean time of 2.1 years post pump implantation. Twenty-three of the participants were capable of speech production, and of these, 10 reported improvements in speech following ITB therapy. Two children/caregivers reported a negative effect of ITB therapy on speech production. The authors concluded that "individual children with spasticity of cerebral origin receiving ITB experienced highly variable and unpredictable consequences in the domains of nutrition, oral motor function, communication and GI function."

Studies that Administered an Objective Measure of Speech Outcome

Mason, Gilpin, McGowan and Rossiter completed a single-subject study in 1998. They studied a 28 year old male with CP who was admitted to their facility for a trial of ITB. They assessed the participant's speech at two points in time before drug administration, after an injection of "25mgs" baclofen and after an injection of "100mgs" of baclofen. The measures used at these points in time were the Frenchay Dysarthria Assessment (Enderby, 1983) and the AIDS (Yorkston & Beukelman, 1981). Results of the study indicated a significant increase in sentence intelligibility from 18% (at baseline) to 65% (for the "25mgs" dose) to 51% ("100mgs" dose) ($p < 0.001$ using Fisher exact). The participant's

speaking rate slowed from 50 words per minute at baseline to 29 words per minute for both the 25 and “100mgs” doses. The intelligible words per minute increased from a baseline mean of 9 to a post-trial mean of 17 (Fisher exact: $p < 0.001$). The participant’s intelligibility of single words did not show any significant improvement. The results from the Frenchay Dysarthria Assessment (Enderby, 1983) indicated that volume and ‘in speech’ measures from the laryngeal section improved significantly (both changing from 2 to 4.5). The authors concluded that there was a significant change in the intelligibility of speech after administration of intrathecal baclofen.

Leary, Gilpin, Lockley, Rodriguez, Jarret, & Stevenson, (2006) completed a single-subject study in order to determine the effect of ITB on the speech of an ambulant adult with CP. Their participant was a 40 year old male with severe spastic dysarthria whose speech was “characterized by a harsh and effortful voice with intermittent phonation breaks and probable laryngeal spasm.” In addition, the participant reported tightness and pain in the throat along with diaphragmatic tension when talking. The participant had a reduced intelligibility of speech.

The AIDS was used as the outcome measure for speech and was performed by one observer and scored by another independent observer. Observers were not blinded to treatment status. Outcome measures were obtained at baseline, post trial and 6 months post-pump implantation. Study results indicated improvements following the trial of 25 μ g of ITB. Outcome measures at 6 months post implantation indicated sustained improvements. From the AIDS, intelligibility for single words changed from 88% to 84% to 94% from baseline, to post-trial to post-implant, respectively. His correct complete sentences changed from 9.1% to 31.8% to 41%. His correct single words within sentences changed from 55% to 73.6% to 75%. No statistical analysis was applied due to small sample size. The authors concluded that “ITB may be an effective treatment for spastic dysarthria in carefully selected patients.” They also concluded that “the AIDS is a useful tool to assess the effect of ITB in the treatment of spastic dysarthria.”

Critical Appraisal of Research

Subjective Measure Studies

The first three studies outlined administered subjective measures such as questionnaires and interviews as the only outcome measure of speech. Several weaknesses result in these studies due to the use of subjective measures. According to Portney & Watkins (2000), questionnaires are not useful for studying behaviours which should require objective

information. In other words, they are not useful for studying behaviours, such as speech, which are measurable. To improve the validity and reliability of their studies, the researchers should have used objective measures such as intelligibility tests or acoustic measures.

Questionnaires and interviews carry several inherent weaknesses when used as an outcome measure. There is the possibility of a misunderstanding or misinterpretation of the questions or answers offered, and the accuracy or motivation of the respondent are unknown. They gather information that is based on self-report which leads to the possibility of bias or inaccuracy. Questionnaires/interviews obtain subjective information which is descriptive in nature and cannot be used to establish causality. Recall bias may also be an issue when the participant is asked to remember an event from the past (Portney & Watkins, 2000). In addition to the above weaknesses, Portney and Watkins state that data gathered from questionnaires for the evaluation of function must only be interpreted as the respondent’s perceptions of those functions and not as performance measures.

In addition to the weaknesses resulting from the use of questionnaire and interviews as outcome measures, these three studies have several other weaknesses in common. First of all, none of the questionnaires or interviews had been shown to be valid, reliable or sensitive. Secondly, all interviews and questionnaires were administered, on average, around 2 years post-pump implantation, with one study (Albright et al., 2001) having a range of up to 7 years. This puts the results of each study at risk for recall bias and may result in threats to validity such as history and maturation. In addition, mortality was also evident in the study by Albright et al., as not all participants responded to the questionnaire. The final weakness is that each study selected their sample by means of a convenience sample which leads to selection bias.

As previously mentioned, subjective measures obtain descriptive information which cannot be used to establish causality. This makes it impossible to conclude from these studies that ITB causes an improvement in speech. One can only conclude that ITB therapy and improvements in speech may be related.

Objective Measure Studies

In contrast to the previously discussed studies, the two single-subject design studies employed an objective measure, the AIDS, to evaluate speech outcome. This can be seen as a major strength of these two studies. The AIDS is a standardized assessment of intelligibility that has face validity and

is reliable. The test also purports to be sensitive to change. Intelligibility is a good outcome to measure because it may be considered the universal consequence of dysarthric speech, and may serve as global index of severity (Yorkston & Buekelman, 1981). Intelligibility is considered by Yorkston and Buekelman (1981) to be the “sum of the interacting processes that are involved in speech production.” So, if breath support is improved as a result of ITB, this will in turn improve intelligibility, or if laryngeal spasticity is reduced as a result of ITB, this will improve intelligibility, and so on. Improvements seen in intelligibility will mean that improvements have been made in speech.

Despite this major strength in the two single-subject studies, both studies had several weaknesses which result in caution needing to be taken when interpreting their results. The major weakness of both studies was the use of a single-subject design. This study design leads to major flaws such as a lack of power and an inability to generalize results to the larger population at hand.

The study by Mason et al (1998) had multiple weaknesses which call into question the validity of the results. First, little information regarding the participant and methods were given, further affecting the generalizability of the results. Second, the authors did not mention whether the two pretests and two posttests were rated by the same individual. The same observer needs to rate both tests in order to maintain reliability of the AIDS (Duffy, 2005). If not, this could result in instrumentation, a threat to internal validity. In addition, the researchers only give the mean intelligible words per minute, so the reader is uncertain if any outliers had made the participant’s pre-trial intelligibility seem worse or his post-trial seem better than they really were. Also, it should be noted that the participant’s speaking rate slowed substantially from pre-trial to post-trial. This slower speaking rate in itself may be responsible for the improved intelligibility in sentences. Of added concern to the previously mentioned weaknesses, there are major typos in this abstract that call to question the credibility of the researchers. For example, they call the AIDS by the wrong name and they wrote that they gave the client “100mgs” of ITB which would be 1000 times the usual dose given in other studies and reported in the literature. The number should read 100µg, not 100mgs. Finally, the statistics used to judge statistical significance were inappropriate for the data obtained. The sample size was extremely small (n=1) so the use of statistics in this study was unsuitable.

The study by Leary et al (2006) also had some additional weaknesses. One weakness is that the raters were not blind to the treatment status. Blinding

could have been easily achieved in this study because the AIDS is tape recorded. Tape recordings of the pre- and post-trial tests could have been shuffled and then rated in random order following the final administration of the test. In addition, it seems as though some data is missing that may have been useful information to the reader. This information includes the second trial of ITB data, and the rate (WPM) of speech. The WPM may have played a significant role in the improvement of sentence intelligibility if the rate had slowed substantially.

Recommendations

From the above discussion of the current evidence, it is seen that some weak evidence does exist that ITB may improve speech in certain individuals with CP. However, this evidence is overwhelmed by multiple flaws, and at this point, must only be viewed as preliminary evidence.

It is obvious at this point in time, that ITB should not be used to treat speech alone, due to several uncertainties. It is uncertain how many individuals will experience an improvement in speech, who will experience a change, and how large of a change the individual might experience. In addition, Leary et al. (2006) cautioned that care must be taken in targeting dysarthria with ITB as high ascending concentrations may result in serious side effects such as respiratory depression or arrest.

At this time, it is recommended that the speech-language pathologist monitor for changes in the speech of individuals undergoing ITB therapy. This is important for two major reasons. First, a small percentage of individuals from the studies reported that they experienced a decline in their speech abilities following the beginning of ITB therapy. The second major reason is that record keeping of positive changes may add to the evidence-base for this topic.

Several recommendations regarding future research in this area can be made. A good starting point for further research would be to complete quasi-experimental studies with subjects pre-assigned to a treatment group or a control group, with an adequate sample size in each group. A true experimental design is not possible in this case as it would be unethical to withhold treatment from an individual who would benefit from ITB therapy. Instead, the control group could be obtained by selecting subjects who are not good candidates for ITB and are undergoing a different treatment (ex: physiotherapy, botox injections in the legs, etc.) that is known to not affect speech. Objective outcome measures should be used, including intelligibility measures such as the Computerized Assessment of

Intelligibility of Dysarthric Speech (CAIDS) or the Preschool Speech Intelligibility Measure (Morris, Wilcox, Schooling, 1995), and acoustic measures such as jitter and shimmer. Acoustic measures can be used on all individuals while the intelligibility test chosen will depend on the age, mental abilities, and literacy skills of the subjects included in the study. Intelligibility and/or acoustics should be measured pre ITB, post ITB trial, and a couple of times post ITB pump implantation to monitor for continued change.

In addition to the quasi-experimental design, future research should also include an analysis regarding the characteristics of those subjects whose speech does improve versus those who experience no change. This will help future professionals to better predict those individual's whose speech will benefit from ITB therapy and those who won't.

Following completion of the above research recommendations, future research may also focus on comparing improvements in individuals treated for spasticity versus those individuals treated for dystonia.

Conclusions

It is concluded that each article on its own appears to provide support for the notion that ITB may improve speech in individuals with CP. Although the three studies containing subjective evidence reported that 33-50% of subjects experienced an improvement in speech, this information is descriptive in nature and cannot be used to establish causality. The two studies that obtained objective evidence reported that there was an improvement in speech. However, both of these studies were single-subject studies, causing them to lack power and making the results not generalizable to the larger population at hand.

Regardless of these major flaws, it is concluded that together the studies do provide some weak evidence that ITB may improve speech in some individuals with CP. This improvement should be seen as variable, as the current evidence has shown that not all individuals will experience a change in speech. Additional research needs to be completed in order to come to a stronger conclusion regarding this topic.

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Appendix A - Outline of Articles with Regards to Speech

Reference	Purpose of Study	Participants	Location of Baclofen Injection	Outcome Measures Used with Regards to Speech	Results
Albright, Barry, Shafron and Ferson (2001)	To “evaluate the effects of ITB on patients with severe generalized dystonia”	- 86 total, all with generalized dystonia - 33% had coexisting spasticity - 71% had CP	Lumbar region	Telephone questionnaire administered post-implantation. 62 participants responded	- 33% reported better speech - 63% reported speech the same - 4% reported that speech became worse
Motta, Buonaguro, Stignani, and Concurso (2004)	To “evaluate the efficacy of ITB in the treatment of dystonia in children with CP”	22 participants with CP	Unknown	Subjective patient questionnaire administered post-implantation	50% of participants reported speech improvements
Bjornson, McLaughlin, Loeser, Nowak-Cooperman, Russel, Bader and Desmond (2003)	To “clarify what issues, if any, related to oral motor control are affected by ITB”	30 children with spasticity of cerebral origin	Unknown	In person interview administered at mean 2.1 years post-implantation Speech was one of four functional domains sampled.	Of 23 participants who were capable of speech, 10 reported improved speech and 2 reported a negative impact of ITB on speech
Mason, Gilpin, McGowan and Rossiter (1998)	None specifically given	Single-subject study of a 28 year old man with CP	Unknown	1) <i>Frenchay Dysarthria Assessment</i> 2) <i>Assessment of Functional Intelligibility of Dysarthric Speech</i> Both performed twice at baseline, once at 25mgs trial, and once at 100 mgs trial injection.	1) Frenchay: a. volume ↑ signif. b. “in speech” measures of laryngeal section improved signif. 2) a. Sentence Intelligibility changed from 18% to 65% to 51% b. speaking rate slowed from 50 to 29 WPM c. intelligible words per minute increased
Leary, Gilpin, Lockley, Rodriguez, Jarret and Stevenson (2006)	To determine the effect of ITB on the speech of an ambulant adult with CP.	Single-subject study of an ambulant 40 year old man with CP	Level of T12/L1	Assessment of Intelligibility of Dysarthric Speech – Adm. 3 times: once at baseline (BL), once post trial (PT) injection and once post-implantation (PI)	a. Single words: 88% at BL, 84% PT, and 94% PI. b. correct complete sentences: 9.1% BL, 31.8% PT, and 41% PI c. Correct single words within sentences: 55% BL, 73.6% PT and 75% PI.