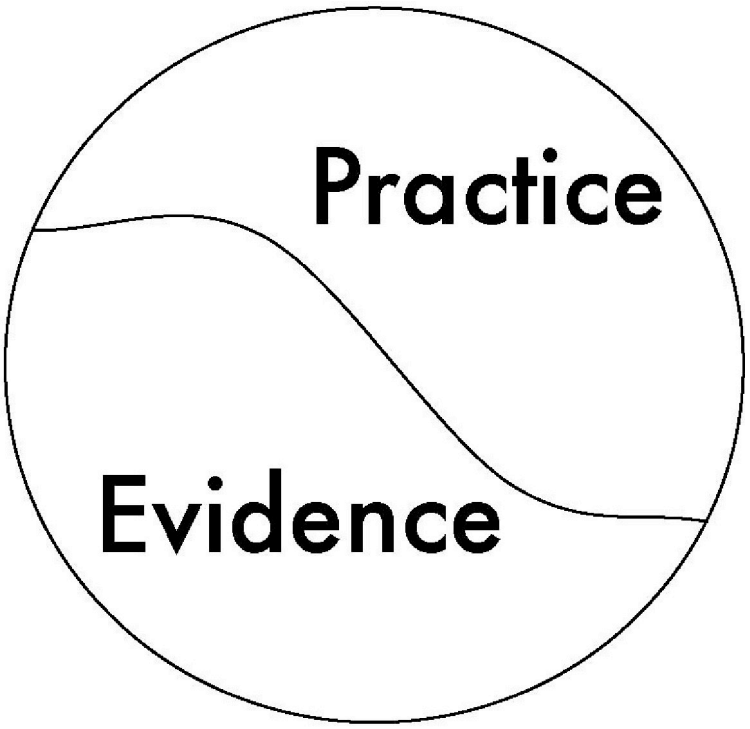
School of

Communication Sciences & Disorders



Proceedings of

the Second Annual CSD Research Day

February 10, 2006

the Second Annual CSD Research Day
Friday, February 10th, 2006

Poster Session #1: 1:00pm to 2:00pm

Poster No.	
1	The use of speech supplementation to improve speech intelligibility for patients with dysarthria *Ambrose, K.*
2	Therapeutic use of Antioxidants in the Protection from Noise Induced Hearing Loss *Beach, C.H.*
3	Psychophysical evaluation of pleasantness and acceptability for electrolaryngeal speech *Beaudin, P.G., Eadie, T.L., & Doyle, P.C.*
4	Do Cochlear Implants Provide Significant Reduction in Tinnitus Levels in Adult Patients? *Broniewicz, A.*
5	Do speech impairments alone negatively impact literacy development? *Charette, C.*
6	A case study evaluation of hearing aid frequency compression *Glista, D., Scollie, S., & Parsa, V.*
7	The Effectiveness of PECS on the Development of Communication in Children with Autism Spectrum Disorders *Greene, S.E.*
8	The Efficacy of Peer-Mediated Intervention for Increasing Social Functioning of Children With Autism *Grigg, D.M.*
9	The effectiveness of surface electromyography in swallowing management of patients with oropharyngeal dysphagia *Harkot, K.E.*
10	The Reliability and Validity of Cervical Auscultation as a Dysphagia Assessment Tool. *Harp, L.*
11	The Effects of Computer-Based Interventions on Improving Phonological Awareness in Children with or at Risk for Reading Problems *Kalka, M.M.*
12	Effects of Prolonged Endotracheal Intubation on Swallowing Function *Kilian, S.L.*
13	How can occlusion and ampclusion be alleviated? *Kim, M.*
14	Does Occupational Noise Exposure during Pregnancy have an Adverse Effect on the Auditory System of the Developing Fetus? *King, L.*
15	The efficacy of pharyngeal flap and sphincter pharyngoplasty surgery on resonance in the treatment of velopharyngeal insufficiency *McAskill, C.A.*
16	Speech perception outcomes in children with cochlear implants compared to conventional hearing aids *Miceli, S.*
17	Costs to workers' compensation systems for approved noise-induced hearing loss claims *Mignelli, L.M.*

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Poster Session #2: 2:00pm to 3:00pm

Poster No.	
1	Impact of Early Cochlear Implantation on Oral Language Development *Molenhuis, J.*
2	The effects of signal to noise ratio on sentence recognition in children with and without hearing loss *Ng, S., & Scollie, S.*
3	The effectiveness of Lee Silverman Voice Treatment in patients with hypokinetic dysarthria *Nicholls, S.N.*
4	Efficacy of classroom intervention methods for children diagnosed with a permanent unilateral hearing loss *Powell, M.*
5	The effectiveness of pulse oximetry in detecting aspiration *Rody, C.*
6	The Impact of Otitis Media on the Development of Language in the Preschool Child *Roloson, A.*
7	Does Cochlear Implantation Improve Speech Perception in the Geriatric Population? *Sadra, N.*
8	The effectiveness of Functional Communication Training (FCT) in reducing behavior problems in autistic or developmentally disabled persons *Saleh, S.*
9	Drawing therapy and its effect as a means of communication in patients with severe non-fluent aphasia *Samaan, S.*
10	The effectiveness of tinnitus retraining therapy for treating hyperacusis *Shin, G.*
11	What Evidence is there to Support the Bilingual-Bicultural Model of Literacy Education for the Deaf? *Soltys, A.J.*
12	Does Speech Perception Training Improve Sound Production for Children with Articulation or Phonological Disorders? *Stephenson, R.*
13	Is the modified barium swallow a reliable method of assessing swallowing function? *Stewart, R.L.*
14	What evidence is there that auditory verbal therapy is effective? *van Eendenburg, K.*
15	Effectiveness of bilateral and unilateral botox injections for the treatment of adductor spasmodic dysphonia *Varghese, M.*
16	Effectiveness of therapy approaches for Developmental Apraxia of Speech *Vreugdenhil, T.*
17	The Effect of a Chin Tuck Posture on Swallow Function *Weber, K.A.*

Critical review:
The use of speech supplementation to improve speech intelligibility for patients with dysarthria

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This critical review examines whether implementing speech supplementation (alphabet cues, topic cues and combined cues) will improve the speech intelligibility of subjects with dysarthria. Study designs include: within subjects design (5). Overall, research supports that combined cues, as well as alphabet cues, can improve the speech intelligibility of dysarthric subjects.

Introduction

Dysarthria is characterized by articulation difficulties from damage to the nervous system (Borden, Harris & Raphael, 2003) and is a common speech characteristic among patients with traumatic brain injury (TBI) and cerebral palsy (CP) (Beukelman, Fager, Ullman, Hanson & Logemann, 2002; Hustad, Auker, Natale & Carlson 2003). Intelligibility is generally a goal of treatment for patients with dysarthria, as poor intelligibility is typical of their speech in everyday communication. In the field of speech language pathology, intelligibility is seen as something that can be considered a part of a person and can contribute to the overall importance of their communication message from the listener's perspective (Hustad, Jones & Dailey, 2003).

There are a number of different speech supplementation strategies, or AAC strategies, that have been suggested to improve the intelligibility of dsyarthric subjects. These include topic, alphabet and combined cues. When using topic cues, listeners are given cues regarding the general topic the speaker will be communicating about. These cues can be given in written form or by use of a communication board and picture symbols (Hustad, Jones et al., 2003). When alphabet cues are used, speakers give listeners the first letter of each word they are going to be speaking by using the alphabet board. Giving the listener the first letter of the word can limit the possible words the speaker could be saying (Hustad, Jones et al., 2003). Finally, combined cues are when speakers use both alphabet and topic cues. (Hustad, Jones et al., 2003).

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the influence of speech supplementation on improving speech intelligibility of patients with dysarthria. The secondary objective is to propose evidence-based practice recommendations for future research and implication of speech supplementation for patients with dysarthria.

Methods

Search Strategy

Computerized databases, including CINAHL, MEDLINE and PubMed, were searched using the following search strategy:

> (Dysarthria) and (speech supplementation) OR (AAC) OR (linguistic cues)

The search was limited to articles written in English between 1980 and 2005.

Selection Criteria

Research studies selected for inclusion in this critical review paper were required to investigate the impact of speech supplementation (alphabet, topic and combined cues) on speech intelligibility of patients with dysarthria. No limits were set on the demographics of the research participants.

Data Collection

Results of the literature search yielded the following types of articles congruent with the chosen selection criteria: within subjects design (5).

Results

Impact of speech supplementation on intelligibility

Beukelman et al. (2002) looked at differences in intelligibility and speaking rate scores for 8 traumatic brain injury (TBI) patients with dysarthria, when speech supplementation strategies were implemented and compared to the use of no cues. Ten listeners determined intelligibility for each strategy, while 1 listener used a visual display of the acoustic waveform to determine the speaking

rate. After the participants were videotaped using the different strategies for a total of 16 sets of sentences (a different set of sentences for each strategy and no cues) video clips were digitally edited. Analysis was completed by the use of a paired t-test and results for individual participants as well as group data showed that implementing alphabet cues was associated with the most improvement on speech intelligibility.

Hustad, Auker et al. (2003) used a repeated measures design to look at whether intelligibility scores changed when three cerebral palsy (CP) participants, with profound dysarthria, used different speech supplementation strategies. Participants were videotaped while reading four passages using the different strategies that were taught and learned in approximately fifteen minutes. Twenty-four listeners watched the videotapes of each participant reading the 4 passages while using only one of the strategies. Analysis was completed by the use of a split-plot analysis of variance (ANOVA) and a non-parametric analysis for repeated measures, similar to an ANOVA, which are both appropriate for the research design. Results looked at both group and individual data, overall results indicated that using combined cues helped increase intelligibility scores across all speakers and listeners felt that for the majority of speakers, combined cues were the most effective strategy to use when communicating.

Hustad, Jones et al. (2003) used a 4 x 5 split plot design to determine whether speech supplementation strategies would affect the intelligibility and speaking rate of 5 participants with severe dysarthria (4 patients with CP and 1 patient with TBI) when compared to the use of no cues. A total of 120 listeners (24 listeners for each participant) watched videotapes of the participants using one of the strategies while reading one of four passages. One experimenter using a spectrographic display determined the speaking rates of the participants. To verify this information a second person used this technology to determine the speaking rates of two sentences for each participant. Analysis was completed using an appropriate a-priori approach to analysis of variance (ANOVA) for this research design. Results showed that both combined and alphabet cues helped participants make improvements in their intelligibility and the use of alphabet cues decreased the speech rate of the participant the most.

Hustad and Beukelman (2001) used a 2 x 4 repeated measures design to look at whether intelligibility scores changed when participants, with CP and severe dysarthria, used different speech supplementation strategies as well as the use of no cues when reading related and unrelated sentences. Participants were videotaped producing all 160 sentences (10 sentences per passage) and data was taken and edited to make 24 different videotapes for listeners to watch. A total of 3 listeners watched each videotape, which consisted of 80 sentences, 40 related (part of a narrative) and 40 unrelated. The authors did not explicitly mention how many times an individual participant was viewed on each videotape, but that each sentence, of the 160 possible sentences, were seen approximately 12 times throughout the strategies and videos. Listeners watched the videos that displayed the alphabet, topic or combined cues and the audio information of the four participants speaking two times. Analysis of the information was conducted through an a priori approach to ANOVA, an appropriate type of analysis for this study, and results concluded that the use of combined cues increased intelligibility scores across the videotapes and that for alphabet cues, improvements in intelligibility were seen the most in the related sentences.

In a follow up study, Hustad and Beukelman (2002), looked at whether using speech supplementation strategies would improve listener's comprehension of communicative message in four subjects with CP and severe dysarthria. The researchers went to great efforts to make sure that topic cues and comprehensive questions were appropriate for the given sentences; specifically comprehensive questions were tested on a set of judges to make sure that the questions were not guessable and could be used to determine whether the listener comprehended the participant's message. Like the previous study, participants were videotaped reading all of the 160 sentences and this information was then edited to make 24 different videos. Listeners watched videos that showed all four participants, each using a different strategy. In the videos, all of the sentences were shown between the participants, some of the sentences were used as related sentences (as part of one of the 16 narratives) and others were used on their own as unrelated sentences. This occurred among the sentences that were used for intelligibility scores and the sentences used for comprehension. Data was analyzed by the use of a planned approach to ANOVA and results showed that combined cues improved comprehension the most and comprehension was higher with sentences that were related (part of a narrative) when compared with the unrelated sentences for all strategies. Results also indicated that there was a significant relationship between intelligibility and comprehension for topic cues with unrelated

sentences, and alphabet cues with related sentences.

Discussion

Appraisal of the results
It is important when looking at the results of this research evidence, to address issues with regard to subject selection, sample size and methodology in the literature. It is important to consider these issues when looking at the literature and understand that these issues may impact the strength of the evidence.

Subject Selection and sample size
The most obvious issue with regard to subject selection was that researchers did not mention whether subjects were randomly selected to participate in the research study (Beukelman et al., 2002; Hustad, Auker et al., 2003; Hustad & Beukelman, 2001; Hustad et al., 2002; Hustad, Jones et al., 2003).. Random selection of participants is important for representing and generalizing research findings to the dysarthria population as a whole.

The sample sizes in these studies were small (ranging from 3 to 8) which could also limit the generalizability of the findings.

Methodology
When interpreting the results of the studies, it is important to consider limitations of the methodologies, in particular prominent information that was not included in the research descriptions.

Information regarding the participant's communication difficulties was not included in the methodology (Beukelman et al., 2002; Hustad, Auker et al., 2003; Hustad & Beukelman, 2001; Hustad et al., 2002; Hustad, Jones et al., 2003). It would be important to know how long the participants had experienced their communication problems.

Researchers failed to state how much time they allowed for the participants to learn the new speech supplementation strategies before they were videotaped for the study (Hustad & Beukelman, 2001; Hustad & Beukelman, 2002). Beukelman et al. (2002) showed participants the speech supplementation strategies and experimenters decided when the participants had gained competency using the strategy or an hour of practice had passed. It is hard to determine whether the participants in these studies were using the strategies with 100% precision, which could influence intelligibility scores.
Researchers failed to state how topic cues were determined for the speech supplementation strategies during the study (Beukelman et al., 2002; Hustad, Jones et al., 2003; Hustad, Auker et al., 2003). It is important to understand how topic cues were determined as it is possible they could affect intelligibility scores as well. Topic cues could give too much information and would make it easy for listeners to decide what the participants had said or topics may not represent what the sentence is about.

During the assembly of the videotapes that were to be viewed by the listeners, researchers instructed participants to repeat sentences if they made mistakes when implementing the strategies (Hustad, Auker et al., 2003; Hustad, Jones et al., 2003). Editing was also done on the videotapes before the listeners watched them. The volume was increased, alphabet and topic cues were enhanced on the videos so they could be seen by the listeners, and the cues lasted from between 1 and 3 seconds or as long as the participants were speaking (Beukelman et al., 2002; Hustad, Auker et al., 2003; Hustad & Beukelman, 2001; Hustad et al., 2002; Hustad, Jones et al., 2003). Listeners were also instructed by the researchers to listen to the videotapes two times and during the second viewing they were asked to write down what they thought was said (Hustad , Auker et al., 2003; Hustad & Beukelman, 2001; Hustad & Beukelman, 2002; Hustad, Jones et al., 2003). These variables may not be as easily altered in a natural communication interaction. In a real face-to-face interaction, mistakes will be made when using the strategies and speakers will have to make revisions. In face-to-face interactions, listeners can also ask for repetition when a message is not understood. However, in these studies, allowing the listeners to watch the videotapes twice potentially helped to improve their familiarity of the sentence.

Recommendations

After reviewing the research evidence, it is important to acknowledge for clinical application that all of the studies were experimental.

For future research it is recommended that researchers be sure to include relevant and important information for the readers to fully understand their methodology and conclusions

It will be important for future research to be implemented into a natural communication setting, where speakers and listeners can interact face-to-face. During face-to-face interactions, intelligibility scores can be determined when speakers are using their strategies in environments that may subject

them to background noise; participants can decide what they want to say instead of reading predetermined sentences; listeners can ask participants to repeat what they have said when they do not understand; participants with limited motor abilities, may find it difficult to implement the strategies and listeners may not be able to see the cues as easily when participants are pointing to them which could affect intelligibility rates for the different speech supplementation strategies.

It may also be important for researchers to incorporate the thoughts and feelings of the participants with regard to their competency of strategy use as well as more research about how listeners feel when speakers are using these strategies.

Conclusions

The present research findings suggest that implementing the use of combined or alphabet cues can help increase the intelligibility of individuals with severe dysarthria. This information is important for researchers to consider when suggesting the use of speech supplementation strategies to their patients. Even though the research is very much experimental in nature, there were significant improvements in intelligibility. Although further research involving the use of cues in a natural setting is required, the findings from these studies support the use of speech supplementation for intelligibility deficits in subjects with severe dysarthria.

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Critical Review:
Therapeutic use of Antioxidants in the Protection from Noise Induced Hearing Loss

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This critical review considers the potential efficacy of using specific antioxidant compounds: N-L-acetylcysteine (NAC), acetyl-L-caritine (ALCAR) and D-methionine (D-met) to protect against noise induced hearing loss. Each of the studies employed an experimental design using animal subjects with analysis of variance and post-hoc testing. Overall, the examined research supports the feasibility of pharmacological intervention in providing some protection of cochlear integrity in toxic noise environments; however, to date, the effects of these compounds have not been studied in a human population.

Introduction

Given the large number of patients with Noise Induced Hearing loss (NIHL), there has been an increased interest in searching for agents that could protect or repair cochlear hair cells from excessive noise exposure. Clearly the most direct way to prevent harmful levels of noise exposure is to use appropriate hearing protection or to avoid exposure altogether; however, there are certain instances, for example, in military settings, when exposure to harmful noise levels is unavoidable.

There has been some evidence that some natural protection from NIHL may occur due to lifestyle. For example, a high-fat diet, smoking and heavy alcohol consumption have each been correlated with higher incidences of hearing loss, while moderate alcohol consumption and exposure to music that is enjoyable, as opposed to music that is not enjoyable, decreases the risk of NIHL (Campbell, 2004). It would seem logical that enhancing the body's natural defence mechanisms may help to prevent damage from harmful forces, including noise.

Antioxidants are substances produced naturally in the body that help to protect the tissues from damage caused by free radicals. Some antioxidants are formed naturally in the body, while others must be supplied in the diet. Free oxygen radicals (FOR) are atoms with an odd (unpaired) number of electrons that are formed when oxygen interacts with certain molecules. This interaction can cause damage to cells, which may impair the immune system and lead to infections and various degenerative diseases. Antioxidants defuse free radicals by binding to their free electrons.

Also known as reactive oxygen species (ROS), these free radicals have been found to form in the inner ear after exposure to high-intensity noise, and are believed to play an important role in the haircell damage that leads to NIHL (Yamashita et al, 2004).

Stimulation of the haircells causes increased generation of free radicals. In response, the cochlea produces antioxidant enzymes, antioxidant molecules or glutathione (GSH), as a defensive measure. When these antioxidant defenses are overwhelmed, the hair cell is susceptible to injury to its DNA, mitochondria, and membranes. When hair cells are damaged in this way, they are prone to a genetically programmed cell death sequence (known as apoptosis), in which the ongoing loss of hair cells can continue for days to weeks after an acute exposure to loud noise (Kopke, 2003).

Evidence for the protective capabilities of antioxidants comes from two lines of research. First are studies of "toughening" where a series of non-traumatic noise exposure episodes function to make the ear more resilient to the effects of otherwise toxic noise levels. The second line of evidence comes from studies of direct pharmacological interventions (Henderson et al). Recent studies have assessed the protective efficacy of antioxidants (Karlida et al, 2002, Gok et al, 2004, Sergi, et al, 2004, Kopke et al, 2005) with overwhelmingly positive results.

Three antioxidants, which are already approved by the United States Food and Drug Administration (FDA) for alternate uses, have recently been cited as having promising otoprotective ability (Campbell, 2004) and can be administered orally without adverse side effects. Current literature on the efficacy of using specific antioxidant compounds: N-L-acetylcysteine (NAC), acetyl-L-caritine (ALCAR) and D-methionine (D-met) to protect against noise induced hearing loss (Duan et al., 2004; Kopke et al., 2000; Kopke et al., 2002; Kopke et al., 2005; Ohinata

et al., 2003) will be evaluated to assist in determining if a pharmacological intervention might be considered in a comprehensive approach to maintaining cochlear integrity in toxic noise environments.

Objectives

The objective of this paper is to critically evaluate existing literature regarding the efficacy of using specific antioxidant compounds: N-L-acetylcysteine (NAC), acetyl-L-caritine (ALCAR) and D-methionine (D-met) to protect against noise induced hearing loss.

Methods

Search Strategy
Computerized databases, including PubMed, ComDis Dome and MEDLINE-Ovid, were searched using the following search strategy:

> ((Noise induced hearing loss) OR (NIHL)) AND ((antioxidant) OR (NAC) OR (ALCAR) OR (pharmacological)).

Selection Criteria
Studies selected for inclusion in this critical review paper were required to investigate the impact of any *one* or any *combination* of the specified antioxidants. Selection was limited to studies of antioxidant effect on hearing loss due noise toxicity.

Data Collection
Results of the literature search yielded five studies that met the aforementioned selection criteria. Each of the included studies implemented an experimental design with animal subjects.

Results

In all but one of the studies, experimenters were experienced and blinded as to the conditions of the animals for the entire study. They used a selection of homogeneous animals controlled for weight, pre-treatment thresholds, and sex. This is particularly important as sex differences have been associated with differing ability to detoxify ROS and varying activity of glutathione S-transferase in the cochlea (McFadden et al, 1999).

Internal validity, which is important in establishing a causal relationship, was ensured in each of the studies by using the auditory brainstem response (ABR) for scoring both pre- and post-treatment thresholds. This use of repeated measures has the advantage of being quite powerful because subjects are used for their own controls, thereby reducing possible error. As ABR is a non-behavioural test, repeated exposure effects were non-applicable. The incidence of threshold shift, both temporary and permanent, can be determined quickly, so any potential effects of maturation or attrition were avoided.

The protective effects of the antioxidants: NAC and ALCAR against NIHL were investigated by Kopke et al. in 2005. Kopke and his colleagues have previously undertaken similar studies. In 2000 they investigated the efficacy of utilizing a combination of antioxidant compounds (salicylate and NAC) to either prevent or attenuate the level of NIHL. In a subsequent study (2002) they examined the effect of the antioxidants ALCAR and D-Met, as well as an N-methyl-D-aspartate (NMDA) antagonist, Carbamathione, on limiting NIHL.

A 2003 study by Ohinata et al. assessed the effect of several pharmacological agents, including NAC, on their ability to protect against noise trauma in the male guinea pig in order to delineate mechanisms of NIHL. A total of five different pharmacological agents were examined, two combined, and two saline control groups, for a total of eight treatment groups. A non-exposed control group was added in order to measure lipid peroxidation (8-isoprostane formation).

The study by Duan et al (2004) investigated the effect of NAC in the protection of the cochlea against noise trauma and tested the hypothesis that the degree of protection is dose and time-dependent.

Each of the examined studies employed appropriate statistical treatment of the data in the form of one-, two-, or three-way analyses of variance (ANOVA) and appropriate post-hoc testing with a P value of < 0.05.

Impact of antioxidants on threshold shift
In each of the studies, baseline ABRs were measured prior to noise exposure and there was no significant pre-noise threshold difference between the groups. The ABR is a reliable, valid, and sufficiently sensitive measurement tool commonly used for determining threshold, and the use of a repeated measure protocol would effectively determine that the exposure to noise preceded any changes in threshold. Noise exposure conditions included both continuous and impulse stimuli ranging from 105dB SPL to 160dB SPL at a number of different frequencies.

Post-exposure ABRs were conducted at several pre-determined intervals from 15 minutes to three weeks,

and hearing loss was observed after noise exposure in all groups. Initial post-exposure testing revealed thresholds ranging from about 30dB at 1kHz to 87dB in the higher frequencies in both the control groups and those treated with ALCAR or D-Met (Kopke et al., 2002). The groups treated with NAC showed significantly less threshold shift immediately following noise exposure (Duan et al., 2004; Kopke et al., 2000; Kopke et al., 2005).

In subsequent ABR tests, all three antioxidant treatments were seen to result in a recovery of threshold shift. As compared to the controls, animals treated with D-Met showed an overall treatment effect (P<.001) beginning one week after exposure (Kopke et al., 2002). Thresholds in those animals treated with NAC showed greater and statistically significant improvements in hearing immediately post-exposure, and then a relatively slower recovery afterwards. Conversely, the thresholds of ALCAR-treated animals recovered more rapidly (Kopke et al, 2005).

Three to four weeks after exposure, the permanent threshold shifts (PTS) in all the animals that received antioxidant treatment were significantly reduced in comparison to their non-treated controls. The resulting thresholds were reported between 0 and 20dB, depending on the study.

While all three treatment conditions showed significant improvements in permanent threshold shifts PTS as compared to their controls, NAC was shown to also be effective in limiting temporary threshold shift (TTS) when administered prior to noise exposure.

Impact of antioxidants on haircell loss

Following the final threshold measurement, the animals were euthanized and the cochleae were examined for hair cell damage. Animals in the control conditions typically showed substantial outer haircell (OHC) loss which ranged from between 40% to 70% after subjection to continuous noise (Kopke et al., 2002) up to 98% in the areas of the basilar membrane corresponding to between 2-8kHz after subjection to impulse noise (Kopke et al., 2005). Inner haircells (IHCs) were also shown to be susceptible to noise, but damage was generally less severe than OHC loss.

Animals treated with D-Met showed significantly less (P<.001) OHC loss as compared with controls (Kopke et al., 2002). There was also shown to be less OHC loss in the ALCAR-treated animals from 10% after continuous noise (Kopke et al., 2002) and 46-61% after impulse noise (Kopke et al., 2005). NAC treatment resulted in OHC loss ranging from 5-33%. This was significantly less than the non-treated controls.

All of the examined studies suggest that application of any of the antioxidant compounds resulted in significantly less noise-induced haircell loss than the non-treated animals.

It is interesting to note that while NAC appeared to afford somewhat better protection to OHCs than ALCAR, ALCAR was shown to be particularly effective in protecting IHCs from damage. Kopke et al., (2005) also observed that the patterns of haircell loss were different depending on the type of pre-noise treatment, suggesting that differing mechanisms of protection might be involved.

Dose-dependant protection

Data from the study by Duan et al., (2004) offer evidence that the protection offered by NAC is affected by the quantity in which it is administered. Higher (1750mg/kg) dosage of NAC in rat subjects resulted in greater PTS and haircell loss than a lower (1050mg/kg) dosage.

Conclusions

Review of the relevant literature suggests that the antioxidant compounds: NAC, ALCAR, and D-met do afford significant protection from damage due to noise toxicity in some animal populations. Though still in the early stages, these data appear to support the potential for development of pharmacological protection for humans. While each of the examined compounds are presently approved for alternate uses, offering them as an intervention for NIHL would require extensive clinical trials in a human population.

In the reviewed studies, antioxidants were administered by injection. For clinical consideration, an ideal protective agent would likely be administered orally. Other critical factors would include cost relative to current hearing protection methods, side effects, appropriate dosage, and possible antioxidant combinations and interactions.

While examination of the mechanisms by which each antioxidant operates is beyond the scope of this report, the differing effects detailed in the current research suggests that a combination of specific antioxidants may have a greater effect than any one particular compound. Though the present data are promising, avoidance and traditional methods of

hearing protection are currently the most valuable safeguard against cochlear noise damage.

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Psychophysical Evaluation of Pleasantness and Acceptability for Electrolaryngeal Speech

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This investigation gathered information on the psychophysical, auditory-perceptual (AP) characteristics of electrolaryngeal (EL) speech. Electrolaryngeal speech is widely used as a postlaryngectomy method of speech rehabilitation. Sentence stimuli produced by laryngectomized speakers using the Servox EL were assessed by 20 naïve listeners for the perceptual features of pleasantness (PL) and acceptability (AC). Methodological concerns influencing psychophysical measurement of each psychophysical dimension and the related empirical and clinical implications are discussed.

Critical Review:
Do Cochlear Implants Provide Significant Reduction in Tinnitus Levels in Adult Patients?

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This critical review examines the effects of cochlear implants on the reduction of tinnitus in the adult population. Study designs include prospective and retrospective cohort studies and cross-sectional designs. Overall, research supports the hypothesis that cochlear implantation does in fact have some effect on the reduction of tinnitus; however due to the un-standardized nature of the outcome measures used, results were difficult to compare among the various studies.

Introduction

Tinnitus is the sensation of ringing in the ear(s) that occurs without any external presence of sound. It can be a debilitating phenomenon for which cause and treatment are still being researched. Reports show that roughly 5-8% of all patients who visit otolaryngology clinics suffer from tinnitus, and that 80% of patients with ear disease have tinnitus (Ito, 1994a). Although a variety of procedures can help tinnitus sufferers adapt to their tinnitus sensation, at present there are no treatments that reliably eliminate tinnitus completely (Eggermont, 2004). One of the current treatment modalities for tinnitus involves the use of acoustic stimuli to inhibit the sensation of tinnitus. This method has been shown to be effective, although it is not feasible for persons with severe to profound hearing impairments because their hearing loss is too severe.

Cochlear implants (CI), which stimulate the cochlea electrically, have been successful in restoring the hearing for severely and profoundly deaf individuals worldwide. Ito et. al. (1994b) has reported that 69% of patients experienced tinnitus suppression after a promontory stimulation test that involved electrical stimulation of the cochlear wall. Cochlear implantation may also be effective in relieving tinnitus.

The purpose of this review was to evaluate the effectiveness of CI's on the suppression of tinnitus. The research that has been done on the topic to date concentrates specifically on adults. Although children with sensorineural hearing loss also exhibit significant amounts of tinnitus, reports are difficult to obtain from this population. The measurement of tinnitus is purely subjective and such reports have been unattainable from children (Ruckenstein, 2001).

Objectives

The primary objective of this paper was to critically evaluate existing literature regarding the suppression of tinnitus after cochlear implantation. The secondary objective was to propose evidence-based practice recommendations for clinicians regarding patient counseling and informed consent.

Methods

Search Strategy
Computerized databases, including Medline and ComDisDome, were searched using the following search strategy:

(tinnitus) AND (cochlear implant).

The search was limited to articles written in English between 1991 and 2005.

Selection Criteria
Studies selected for inclusion in this critical review paper were required to investigate the effectiveness of cochlear implantation on the reduction of tinnitus in adult patients who were severely to profoundly hearing impaired. Patients involved in these studies were those who were candidates for CI's, allowing us to look at both pre-implantation tinnitus and the effects of post-implantation.

Data Collection
Results of the literature search yielded cross-sectional and prospective and retrospective cohort studies congruent with the aforementioned selection criteria.

Results

The literature articles were each thoroughly examined, and their methodological strengths and weaknesses were appraised. It is important to determine an article's worth before accepting any of

its results. To conclude that an article is in fact valid, the methodology was examined for subject selection methods, study design, instrumentation used, and the method of data analysis.

There are no generally accepted, standardized outcome measures of reporting the degree of tinnitus. Each study used a different form of an un-standardized questionnaire to report on tinnitus severity, which made it difficult to compare results between studies. Each study was therefore reviewed separately and results were looked at individually. With the exception of a few studies, there was usually a lack of information provided regarding the formulation of the questionnaire, and there was often no mention of how it had been administered to the patients. The construct validity of such studies was therefore poor.

The construct validity of the study by Ito (1994a), as well as Tyler (1995) is questionable. In these studies two different questionnaires were administered at different time frames throughout the study. This reduces the consistency in data collection, and any conclusions regarding tinnitus change pre- and post-implantation cannot be confidently made.

The advantage of having a written questionnaire is that written forms are standardized so that everyone is exposed to the same questions in the same way, thereby reducing bias from interactions with an interviewer.

All studies used convenience sampling to select their sample population. Subjects were selected based on their presence in a CI program in a particular facility. Although the use of convenience sampling was unavoidable in the research design, it allowed for a greater sample size. The number of participants included in the studies ranged from 6 to 84. Random sampling may have reduced this number further.

The research articles used some form of a non-experimental study design. Subjects were not assigned to different groups in this type of design. Instead, the same subjects were followed over a short period of time and compared on one common variable (in this case: the severity of tinnitus). It is important to note that because the same individuals were tested throughout the study, personal characteristics remained relatively constant.

Tinnitus reduction post-implantation

Souliere et. al. (1992) quantified changes in tinnitus after cochlear implantation of the Nucleus CI. Data from the twenty-eight patients, who experienced tinnitus pre-implantation, was collected using self-report questionnaires. Twenty (77%) of the patients experienced a decrease or complete elimination of tinnitus in the ipsilateral ear and a 42% decrease contralaterally. Unlike some of the other studies, where the patients were only questioned regarding their presence of tinnitus, Souliere used a 10 point linear scoring system for the tinnitus questions. This 10 point scale allows for a better quantification of tinnitus change rather a more binary (yes/no) outcome. The results were statistically analyzed and found to have significance in the decrease of tinnitus loudness and annoyance post-implantation.

Another study by Mo et. al. (2002) found a 54% (32 out of 59 patients) improvement in patients who experienced pre-operative tinnitus. This study had used control groups of non-cochlear implant patients as well as hearing aid users as a means of comparison. The use of control groups in the study design further increases the validity of the results.

Both Souliere (1992) and Mo (2002) included in their purpose the effect of confounding variables on tinnitus suppression. Such variables as age, gender, cause of hearing loss, tinnitus duration, and health were accounted for in the studies. It was determined that these factors did not significantly contribute to tinnitus suppression after implantation.

Of the eight reviewed studies, Souliere (1992), Mo (2002), and Tyler (1995) had superior study designs which provided enough knowledge for study replication for the future. In these studies, data collection procedures were described in a clear and detailed manner that would allow replication. The self-report questionnaires used were either outlined with sufficient detail or referenced adequately by the researchers.

Worsening of tinnitus

In addition to tinnitus suppression in cochlear patients, there have also been reports of the worsening of tinnitus post-implantation in the majority of the reviewed literature. Results show that this is a rare occurrence, appearing in roughly 1%-8% of those involved in these studies. Although rare, this is a significant finding when obtaining informed consent from cochlear implant candidates.

Tyler (1995), Ito (1997) and Souliere (1992) all reported some degree of aggravated tinnitus in their patients after implantation, although suppression was evident in a 2-24 month follow up. The remainder of the literature did not follow their patients over a

significant amount of time to observe any changes in tinnitus.

Conclusions

The majority of the studies reported that a significant number of implantees exhibited a lessening of tinnitus after cochlear implantation. When counseling patients, based on this research, it is significant to mention the added benefit that cochlear implants provide in the reduction of tinnitus.

There were a number of trends evident regarding the effect of cochlear implantation on tinnitus:

- Reduction of tinnitus intensity and annoyance were observed
- Risk of worsening of tinnitus post implantation
- Both ipsilateral and contralateral reduction in tinnitus
- Long-term effectiveness of CI on tinnitus reduction

Further research should be conducted with regards to the worsening of tinnitus, as well as any long-term effects that CI's may have on tinnitus. Such research would provide clinicians with useful counseling tools for the cochlear implant candidate.

The risk of tinnitus worsening post-implantation has been documented, and although it is a rare finding it is of clinical importance. It becomes relevant, when obtaining informed consent from a patient, to state the researched benefit that cochlear implantation may have on reducing tinnitus and any possibility of the development/worsening of tinnitus.

Further research needs to be done to examine the long-term effects of CI's on tinnitus suppression. The small number of studies that found aggravated tinnitus in a small percentage of their patients noted that the condition of tinnitus changed (alleviated tinnitus) over time after the surgery.

Although limitations were evident in some of the study designs, they were not so great that deemed the findings to be inconclusive. The combined evidence included in this review is strong enough to conclude that CI's do provide some suppression of tinnitus in the adult population.

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Critical Review:
Do speech impairments alone negatively impact literacy development?

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This critical review examines whether speech impairments in the preschool years negatively impact literacy development and if so, what recommendations can be made to practicing speech-language pathologists. The research studies include longitudinal, prospective and cross-sectional designs. Based on the critical review, there is inconclusive evidence as to whether children with speech impairments alone will have difficulties with literacy development. Further research needs to be conducted in order to obtain more consistent results that will inform professionals what to communicate to parents of preschool children with speech impairments about future literacy development.

Introduction

In recent years, the importance of early identification of children with speech and language impairments has been emphasized. Clinicians and scientists seek to identify which children are at risk for particular impairments and provide them with appropriate intervention in order to prevent further difficulties. Speech impairments are the most prevalent communication difficulty observed in young children (Lewis, Freebairn & Taylor, 2000). One issue that has become a concern in the field of speech-language pathology is the relationship between speech impairments and literacy development.

Many different terms for speech impairments are used in the literature. The terms speech impairment, articulation disorder, speech sound disorder, articulation impaired, and expressive phonology disorder are all used to describe "physically normal children who do not produce the full range of phonemes of their native language at an age when most children have acquired this ability, despite them developing normally in all other respects" (Bird, Bishop & Freeman, 1995, p.447). Literacy is a term used to encompass multiple aspects of academics. It can be defined as "the process by which one constructs meaning from printed symbols" (Larson & McKinley, 2003, pg.83). Adequate phonology skills may be seen as a necessary component for literacy acquisition because decoding of words requires children to sound out the letters. If the phonology system is disordered, this may be a difficult task for these children. Literacy difficulties can have an impact on the child's academic, social and emotional success.

The relationship between speech impairments and literacy development is important to understand because early identification of risk for literacy problems (if any) in children with speech impairments could prevent the onset of literacy problems. In addition, parents could be given an informed explanation of what to expect in the future when their child enters school.

Objectives

The primary objective of this paper is to critically evaluate the existing literature that examines the impact of speech impairments on literacy development. The secondary objective is to determine an appropriate recommendation for clinicians in the practice of speech-language pathology.

Methods

Search Strategy

The research articles were found using a computerized database search, including CINAHL, PubMed and Medline. The following key terms and search strategies were used:

> ((phonolog* OR speech OR articulat*) AND (impairment* OR disorder* OR delay* OR disabilit*) AND (literacy OR academic* OR read* OR spell* OR written OR writing)).

The search was limited to articles written in English between 1985 and 2005.

Selection Criteria

The studies that were selected for this critical review paper examined the relationship between any speech disorder and later literacy development. The studies were not limited to outcome measures or the demographics of the research participants.

Data Collection

The literature search identified ten studies that met the above selection criteria. These consisted of studies employing longitudinal (8), prospective (1) and cross-sectional (1) designs.

Results

Of the ten studies examined for this critical literature review, five concluded that speech impairments did not negatively impact literacy development (Lewis & Freebairn, 1992; Hesketh, 2004, Catts, 1993; Bishops & Adams, 1990; Lewis, Freebairn, & Taylor, 2000).

Lewis and Freebairn (1992) conducted a study using a cross-sectional design to examine the performance of people with histories of preschool phonology disorders on measures of reading, phonology and spelling across different age groups (i.e., preschool, grade school, adolescence, and adulthood). The researchers found that individuals with phonology problems alone did not demonstrate later reading difficulties.

Lewis et al. (2000) hypothesized that children with an isolated phonology disorder would demonstrate better language and achievement outcomes than children with phonology disorders accompanied by other language disorders. They reported that children with phonology disorders had significantly better outcomes in reading than those with both language and phonology disorders ($p<.001$).

Both Bishop and Adams (1990) and Catts (1993) examined children with phonology problems who were incidentally discovered during the course of data collection for a study of the literacy outcomes of children with language impairments. These groups of children did not fit criteria for language impairment in either study. Bishop and Adams found that, upon follow-up, children at eight years of age with a history of preschool phonology disorders in isolation were not likely to have later reading deficits, but the data were not analyzed statistically. By contrast, Catts performed some statistical analysis, lending more accuracy to his conclusions. In his study, there was no significant relationship between speech impairments and literacy development ($p>.05$).

Hesketh (2004) examined the literacy and phonological awareness skills at 6 to 7 years of age in children with a history of a speech disorder. The results indicated that children with histories of speech disorders made good progress in speech and showed age appropriate literacy development. There were no statistical analyses conducted in this study, limiting the strength of the findings. Comparisons were made between the standard scores in the phonology subtests and the reading subtests.

Five of the reviewed studies concluded that preschool speech impairments do put children at risk for later literacy difficulties (Larrivee & Catts, 1993; Nathan, Stackhouse, Goulandris, & Snowling, 2004; Bird, Bishop, & Freeman, 1995; Leitao & Fletcher, 2004; Raitano, Pennington, Bruce, Tunick, Boada & Shriberg, 2004).

Larrivee and Catts (1993) examined the relationship between expressive phonological disorders and early reading achievement. They also examined whether variability in reading achievement was related to individual differences in expressive phonology. The researchers found that the phonologically disordered group performed significantly less well than the phonologically normal group ($p<.001$). The results indicated that problems in expressive phonology in the preschool years may serve as an early sign of potential reading disabilities.

Nathan et al. (2004) looked at the early literacy development of children with primary speech difficulties. Children with speech difficulties alone were compared with children with speech and language difficulties and children who were normally developing. The researchers found that, as a group, children with isolated speech impairments were not significantly different from the normally developing children with respect to later literacy development. However, children who had ongoing speech difficulties at six and seven years of age were more susceptible to problems in reading-related processes.

Bird et al. (1995) were interested in whether or not persistent literacy problems would be found in children with expressive phonological impairments. Results indicated that children who presented with a history of expressive phonological impairments had more difficulty completing phonological awareness and literacy tasks ($p< .001$) than subjects with no history of phonological impairments.

Leitao and Fletcher (2004) hypothesized that participants who presented with non-developmental speech errors in the preschool years would have more difficulties than those with developmental speech errors with respect to acquiring literacy skills. The researchers found that participants with non-developmental speech impairments were significantly more likely to experience literacy difficulties

compared to those with developmental speech impairments.

Raitano et al. (2004) compared the pre-literacy skills of children with speech impairments to those of children with speech impairments and language disorders combined and children with no history of speech and language difficulties. Results revealed that the entire group with speech impairments alone performed less well than control participants on phonological awareness and letter knowledge tasks.

Overall, six of the ten papers had the ability to answer their research question based on the methodologies and designs used. Three of the sound studies agreed with the research question and three did not. Many of the studies used longitudinal designs, which was suitable because in order to answer the research question the researchers were required to measure changes over a period of time. However, some authors experienced difficulties in using a longitudinal design. Bird et al. (1995) indicated that it was not possible to follow all control children so a different matched control group was recruited for each phase of testing; this may have impacted the results because the researcher may have found a different outcome if the original control group was used. Participant demographics were not well controlled in all of the studies. Many of the studies included more boys than girls, making it more difficult to generalize to all children with speech disorders. Some studies did not include a control group of normally developing peers (Lewis & Freebairn, 2000; Bird et al., 1995; Leitao & Fletcher, 2004; Hesketh, 2004; Bishops & Adams, 1990). In order to adequately examine the impact of pure phonological impairments on literacy, a control group of normally developing peers should have been included in order to determine the base rate of literacy problems, which would allow the researchers to adequately compare literacy development among the two groups.

Six of the ten papers used appropriate standardized measurement tools and statistical analyses given the research question and the number of variables involved (Lewis & Freebairn, 1992; Lewis et al., 2000; Larrivee & Catts, 1999; Nathan et al., 2004; Bird et al., 1995; Raitnao et al, 2004). Lewis and Freebairn (1992) used a paired t-test to examine differences between the experimental and control group, which may be a more powerful statistical analysis compared to an independent sample t-test because individual variability is better controlled. Leitao and Fletcher (2004) used age equivalent scores for their analysis instead of standard scores. Age equivalent scores are not as reliable as standard scores because they do not represent equal intervals across the range of scores or include a measure of normal variation.

Across the studies, the researchers' interpretations of their statistical analysis were appropriate. The researchers discussed the limitations of their studies and, for those studies that found that speech impairments do put children at risk for later literacy problems, indicated that speech impairments are only one of the variables or risk factors that impact a child's literacy achievement.

Recommendations

Although the available literature on the relationship of speech impairments and later literacy development is inconsistent, some recommendations can be made for clinicians working with this population. Clinicians can inform parents that, although there is no direct support that children with speech impairments will most certainly have difficulties with literacy development, there is still a chance that these children may be more at risk for literacy problems than their peers who do not have speech impairments. Some of the rigorous studies provided evidence that these children do have difficulty with some literacy tasks. Therefore, clinicians and teachers should be made aware of children who had preschool speech impairments and monitor them as they acquire literacy skills.

Conclusion

A critical review of the literature has demonstrated that there is inconclusive evidence to suggest that speech impairments directly have a negative impact for future literacy development. However, there is some research that indicates that these children may be at risk for literacy difficulties and should be closely monitored.

In order to make better recommendations for teachers and clinicians, future research should focus more closely on several variables. First, researchers should examine and control for the types of speech impairments (i.e., phonological processes vs. developmental errors) in their samples. Second, severity of speech impairment should be considered in order to determine if severity predicts who is at greater risk for literacy problems. Lastly, some studies indicated that children who have speech impairments that persist into the school years had

more difficulties with literacy than those children whose speech impairments had resolved. More studies should address the persistence of speech impairments into grade school and how they impact on literacy development. By focusing future research on these variables, researchers can determine which children are most at risk for developing literacy problems in the future and appropriate support can be implemented by teachers, parents and clinicians.

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Critical Review: The Effectiveness of PECS on the Development of Communication in Children with Autism Spectrum Disorders

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This critical review examines the effects of the Picture Exchange Communication System (PECS) on the development of communication in children with autism spectrum disorders (ASD). Study designs include: quasi-experimental, multiple baseline, alternating treatments, retrospective and prospective designs. Overall, the available research makes generally positive conclusions about the effectiveness of PECS as a mode of communication for children with ASD, however further research is suggested in order to more systematically evaluate the impact of this treatment.

Introduction

Children with autism spectrum disorder (ASD) often experience serious receptive, expressive and pragmatic communication difficulties (Dooley, Wilczenski, & Torem, 2001). It is important to note, that "communication" involves all of the areas mentioned above, and may be defined as, "any act by which one person gives to or receives from another person, information about that person's needs, desires, perceptions, knowledge, or affective states. Communication may be intentional or unintentional, may involve conventional or unconventional signals, may take linguistic or nonlinguistic forms, and may occur through spoken or other modes," (Beukelman & Mirenda, 1998). Difficulties with these areas of communication may affect a child's ability to interact effectively, making intervention of communication deficits a top priority for families and clinicians (Bondy & Frost, 1994; Charlop-Christy, Carpenter & LeBlanc, 2002; Schwartz, Garfinkle & Bauer, 1998). An option for children with communication difficulties is an augmentative and alternative communication (AAC) system.

An AAC system is an integrated group of components, including the symbols, aids, strategies and techniques used by individuals to enhance communication (Beukelman & Mirenda, 1998). When used by persons with disabilities to replace or supplement insufficient communication skills, AAC systems have been shown to be a successful language intervention (Ganz & Simpson, 2004; Kravits, Kamps, Kemmerer & Potucek, 2002). AAC systems give individuals with autism a method for expressing personal choice and preference in the absence of verbal language that may be difficult, if not impossible, for them to produce with mastery (Frea, Arnold, & Vittimberga, 2001).

One picture-based AAC method used frequently for intervention with children with ASD is the Picture Exchange Communication System (PECS) (Ganz et al., 2004). PECS was developed by Bondy and Frost (1994) for use with children with social-communication deficits. PECS simultaneously teaches initiation of wants and needs and provides verbal models of language (Kravits et al., 2002). PECS uses a more naturalistic teaching approach than many other types of intervention because communication is initiated by the child rather than controlled by adult verbal cues (Kravits et al., 2002). Pictures are kept by the child on a "PECS board" and the child is instructed to use his or her PECS board to construct a "sentence" by selecting picture cards and bringing the cards to a communicative partner to request the desired item (Charlop-Christy et al., 2002). PECS is organized into stages that initially require the child to practice exchanging the PECS symbols with an adult and eventually with his or her peers.

PECS is based on a number of key concepts regarding individuals with ASD and how they learn language and social interaction skills (Ganz et al., 2004). Unlike many traditional programs targeting increased verbal output such as sign language, which first requires children to attain attending skills (e.g. eye contact), PECS does not require training in such prerequisites. Additionally, while traditional speech programs often begin by teaching students to respond to verbal prompts, PECS teaches a social approach, a key area of deficit in ASD. Finally, while many communication techniques begin by teaching children to label, requesting is taught in the PECS program because it is rewarded and maintained by concrete reinforcement such as food and toys (Ganz et al., 2004).

Regardless of its logical design and foundation in applied behaviour analysis, support for PECS is largely subjective in nature. Few published experimental studies have addressed the efficacy of PECS or its ability to stimulate speech when used with children with ASD (Charlop-Christy et al., 2002; Ganz et al., 2004; Kravits et al., 2002; Magiati & Howlin, 2003; Schwartz et al., 1998). Despite the limited data on the efficacy of PECS, it is used widely in schools and treatment centers (Ganz et al., 2004).

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the effectiveness of PECS on the development of communication for children with ASD. The secondary objective is to propose evidence-based practice recommendations about the use of PECS in this population and areas for future research.

Methods

Search Strategy
Computerized databases, including PubMed, Web of Science and PsycInfo were searched using the following search strategy:

> ((autism) OR (autistic*) OR (ASD) OR (autism spectrum disorder*)) AND ((PECS) OR (picture exchange communication system) OR (AAC) OR (augmentative and alternative communication)).

The search was limited to articles written in English.

Selection Criteria
Studies selected for inclusion in this critical review paper were required to investigate the impact of PECS based therapy on communication outcomes for children with ASD. No limits were set on the demographics of research participants or outcome measures.

Data Collection
Results of the literature search yielded the following types of articles congruent with the previously stated selection criteria: quasi-experimental (3), multiple baseline design (2), alternating treatment design (2), and a design with both retrospective and prospective components (1).

Results

Impact of PECS on Communication
Ganz et al. (2004) investigated the role of PECS in improving the number of words spoken, increasing the complexity and length of phrases and decreasing the occurrence of non-word vocalizations. It was found that after teaching three children with autism phases 1-4 of PECS, their utterances increased in number of words and complexity of grammar.

Communicative output was also examined in a study by Magiati et al. (2003). In this study, 34 children with ASD improved in their PECS vocabulary and the majority of these children also slowly showed improvements in their general communication.

Charlop-Christy et al. (2002) explored the acquisition of PECS in three children with autism. All children showed increases in verbal speech as well as gains associated with increases in social communicative behaviours.

A case study of a six-year old girl with autism indicated that the introduction of PECS increased her spontaneous language (requests and comments) including the use of icons and verbalizations across the settings in which PECS was taught (Kravits et al., 2002). Intelligible vocalizations increased in two of the three settings in which PECS was implemented and changes in peer social interaction were also noted.

Liddle (2001) also looked at changes in communicative output in children with autism who were trained in each of the PECS stages. For 15 children with autism or severe learning disabilities, it was found that all except one learned to use PECS to request. Forty-two percent of these children showed increases in their attempts at spoken language and 33% attempted single words.

Tincani (2004) compared PECS versus sign language in two students with autism. One participant acquired more mands (requests for preferred items) using sign language while the other participant acquired more mands using PECS. However, it was found that for both participants, using sign language was associated with more vocalizations.

A final study that looked at communicative output in its participants was conducted by Cummings et al. (2000). The authors found that the children learned to imitate simple sounds within a few sessions after demonstrating mastery on PECS.

Acquisition of PECS

Ganz et al. (2004) and Schwartz et al. (1998) noted that children with autism were able to learn PECS quickly and effectively. Magiati et al. (2003) found that the children with ASD improved in the level of PECS attained as well as increased their frequency of PECS use over time. The majority of these children also showed improvements in their ability to use PECS. In the study by Charlop-Christy et al. (2002), all children met the learning criterion for PECS, which was 80% correct for each PECS phase.

Generalization of PECS

A final element of PECS training in children with autism is generalization. By taking language samples during snack time and free time, Schwartz et al. (1998) suggested that PECS generalizes to untrained settings and may have effects on untrained language functions.

Analysis of Results and Interpretations

The above studies made generally positive conclusions about the effectiveness of PECS on the development of communication in children with ASD. However, the ability of these studies to answer this question and the hypotheses stated in each article is limited when the methods, study designs and use of statistical analyses are taken into consideration.

Three of the above studies should be interpreted with much caution as they did not include baseline measures, controls or statistical analyses (Ganz et al., 2004; Liddle, 2001; Schwartz et al., 1998). These studies were not able to account for whether or not changes were due to treatment or to maturation over time. An additional concern with the study by Liddle (2001) was that ages of the subjects was not reported, which makes it difficult to generalize the results to a specific population. A positive aspect about the studies by Liddle (2001) and Schwartz et al. (1998) was that larger sample sizes of 21 and 31 children respectively, were used.

Studies by Charlop-Christy et al. (2002), Cummings et al. (2000) and Tincani (2004) had moderate problems because they all collected baseline measures but did not use statistical analyses. Another concern with these three studies was the small size of the samples, which ranged from two to five. One particular limitation of the study by Tincani (2004) was that the participants did not receive the recommended number of communication opportunities during PECS training as suggested by Bondy and Frost, which may have limited their acquisition of PECS.

Minor limitations were evident in the study by Magiati et al. (2003) because multiple baseline measures were not collected but statistical analyses were applied. Another particular problem with the study by Magiati et al (2003) was that the outcome measures that were used relied almost entirely on rating scales and questionnaires completed by teachers and parents. There was no objective assessment of the children's communicative and cognitive abilities and it is possible that ratings may have been influenced by expectations of staff and parents rather than actual changes. Similarly, minor problems were found in the study by Kravits et al. (2002) because baseline measures were collected and statistical analyses were conducted but possible effects of co-occurring treatments were not controlled. Specifically, social skills booster sessions took place at the time of treatment, which may have had an impact of the children's acquisition of PECS. It was unclear what social effects were from PECS alone, and which may have been from the social skills booster sessions (Kravits et al. 2002). A larger sample size of 34 children was reported in the study by Magiati et al. (2003) compared to the number of participants in the study by Kravits et al. (2002), which was only one.

Recommendations for Future Research

In order to address the above-mentioned concerns related to study designs and statistical analyses, there is a need for future research. First, future research should include controls. It would be appropriate to have the children act as their own controls, thus avoiding the ethical issues of withholding treatment in a control group. Second, future research should include baseline measures in order to determine the amount of change pre-treatment compared to post-treatment. It is important that it is determined whether the changes observed are due to treatment or simply due to maturation. Third, thorough statistical analyses are recommended in order to determine significance of change and the difference in the children's abilities at various points throughout treatment. Finally, future research should keep treatment fidelity issues in mind as it appears that PECS is not always implemented in a way that is consistent with the procedures outlined in the PECS manual by Bondy and Frost.

Recommendations for Clinical Practice

The literature examined provides information that is directly relevant to clinical practice. First, it is important that speech-language pathologists inform parents that PECS is not intended as a way to teach

children to learn how to speak. Instead, PECS is taught in order to teach children functional communication skills and the acquisition of speech can be viewed as a wonderful by-product of the approach, rather than its direct focus (Tincani, 2004). Parents can be told that the literature supports the use of PECS as a mode of communication and that the speech output of children with ASD often increased as well. It can also be mentioned to parents that literature relating to PECS having a negative impact on communicative output has not been encountered during this review.

Second, it is important that speech-language pathologists monitor the child's progress while learning PECS using objective measures (such as a single-subject multiple baseline design) and employ another means of communication (e.g., sign language) if the child does not seem to be making good progress with PECS.

Conclusions

The information that has emerged about this treatment approach looks promising. Upon examination of the results of the reviewed studies, it is evident that future research in the area of PECS as a treatment approach for children with ASD is necessary to continue to build on the previously mentioned conclusions and fill in any gaps in the research. In particular, concerns related to study designs and statistical analyses should be addressed in order to more systematically evaluate the impact of this treatment. Based on the existing research, it is suggested that PECS may be a beneficial mode of communication for certain children with ASD.

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Critical Review: The Efficacy of Peer-Mediated Intervention for Increasing Social Functioning of Children With Autism

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This critical review examined the effects of peer-mediated intervention on the social functioning of children with autism. In particular, studies were examined in which peers were trained as therapy agents. Study designs included: pretest-postest with control, single-subject reversal, and single-subject repeated measures designs. Overall, research suggests that peer-mediated intervention may have some positive effects on the social skills of children with autism, including improvements in both quality and quantity of social interactions. However, there are some weaknesses in the quality of the research in this area and results should be interpreted with caution.

Introduction

One of the most salient characteristics exhibited by individuals with autism is a deficit in social functioning (Rogers, 2000). For this reason, intervention for children with autism has placed considerable focus on improving the social skills of these children. Various interventions have been used in the past, with primary emphasis on adult-directed procedures. While these adult-directed interventions have been somewhat effective in improving social skills during treatment, questions have arisen concerning the artificial context of this type of intervention (Shafer, Egel & Neef, 1984). As a result, professionals in the field of autism have begun to turn towards social skills interventions that involve the peers of children with autism, rather than adult direction. These peer-mediated interventions are considered to be more naturalistic and perhaps more easily generalized to the child's daily environment (Rogers, 2000).

Peer-mediated interventions require training of same-age peers by skilled professionals. Peers are first taught ways to initiate and maintain interactions with children who have social impairments. Once the peers have been sufficiently trained, they are placed in social situations with children with autism and are asked to use the trained skills (Goldstein, Kaczmarek, Pennington, & Shafer, 1992). In most peer-mediated interventions, adults are generally involved to some extent in order to monitor the children's interactions, and to provide reinforcement or reminders when necessary (Rogers, 2000).

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the efficacy of peer-mediated intervention for improving the quantity and quality of social interactions of children with autism. Specifically, peer-mediated interventions utilizing trained peers as the therapy agents will be examined. The secondary objective of this paper is to propose evidence-based practice recommendations concerning the use of such an intervention for children with autism.

Methods

Search Strategy

Computerized databases, including Web of Science and Psychinfo, were searched using the following search strategies:

1. ((social interactive training) OR (peer-mediated intervention) OR (social skills training)) AND ((Autism) OR (Autistic*))
2. (social skills) AND (intervention) AND (peers) AND ((Autism) OR (Autistic*)).

The search was limited to articles written in English between 1980 and 2005.

Selection Criteria

All of the studies selected for inclusion in this critical review paper investigated the impact of peer-mediated intervention of the social functioning of children with autism. In addition, all studies used peer-mediated interventions in which peers were trained and functioned as the therapy agents. These studies were not limited to specific participant demographics or outcome measures.

Data Collection
Results of the literature search yielded the following ten quantitative, prospective studies examining treatment outcome: pre-test, post-test with control designs (2), single-subject reversal designs (2), and single-subject repeated measures designs (6).

Results

Outcomes
Of the ten studies reviewed in this paper, eight reported positive outcomes for the use of peer-mediated intervention to increase social functioning of children with autism (Goldstein, Kaczmarek, Pennington and Shafer, 1992; Kalyva & Avramidis, 2005; Kamps, Potucek, Lopez, Kravitz, & Kemmerer, 1997; Laushey & Heflin 2000; McGrath, Bosch, Sullivan, & Fuqua, 2003; Pierce & Schriebman, 1995, Pierce & Schriebman, 1997, Shafer, Egel, & Neef, 1984).

Kalyva and Avramidis (2005) used a pre-test, post-test with control design to investigate the effects of training and using a peer group to administer social skills intervention for children with autism. Preschool subjects with autism were randomly assigned to experimental and control groups. An appropriate non-parametric statistic (i.e., Mann-Whitney test) was used to analyze the data. The authors concluded that children in the experimental group displayed significantly greater response and initiation rates following intervention. However, the authors made only one, one-hour observation of the children's social skills at each stage of research (i.e., baseline, intervention, post-intervention). This may not have been enough observation points to obtain reliable data on changes in social behaviours.

Two studies used a single-subject reversal design (Goldstein et al., 1992; Laushey & Heflin 2000) to examine the effects of peer-mediation for targeting the social skills of children with autism. Statistics were not used in either of these studies. However, both articles used appropriate multiple baseline designs. Social behaviours were observed until stable before moving to the next stage of the study. Goldstein et al. (1992) reported increases in the amount of time children with autism spent in interactions following intervention, as well as increased responsiveness to peers after intervention. However, the authors reported a lack of reversal to baseline for one child. This may suggest that there were either carry-over effects of intervention, or that changes in behaviour for this participant were not due to the intervention. Laushey and Heflin (2000) concluded that peer-mediated intervention improved both initiating and maintenance of social interactions by children with autism. This study also reported increases in turn-taking following the intervention (Laushey & Heflin, 2000).

Five of the eight articles suggesting positive outcomes for the use of peer-mediated intervention (Kamps et al., 1997; McGrath et al., 2003; Pierce & Schriebman, 1995, Pierce & Schriebman, 1997, Shafer et al., 1984) used a single subject repeated measures design. In these studies, participants served as their own controls. None of these studies used statistical analyses. However, all five used a multiple baseline design, which was appropriate for determining whether changes in behaviour were due to treatment. Of these five studies, four reported that peer-mediated intervention resulted in increased time children with autism spent in social interactions (Kamps et al., 1997; McGrath et al., 2003; Pierce & Schriebman, 1995; Shafer et al., 1984) and two studies reported increases in the frequency of these interactions (McGrath et al., 2003; Shafer et al., 1984). Following peer-mediated intervention, three of these studies observed that children with autism displayed increased initiation with peers (McGrath et al., 2003; Pierce & Schriebman, 1995; Pierce & Schriebman, 1997) and two studies reported improved responding (McGrath et al., 2003; Pierce & Schriebman, 1997). In addition, increases in cooperative and associative play (McGrath et al., 2003) and improved language engagement (Pierce & Schriebman, 1995) were noted for children with autism following intervention.

Despite these positive outcomes, some research has failed to find significant improvements in the social skills of children with autism following peer-mediation. Using a single-subject repeated measures design, Thieman and Goldstein (2004) found no remarkable changes in social skills following this form of intervention. However, written text training was introduced immediately following peer-mediated intervention. As a consequence, the effects of peer-mediation and written text treatment on social skills post-intervention and at follow-up could not be differentiated.

Roeyers (1996) also failed to find strong support for the use of peer-mediated intervention. This study utilized a pre-test, post-test with control design. Participants were matched by age and sex, and then randomly assigned to treatment or control groups. Non-parametric statistics for matched-subjects were used to evaluate the data. However, children with

autism were reported to show no improvements in initiating with peers following the intervention.

Generalization and Maintenance

In general, research has shown maintenance of improvements in social functioning at follow-up for children with autism who received peer-mediated intervention (Kalyva & Avramidis, 2005; Pierce & Schriebman, 1995; Shafer et al., 1984). However, the data on generalization of these improvements in social skills are less clear. While some studies have found that improvements generalized to interactions with other peers (Laushey & Heflin, 2000; Pierce & Schriebman, 1997; Roeyers, 1996) and in multiple settings (Pierce & Schriebman, 1995; Roeyers, 1996), others reported that improvements in social functioning were not consistently generalized (Kamps et al., 1997; Shafer et al., 1984). Shafer, Egel, and Neef (1984) stated that generalization of improvements in social functioning in their study occurred only after the children with autism received additional specific programming.

Methodological Weaknesses

There were several major weaknesses worth noting in the studies presently reviewed. First, several studies used observers (i.e., authors) who were not blind to the purpose of the study (Kalyva & Avramidis, 2005; Kamps et al., 1997; Laushey & Heflin, 2000; McGrath et al., 2003). In these cases, observations of the participants' behaviours may have been biased due to prior knowledge of the hypotheses.

Secondly, with the exception of Roeyers (1996), all of the articles used small sample sizes ranging from one to five participants. Such small sample sizes limit the ability to generalize results to the larger population.

Lack of control for confounding variables was also a weakness. One major confound in several studies was the fact that target children with autism were included in the peer training with their peers (Kamps et al., 1997; Laushey & Heflin, 2000; McGrath et al., 2005; Shafer et al., 1984). As a result, behavioural changes in these studies cannot be said to be a result of the peer-mediated intervention because these children also received adult instruction. Additionally, though Roeyers (1996) controlled for age and sex of participants, many other potentially confounding variables, such as intelligence and severity of autism, were not controlled in the studies presently reviewed.

Finally, interrater reliability was low for several specific behaviours observed by Goldstein et al. (1992), Kamps et al. (1997), Shafer et al. (1984), and Thieman and Goldstein (2004). Low interrater reliability in these studies indicates that observations of these behaviours may not have been entirely accurate and should be interpreted with caution.

Conclusions

Overall, the articles reviewed in this paper provide some support for the efficacy of peer-mediated interventions in improving social skills of children with autism. Following intervention, researchers have reported increases in the time children with autism spend in social interactions, the frequency of these interactions, and in the quality of these social interactions with peers. However, some studies provide little support for the use of peer-mediated intervention. In addition, several methodological weaknesses in the studies presently reviewed indicate that conclusions should be interpreted with caution.

Due to the limited amount of research examining the efficacy of peer-mediated interventions for children with autism, further research in needed. Future research on this topic could be improved in several ways. First, larger sample sizes are needed in order to improve the ability to generalize results. In addition, matched control groups could be used in order to help control for potential confounding variables. Third, future research should address whether peer-mediated intervention is equally beneficial for all children with autism, regardless of the severity of the disorder. Perhaps there is a profile of children with autism who may benefit more or less from this type of intervention. Specific peer training procedures (i.e., intensity, duration, etc.) should also be examined in order to determine those procedures that are most effective in producing changes in the social functioning of children with autism. It would be beneficial to examine whether peer-mediated intervention is any more effective than individual therapy, or whether a combination of the two is most valuable. Finally, more information is needed regarding generalization and longer-term maintenance of any improvements in social functioning following peer-mediated intervention. Research concerning these factors is inconsistent at this time.

Despite the fact that research on the efficacy of peer-mediated intervention is limited, clinicians may consider using this form of intervention with children with autism for several reasons. Peer mediation is very naturalistic, occurring in the child's daily environment. Therefore, exposure to this form of intervention poses little to no risk of harm.

Additionally, if the focus of intervention is to improve a child's social skills, it seems reasonable that intervention occurring in his or her regular social environment would be favourable. Peer-mediated intervention may also be advantageous in terms of time and resources. This form of intervention requires less direct time from the clinician and may provide the child more time in intervention with his or her peers. Finally, the peers of children with autism may benefit from this intervention. Training procedures may aid in improving peers' own social skills, while exposure to a child with a disability may facilitate increased understanding and acceptance. However, until there is more conclusive research available on this topic, it is recommended that, if peer-mediated intervention is to be used, individual therapy continue to occur in combination.

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Critical Review: The effectiveness of surface electromyography in swallowing management of patients with oropharyngeal dysphagia

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This critical review examines the effectiveness of surface electromyography (sEMG) in improving swallowing function among persons with oropharyngeal dysphagia. Study designs include: case (series) reports and a retrospective observational two-group comparison study. Overall, research supports the clinical effectiveness of sEMG as a useful adjunct to swallowing management; however, the studies have been limited to a descriptive nature and have yet to isolate the effects of sEMG in swallowing therapy.

Introduction

Within the realm of swallowing disorders, most research has focused on how to accurately identify and quickly alleviate the symptoms of oropharyngeal dysphagia (Logemann, 1998, p.5). Researchers agree that an ultimate goal of dysphagia management is to help patients treat themselves so that they can learn to improve or cope with their dysphagia (Huckabee & Pelletier, 1999). Therefore, part of the clinician's responsibility is to provide patients with the appropriate instruction and tools to help them deal with their unique swallowing difficulties.

By using biofeedback tools, such as surface electromyography (sEMG), in swallowing therapy, patients are able to gain some voluntary control over a primarily involuntary physiological process (Crary, 1995). Biofeedback can display the abstract concept of a swallow in a concrete form that is more easily understood. Through the use of a visual display screen, patients become aware of what a 'good' swallow looks and feels like, and can attempt to replicate these sensations in subsequent swallows (Huckabee & Pelletier, 1999).

There are challenges in the literature regarding sEMG and dysphagia management. First, there are a limited number of quantitative studies and researchers, examining the effectiveness of sEMG in treating patients with dysphagia. Recent studies evaluate the use of sEMG on normal subjects, and while this information is informative, it cannot be generalized to individuals with disordered swallowing. Another challenge is that no normative data exist for sEMG activity in the swallowing musculature. Variation in the EMG signal cannot be compared across individuals, but can only be compared within the individual (Steele, 2004). This suggests that specific goals regarding intensity and duration of the EMG signal should be made on a case by case basis.

Overall, current research favours the use of sEMG, by speech-language pathologists. sEMG is accepted in many healthcare disciplines and is accessible to clinicians in many acute and rehabilitative facilities. It is a non-invasive way to teach new swallowing maneuvers, which can assist clinicians in planning stages of treatment and assigning realistic and attainable goals for the patient (Bryant, 1991). Swallowing is "…composed of closely coordinated, but potentially modifiable components..." (Logemann & Kahrilas, 1990, p.1138). Therefore, if a patient with dysphagia can gain volitional control over the impaired component of his/her swallow and apply an appropriate compensatory strategy; he/she may be capable of oral feeding (Logemann & Kahrilas, 1990). Patients report the EMG signal as beneficial for learning and helpful in motivating them to practice strategies for swallowing (Huckabee & Pelletier, 1999). Another advantage to using sEMG is that it provides quantitative data regarding patient progress in treatment. This helps accredit the profession of speech-language pathology and may be useful in times when third-party payers are involved (Huckabee, 1997).

Objectives

The objective of this paper is to critically evaluate existing literature regarding the effectiveness of sEMG in improving swallowing function of individuals with dysphagia. Recommendations regarding the use of sEMG in dysphagia management, and suggestions for future research will also be discussed.

Methods

Search Strategy
Computerized databases, including CINAHL, CHID, PubMed, EMBASE, and MEDLINE, were searched using the following search strategy:

> ((dysphagia) OR (swallowing)) AND ((surface electromyography) OR (sEMG)) AND ((treatment) OR (therapy) OR (management)).

Selection Criteria
The studies included in this critical review paper were required to examine the changes in swallowing function of patients with oropharyngeal dysphagia using sEMG in their therapy programs. No limits were set on the demographics of research participants or outcome measures.

Data Collection
The results of the literature search yielded the following study types: case report (1), case series reports (2), and retrospective observational two-group comparison study (1).

Results

Bryant (1991) used a case report of a single subject to illustrate the use of sEMG biofeedback in the treatment of pharyngeal dysphagia. At the end of a 10 week treatment block a videofluoroscopic exam confirmed that the patient was able to tolerate full oral intake. Descriptive statistical data were presented (e.g. baseline and repeated measures), with sEMG and videofluoroscopy data showing evidence of swallowing function improvements. Although it is difficult to identify the extent to which sEMG was responsible for the patient's progress, Bryant adequately supports the use of sEMG biofeedback in addition to traditional swallowing therapy techniques in dysphagia management.

Crary (1995) completed a case series report with 6 persons who had chronic dysphagia secondary to a brainstem stroke. The purpose of this report was to provide immediate clinical outcome, physiologic change and long-term outcome data of the effects of swallowing therapy on patients with dysphagia. Similar to Bryant's study, Crary (1995) did not use any statistics in his study. His findings would have been more credible if he had applied appropriate non-parametric statistical tests to the nominal and ordinal data. Statistical analysis could also been used to determine if there were any significant differences in patient characteristics and patient outcomes. Following completion of the study, it was reported that 3/6 patients were able to return to oral feeding in 3 weeks and 5/6 patients reported positive results at 2 years post-therapy. Posttherapy swallow attempts were characterized by improved coordination, longer duration and increased effort, which suggests that positive changes in swallowing physiology were achieved.

Huckabee and Cannito (1999) completed a case series report, with 10 subjects who had dysphagia secondary to stroke or cancer. Their intent was to partially replicate and extend Crary's study. Pre- and posttreatment swallowing physiology was measured using videofluoroscopy, and functional ability to consume oral intake was measured using a 5 point scale. Non-parametric statistical procedures revealed significant changes in pre- and posttreatment MBS severity scores ($p=.006$) and functional change in diet level across the four ratings (pre-treatment, after 1week, after 6 months, and final outcome) ($p=.002$). The authors reported that 9/10 subjects demonstrated measurable changes in swallowing physiology, 8/10 subjects returned to full oral intake, and 6 of these 8 subjects were able to maintain their gains at diet final (1-4 years post-treatment). Overall, improvements were observed in swallowing physiology and functional oral intake (diet level).

Crary, Carnaby, Groher and Helseth (2004) completed a retrospective observational analysis of 45 persons with dysphagia. Swallowing performance was evaluated pre and post therapy using the Functional Oral Intake Scale (FOIS). Non-parametric statistical methods were used to make group comparisons between patients following stroke and head/neck cancer patients. The authors reported that 87% of patients increased functional intake by at least one scale score following therapy. The average increase in scale score for stoke patients was 2.96 and for cancer patients was 1.58. Of patients who were initially dependent on nonoral feeding, 55% of stroke patients (p value<.002) and 25% of head/neck cancer patients (n.s.) progressed to total oral feeding.

Discussion

At first glance the research findings appear to support the effectiveness of sEMG in improving swallowing function in individuals with dysphagia. However, numerous issues in regards to study design, subject selection, outcome measures/measurement tools and statistical analysis, exist in the reviewed literature. These issues question the credibility of the evidence and should be further investigated.

Study Design
In 3 of the 4 studies, the researchers completed descriptive case (series) reports. Although this is an informative, practical clinical means of gathering data, it is the least rigorous of all research designs. Several limitations accompany this study design, including the lack of appropriate controls subjects, reduced control over potential confounding variables, and weak generalization to other individuals. In order to provide evidence that sEMG is in fact a worthy tool, other more rigorous designs, such as a single subject design (e.g., A-B-A-B design or a multiple baseline design), could have been used.

In addition, 2 of the 4 studies completed retrospective evaluations of previously collected data. Generally, retrospective chart review is a weaker form of data collection because it relies on accurate documentation and interpretation of data by previous clinicians. Therefore, a prospective design should be used in order to eliminate these challenges.

Subject Selection
Crary (1995), Huckabee & Cannito (1999) and Crary et al. (2004) reported that subjects were selected to participate in their therapy programs based on a number of criteria. Some of these criteria, such as pre-treatment feeding tube status, and the use of videofluoroscopy to determine pre-treatment swallowing status, were controlled for by all researchers. However, there were also many inconsistencies regarding the manipulation of potentially confounding variables across the studies. For instance, 2 of the studies did not control for the occurrence of prior therapy. Errors such as this make it difficult to determine whether a patient's success with a therapy program is due to the principles of sEMG or the mere presence of therapy. These issues surrounding subject selection affect the generalization and credibility of their results.

Outcome Measures & Measurement Tools
In order to measure posttreatment status Crary (1995) relied on the interpretation of sEMG activity alone, this is problematic because the reliability of sEMG is still debatable. (Huckabee & Cannito, 1999). Crary et al. (2004) used a self-report tool to estimate functional swallowing ability. The results of these studies would have been more credible if videofluoroscopy had been used to measure post-treatment change, as this is the gold standard for measuring swallowing function.

One of Crary's (1995) outcome measures required an evaluation of swallowing coordination. Considering the limited selection of 4 ratings (e.g., 0=absent swallow and 3=normal), reliability was low: intrajudge reliability was 80%, while estimated interjudge reliability was 60%. In order to make a more robust evaluation of interrater reliability, Cohen's Kappa should have been applied to account for occurrence of chance agreement.

Huckabee & Cannito (1999) reported the use of a 9-point interval scale to evaluate videofluoroscopic swallowing studies. Seventeen very specific physiological events were analysed. While it appeared to be very inclusive, examining parameters associated with all stages of the swallow, there was no evidence that this scale was standardized, and psychometric properties were not reported.

Similarly, Crary et al. (2004) mentioned that the 7-point scale (FOIS) he used to measure patient outcomes had strong reliability and validity specific to stroke populations, but applicability to head/neck cancer patients is unknown. The validity of outcome data would have been improved if the measurement tool had been implemented at time of treatment, rather than retrospectively.

Statistical Analysis
Huckabee and Cannito (1999) and Crary et al. (2004) applied appropriate statistical procedures to test the significance of their data, which enhances the credibility of their findings.

Although statistical analysis is not essential to the case report design, the addition of repeated measures (as in single subject designs) to Crary's (1995) report would have increased the experimental control of the study, thus increasing confidence in results.

Recommendations

It is difficult to have absolute confidence in the research findings due to concerns regarding study design, subject selection, outcome measures/ measurement tools, and statistical analyses. Due to issues found within and across the studies, the reported results should be interpreted with caution. Investigation regarding the effectiveness of sEMG on swallowing function is still in its preliminary stages. Therefore, it is recommended that more research, including replication and extension of previous studies be performed to answer this research question. In addition, researchers working in the area of dysphagia management are strongly encouraged to:

1. Use a single subject design to add greater control to studies with few subjects.

2. Use a group comparison study to determine if sEMG is responsible for improvement in swallowing function.
3. Compare the effectiveness of individual traditional swallowing strategies paired with sEMG (e.g., Mendelsohn maneuver vs. Effortful swallow vs. Masako maneuver)
4. Perform prospective studies.
5. Utilize a reliable measurement tool to measure changes in swallowing physiology and functional oral intake.
6. Include multiple-raters in the evaluation of swallowing physiology.
7. Include follow-up measures at 6 months and 1-3 years post treatment to determine whether therapy had long-term effects.
8. Control for patient characteristics, especially etiology, in order to create a more homogeneous sample.
9. Determine patient characteristics that influence candidacy for sEMG therapy.

Conclusions

Overall, the studies examined serve as a good starting point for describing the use and potential benefits of sEMG in improving swallowing function. However, it seems as though preliminary studies providing statistical evidence regarding the effectiveness of sEMG biofeedback in dysphagia management are lacking in the literature. Although the results from the reviewed studies suggest that sEMG is responsible for at least some of the improvements made in swallowing function, it cannot be stated conclusively that sEMG brought about greater changes in swallowing function than swallowing maneuvers without sEMG. Due to the absence of literature examining the isolated effects of sEMG on swallowing function and the numerous limitations mentioned in the current research, conclusions regarding sEMG effectiveness cannot be made at the present time. With further research, surface EMG may prove to be an asset to speech-language pathologists and their management of patients with dysphagia.

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Critical Review:
The Reliability and Validity of Cervical Auscultation as a Dysphagia Assessment Tool.

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This critical review examines the reliability and validity of cervical auscultation as a bedside dysphagia assessment tool. All authors completed diagnostic test studies. Overall, research shows that cervical auscultation on its own is not a reliable and valid tool for assessing dysphagia at bedside; however, appropriate training does appear to improve an individual's reliability while using cervical auscultation, making it a possible adjunct to a thorough bedside swallowing exam.

Introduction

Dysphagia, an impaired ability to swallow, can occur in all age groups and due to a variety of etiologies (Logemann, 1998). Dysphagia can have severe physical and psychosocial consequences for patients (Logemann, 1998; Ekberg, Hamdy, Woisard, Wuttge-Hannig, & Ortega, 2002), and as such, the presence of dysphagia in at-risk patients needs to be correctly identified. Instrumental assessment, such as a videofluoroscopic swallow study (VFSS), can be expensive, time consuming, and not readily available in some hospitals. A bedside swallowing exam (Logemann, 1998) is often used in lieu of, or along with a VFSS, as it can be a cost and time efficient way to assess numerous at-risk patients.

An assessment tool such as the bedside swallowing exam must not only be cost and time efficient, but reliable and valid as well (Lambert, Gisel, & Wood-Dauphinee, 2001). Reliability is defined as the degree to which an assessment tool obtains the same results on repeated trials. Intra-rater reliability evaluates whether one clinician obtains the same results between one application of the assessment tool and another, while inter-rater reliability evaluates whether more than one clinician assessing the same subject will get similar results while using the assessment tool in question. (Lambert et al., 2001). Validity is defined as the degree to which the tool assesses what it intends to assess. Criterion validity describes how accurately an assessment tool measures the issue at hand, using the concepts of sensitivity (ability of a clinician to correctly identify dysphagic patients using the tool) and specificity (the ability of a clinician to correctly identify healthy patients using the tool). Predictive validity describes the ability of a clinician to predict the presence or absence of a disorder using the tool (Lambert et al., 2001).

The literature has not shown the bedside swallowing exam to be a reliable and valid assessment method (McCullough, Wertz, Rosenbeck, Mills, Ross & Ashford, 2000; Linden, Kuhlemeier, & Patterson, 1993; Ramsey, Smithard & Kalra, 2003; Mathers-Schmidt & Kulinski, 2003). Despite this lack of evidence, the bedside swallowing exam remains widely used because it is quick and feasible. It would be advantageous to add a protocol or tool to the bedside swallowing exam that would increase its reliability and maintain its efficiency.

One assessment tool that has been receiving attention in this regard is cervical auscultation. Cervical auscultation involves listening to the presence and timing of the sounds of deglution and respiration with a stethoscope to predict or detect aspiration (Logemann, 1998). Past research has established the appropriate physical placement of a stethoscope on the neck (Takahashi, Groher, & Macho, 1994; Takahashi, Groher, & Michi, 1994), as well as the preferred type of stethoscope (Hamlet, Penney & Formolo, 1994) and microphone (Cicherio & Murdoch, 2002). Data has been accumulated regarding the sounds normal swallowing across different ages, genders and bolus volumes (Huckabee, Coombes, & Robb, 2005; Cichero & Murdoch, 2002; Boiron, Rouleau & Metman, 1997).

Despite having an evidence base to support elements of cervical auscultation, it remains a controversial assessment tool. Performing cervical auscultation requires a subjective interpretation of the sounds of swallowing, and little research has been completed as to how accurate speech-language pathologists are at this task. If the reliability and validity of cervical auscultation could be established, it is possible that speech-language pathologists would incorporate it into their bedside swallowing exam, thereby increasing its reliability and validity.

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the reliability and validity of cervical auscultation. The secondary objective is to propose evidence-based research and clinical recommendations regarding the use of cervical auscultation in dysphagic practice.

Methods

Search Strategy
Computerized databases, including CINAHL, Embase, PubMed, and Medline were searched using the following search strategy:

> ((cervical auscultation) OR (swallowing) AND (sounds)) AND ((dysphagia) OR (aspiration) OR (videofluroscopy)) AND ((reliability) OR (validity)).

The search was limited to articles written in English between 1980 and 2005.

Selection Criteria
Studies selected for inclusion in this critical review paper were required to investigate the reliability (including inter-rater and/or intra-rater reliability) and validity (including predictive validity and/or criterion validity) of cervical auscultation. No limits were set on the demographics of research participants or outcome measures.

Data Collection
Results of the literature search yielded 3 diagnostic test studies, which were congruent with the aforementioned objectives and selection criteria.

Zenner, Losinski & Mills (1995) hypothesized that "a clinical examination that includes cervical auscultation with a stethoscope distinguishes patients who aspirate from patients who do not" (p. 28). Two of the authors performed cervical auscultation within a bedside swallowing exam on 50 dysphagic patients, and assessed oral delay and residue, pharyngeal delay and residue, and the presence of tracheal aspiration. Individual interpretations were compared to the judgments of the other rater and to results obtained via a subsequent VFSS assessment. A review of the authors' methodology revealed an inadequately designed study, producing weak evidence.

Stroud, Lawrie, & Wiles (2002) examined the inter-rater and intra-rater reliability of cervical auscultation used alone to detect aspiration in dysphagic patients. Five speech-language pathologists listened to recordings of the swallowing sounds of 16 dysphagic patients, and rated the swallows as either aspirating or non-aspirating. Individual interpretations were compared to the judgments of the other raters and to results obtained via a simultaneous VFSS assessment. A review of the authors' methodology revealed an adequately designed study, producing reliable evidence

Leslie, Drinnan, Finn, Ford, & Wilson (2004) examined the inter- and intra-rater reliability of cervical auscultation used alone to distinguish healthy subjects from subjects with dysphagia, and questioned whether years of experience would affect reliability. Nineteen speech-language pathologists listened to recordings of the swallowing sounds of 10 healthy subjects and 10 subjects with dysphagia, and rated the swallows as either normal or abnormal. Individual interpretations were compared to the judgments of the other raters and to results obtained via a simultaneous VFSS assessment. A review of the authors' methodology revealed a rigorously designed study, producing presumably strong evidence.

Results

Inter-rater reliability
Zenner et al. (1995) evaluated inter-rater reliability by calculating percentage agreement between the 2 raters, and found 96% agreement. Although this level of agreement is high, percentage agreement does not account for the possibility of chance agreement. Stroud et al. (2002) evaluated inter-rater reliability with a kappa statistic, which accounts for chance agreement. Kappa was interpreted with Landis & Koch's (1997) guidelines, which evaluates the strength of agreement between or within clinicians. The authors found that the speech-language pathologists using cervical auscultation in their study had a inter-rater reliability kappa figures ranging from –0.12 to 0.71, with a mean of 0.35, or "fair" agreement. Leslie et al. (2004) also evaluated inter-rater reliability with a kappa statistic and Landis & Koch's (1997) guidelines. The authors found that the speech-language pathologists using cervical auscultation in their study had a inter-rater reliability kappa figure of 0.28 or "fair" agreement. Overall, evidence from the two well-designed studies found the inter-rater reliability of cervical auscultation to be fair at best.

Intra-rater reliability
Stroud et al. (2002) again evaluated intra-rater reliability with a kappa statistic, interpreted with Landis & Koch's (1997) guidelines. The authors found that the speech-language pathologists using

CA in their study had a intra-rater reliability kappa figures ranging from 0.31 to 0.85, with a mean of 0.55, or "moderate" agreement. Leslie et al. (2004) also evaluated intra-rater reliability with a kappa statistic and Landis & Koch's (1997) guidelines. The authors found that the speech-language pathologists using cervical auscultation in their study had intra-rater reliability kappa figures of 0.02 to 0.18, or "poor" agreement. Zenner et al. (1995) did not evaluate intra-rater reliability. In summary, the intra-rater reliability of cervical auscultation was found to be poor to moderate.

Criterion Validity

Sensitivity

Zenner et al. (1995) evaluated the sensitivity of cervical auscultation by comparing assessment results with results obtained from a subsequent VFSS. The authors reported cervical auscultation allowed clinicians to identify aspiration with 84.2% accuracy. Stroud et al. (2002) evaluated the sensitivity of cervical auscultation by comparing assessment results with results obtained from a simultaneous VFSS. The authors reported cervical auscultation allowed clinicians to identify aspiration with 86% accuracy. Leslie et al. (2004) evaluated the sensitivity of cervical auscultation by comparing assessment results with results obtained from a simultaneous VFSS. The authors reported cervical auscultation allowed individual clinicians to identify dysphagic patients with 62% accuracy, but allowed the majority of the speech-language pathologists (10 or more) to identify these patients with 80% accuracy. Overall, cervical auscultation was found to have adequate sensitivity, especially when group consensus was evaluated.

Specificity

Zenner et al. (1995) evaluated the specificity of cervical auscultation by comparing assessment results with results obtained from a subsequent VFSS. The authors reported cervical auscultation allowed clinicians to identify non-aspirating swallows with 71% accuracy. Stroud et al. (2004) evaluated the specificity of cervical auscultation by comparing assessment results with results obtained from a simultaneous VFSS. The authors reported cervical auscultation allowed clinicians to identify non-aspirating swallows with 56% accuracy. Leslie et al. (2004) evaluated the specificity of cervical auscultation by comparing assessment results with results obtained from a simultaneous VFSS. The authors reported cervical auscultation allowed individual clinicians to identify healthy patients with 66% accuracy, but allowed the majority of the group of speech-language pathologists (10 or more) to identify these patients with 90% accuracy. In summary, cervical auscultation was found to have poor to moderate specificity, unless group consensus was evaluated.

Predictive Validity

Only Stroud et al. (2002) reported positive and negative predictive validity statistics. The authors reported speech-language pathologists were able to use cervical auscultation to predict aspiration with 31% accuracy, and predict a healthy swallow with 94% accuracy. Cervical auscultation was found to be an adequate tool for eliminating the possibility of aspiration, but not for identifying aspiration.

Conclusions

Overall, research has demonstrated that the inter- and intra-rater reliability of cervical auscultation is poor to moderate, with moderate to high sensitivity but poor to moderate specificity. There appears to be little evidence that cervical auscultation is a valid and reliable tool for assessing dysphagia at bedside.

Zenner et al. (1995) concluded that cervical auscultation was "a highly sensitive and specific method of dysphagia assessment" (p. 27). However, the authors reported that due to low clinical and fluoroscopic agreement, cervical auscultation was "at this time, an imprecise clinical method for evaluating the risks of tracheal aspiration" (p. 30). It is difficult to place confidence in either of these conflicting conclusions, due to methodological problems discovered upon critical review of their research design.

Stroud et al. (2002) concluded that speech-language pathologists are unable to reliably identify aspiration using cervical auscultation alone. They report that while sensitivity of cervical auscultation was found to be high, reduced specificity allowed speech-language pathologists to over-detect aspiration while using the tool. A low positive predictive validity does not allow a speech-language pathologist to feel confident about his or her judgment that aspiration has occurred.

Leslie et al. (2004) also concluded that few speech-language pathologists are able to perform reliable assessments using cervical auscultation. Individual sensitivity and specificity was low, but the authors note that as a group, the speech-language pathologists had highly accurate fluoroscopic agreement. The authors also found that years of experience was unrelated to reliability.

The existing reputable literature on cervical auscultation appears to suggest that cervical

auscultation is not a reliable or valid dysphagia assessment tool, and its inclusion in a bedside swallowing exam would not improve a speech-language pathologist's ability to assess aspiration risk.

The studies reviewed here demonstrated a tendency for speech-language pathologists to over-diagnose aspiration in the dysphagic population while using cervical auscultation. Referring too many non-aspirating patients for the unnecessary cost and radiation of a VFSS or unnecessary diet changes could be a consequence of this overdiagnosis. This evidence underscores the importance of identifying normative data regarding the sounds of a dysphagic but non-aspirating swallow, rather than only healthy and aspirating swallows.

Both Stroud et al. (2002) and Leslie et al. (2004) reported their participants had a wide range of inter- and intra-reliability, and Leslie et al. (2004) showed that group accuracy was high. Although years of experience was found to be independent of reliability, some speech-language pathologists demonstrated strong reliability and accuracy. If years of experience does not explain this accuracy, perhaps type of training does. Further research on the type of training required to perform reliable cervical auscultation is therefore needed. If suitable training was identified, both reliability and validity of cervical auscultation would likely improve. Incorporating improved training into education programs may lead to the use of cervical auscultation as a adjunct tool to a thorough bedside swallowing exam.

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Critical Review:
The Effects of Computer-Based Interventions on Improving Phonological Awareness in Children with or at Risk for Reading Problems

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This critical review examines the effects of using computer-based interventions for treating the phonological awareness skills of children with and at risk for reading impairment. Study designs include: pretest/posttest control, longitudinal, repeated measures, and case study pretest/posttest. Overall, research supports the use of computer-based interventions for improving phonological awareness in children with or at risk for reading problems; however, one must use these programs with caution, as they may not be appropriate for all children.

Introduction

There is a strong positive relationship between phonological awareness and early literacy development, in that good readers tend to have a high level of phonological awareness and poor readers show a deficiency in phonological awareness (Nation & Hulme, 1997; Schneider, Ennemoser, Roth, & Kuspert, 1999). Research in this area has shown that phonological awareness can be successfully taught (Mitchell & Fox, 2001). As a result, many speech-language pathologists (SLP's), teachers, parents, and other clinicians are implementing phonological awareness training programs for children who have or are at risk for reading failure.

Since the majority of children now have access to computers in the home and school, it seems only logical that computer-based phonological awareness programs have been developed. Some of these computer interventions include DaisyQuest (Erickson, Foster, Foster, & Torgesen, 1992), Earobics (Cognitive Concepts, Inc., 1998), Lindamood Phonemic Sequencing Program (LiPS; Lindamood & Lindamood, 1998) and others. These programs claim to increase phonological awareness by training aspects such as sound blending, sound identification, sound segmentation, rhyming, word awareness, and syllable awareness.

The effectiveness of direct instruction of phonological awareness for children with and at risk for reading problems has been established (Segers & Verhoeven, 2004). In contrast, computer-based instruction has not been the subject of much research. Moreover, much of the research has focused on typically developing children (Segers & Verhoeven, 2004). This raises the question of whether computer-based interventions are effective at improving phonological awareness in children with or at risk for reading problems.

Since many SLP's, teachers, and other professionals are implementing computer-based interventions in their therapy sessions and classrooms, it is important to determine whether these programs are effective. Moreover, it is important to determine if these programs are effective at teaching children with and at risk for reading problems since these are the children who need to benefit from the programs most.

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the effectiveness of computer-based interventions at improving phonological awareness in children with and at risk for reading problems. The secondary objective is to propose evidence-based practice recommendations for SLP's regarding the implementation of computer-based phonological awareness programs.

Methods

Search Strategy

Computerized databases, including CINAHL and Web of Science were searched using the following search strategy:

> ((computer) OR (software) OR (multimedia) AND (phon* awar*)

A snowball search through the references was then conducted to ensure the inclusion of all relevant articles. The search was limited to articles written in English.

Selection Criteria
Studies selected for inclusion in this critical review paper were required to investigate whether computer-based interventions increased phonological awareness in children with or at risk for reading problems. No limits were set on the demographics of research participants or outcome measures.

Data Collection
Results of the literature search yielded studies congruent with the aforementioned selection criteria with the following designs: Pretest/posttest control (6), longitudinal (3), repeated measures (1), and case study pretest/posttest (1).

Results

Computer-Based Interventions and Children with Reading Problems

Below Average Readers, Low Progress Readers, and Children One Year Below Grade Level for Reading
The researchers who examined the effectiveness of computer-based interventions at improving phonological awareness in below average readers, low progress readers, and children one year below their grade level for reading all had strong studies that were able to accurately answer the above research question (Barker & Torgesen, 1995; Mitchell & Fox, 2000; Pokorni, Worthington, & Jamieson, 2004). They all concluded that computer-based interventions were able to increase phonological awareness in these populations.

Overall Academic Weakness
Although Trioa and Whitney (2003) concluded that computer-based interventions improve phonological awareness in children with overall academic weakness, this conclusion may have been inaccurate due to methodological weakness. A limitation of this study was that the treatment group was significantly different than the control group at pre test on the number of participants as well as on measures of academic competence and oral expression. The researchers did control for this using ANCOVA before they continued with their repeated measures MANOVAs, however, they found no significant differences between the groups at posttest. When this occurred, the authors reanalysed the data using children who scored below the 25th percentile on the pre test measures. Based on a significant difference between the groups on one measure of phonological awareness on this second analysis, the authors concluded that the computer-based program was effective at increasing phonological awareness in children with reading problems. It is felt that this result was insufficient to conclude that the computer program was effective in this population. In addition, the insignificant results of the initial analysis cannot be overlooked.

Autism
Heimann, Nelson, Tjus, & Gillberg (1995) may have been inaccurate in their conclusion that computer programs improve phonological awareness in children with Autism. The computer based program did not directly target phonological awareness, the amount of training in each group differed, the authors did not test the phonological awareness skills of all of the children, and assessment of phonological awareness was limited to sound synthesis. In addition, significant effects of the program were only found during the intervention and not at the follow up period, suggesting that computer-based programs may not have long-term benefits for children who have Autism.

Computer-Based Interventions and Children at Risk for Reading Problems

Children from Disadvantaged Homes and Children at High Risk for Learning Disabilities
The researchers who examined the effectiveness of computer-based interventions at improving phonological awareness in children from disadvantaged homes and children at high risk for learning disabilities all had methodologically sound studies that were able to accurately answer the above research question (Mioduser, Tur-Kaspa, & Leitner, 2000; Foster, Erickson, Foster, Brinkman, & Torgesen, 1994). They all concluded that computer-based interventions were able to increase phonological awareness in these populations.

Children from Disadvantaged Homes
Another study that examined children from disadvantaged homes had a weak methodology and therefore must be interpreted with caution (Lonigan, Driscoll, Phillips, Cantor, Anthony, & Goldstein, 2003). There were significant differences between the treatment and control groups at pre-test and despite this, the authors conducted repeated measures ANOVAs without first controlling for group differences using ANCOVA or MANCOVA. Also, many of the children did not receive training on certain items because the computer program was designed in a way that required the child to pass certain items in rhyming and segmenting before receiving training on blending. Therefore, some children were tested on blending when they did not receive any training on it. Regardless of this, the researchers found that children from disadvantaged

homes improved on measures of phonological awareness after receiving computer-based training. Although there were weaknesses in this particular study, it is felt that computer-based interventions are effective at improving phonological awareness skills in children from disadvantaged homes. The study by Mioduser et al. (2000) was strong and should be considered over the Lonigan et al. (2003) study.

Children with Specific Language Impairment (SLI)
A study by Segers and Verhoeven (2004) sought to determine if computer programs could improve phonological awareness in children with specific language impairment. Although the researchers concluded that their program was effective, they changed their initial nonsignificant analysis in order to find significant results. This second analysis was executed correctly, however, the insignificant results of the first analysis must be considered. It is felt that this study could not accurately determine whether computer-based programs are effective for children with specific language impairment.

Second Language Learners
The researchers who examined children speaking Dutch as a second language also had some methodological weaknesses in their study (Segers & Verhoeven, 2005). Their sample was biased because only those children who passed kindergarten were included in their analysis at the follow up period and some children received more computer training than others. Due to these flaws, it is unknown if second language learners are able to improve their phonological awareness through computer interventions.

Children Receiving Speech and Language Services
Loeb, Stoke, and Fey (2001) conducted a case study and found that one of the four children receiving speech and language services improved their phonological awareness skills following a computer-based intervention. Since this was a case study that only examined 4 males from upper middle class homes, it is difficult to generalize the results of this study. In addition, the researchers did not use a multiple baseline design, which makes it difficult to determine if the results were due to maturation or the intervention. Thus, it is unknown if children receiving speech and language services can benefit from computer-based phonological awareness interventions.

Conclusions

Research has demonstrated that computer-based interventions can be effective at improving phonological awareness in children with or at risk for reading problems. Strong studies have proven that below average readers, low progress readers, children one year below their grade level for reading, children from disadvantaged homes and children at high risk for learning disabilities can all benefit from these programs. In contrast, the researchers who examined children with overall academic weakness, Autism, and specific language impairment, as well as second language learners all had weak studies that could not effectively answer their question.

As a result, it is recommended that SLP's use these programs with some caution since there is a possibility that they may not be appropriate for all children. Close monitoring of the child's progress is essential to ensure the child is receiving the best service. Another option is to combine traditional phonological awareness training methods with computer-based training methods. SLP's can suggest putting computer-based phonological awareness programs in the classroom so children can receive the benefits of direct therapy as well as indirect computer-based therapy. This can also help to facilitate learning in typically developing children.

Further research is needed to determine the effectiveness of computer-based interventions on specific populations. More specifically, more information is needed on children with Autism, specific language impairment, second language learners, and children with overall academic weakness. Further research is also needed to determine the long-term effects of computer-based phonological awareness programs. All of the longitudinal studies reviewed in this article had significant methodological weaknesses and therefore the long-term effects of these programs are unknown.

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Critical Review:
Effects of Prolonged Endotracheal Intubation on Swallowing Function.

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This critical review examines the effects of prolonged endotracheal intubation on swallowing function. Study designs include: prospective observational clinical study, randomized controlled trial, and nonrandomized group comparison study. Overall, research supports that there is a high incidence of aspiration in patients following prolonged endotracheal intubation; however, identification of a specific causal relationship between prolonged endotracheal intubation and dysphagia has not yet occurred.

Introduction

In an acute care hospital, patients under go intubation for a variety of reasons. Endotracheal intubation involves the passage of a tube through the nose or the mouth of the patient, through the pharynx and larynx (passing between the vocal cords), ending in the trachea (Logemann, 1998). Patients are intubated in order to maintain an adequate airway, often following trauma or during surgical procedures and the post-operation recovery time following these procedures. Intubation has a direct effect on the larynx, which in turn affects the swallow post-extubation (i.e. following removal of the endotracheal tube).

Prolonged endotracheal intubation refers to instances in which patients have been intubated for longer than 48 hours (Solh, Okada, Bhat & Pietrantoni, 2003). Intubation is a necessity in those patients who cannot maintain an airway on their own, thus despite the potential negative side effects intubation may cause, it is indisputable that intubation is an essential treatment procedure required to preserve life. Effects of endotracheal intubation may be numerous and/or exacerbated if the intubation was traumatic, that is if there was difficulty passing the tube through the vocal cords and/or if the intubation required several attempts to pass the tube. Some effects of endotracheal intubation include damage to the larynx, such as redness, edema, nodule or polyp formation and unilateral adductor paresis or paralysis (Logemann, 1998). Once extubated, effects may include decreased range of motion of the lips, tongue, pharynx and larynx which may last up to one week (Logemann, 1998).

Speech Language Pathologists who assess patients for dysphagia have a great interest in the laryngeal function. The function of the larynx during the swallow is to protect the airway and prevent foreign materials from entering the lungs (i.e. aspiration, (Logemann, 1998). Aspiration or foreign material below the level of the true vocal cords into the trachea and lungs can lead to the development of aspiration pneumonia, a potentially fatal medical condition. Transient injury to the larynx and subsequent reduction of the protective mechanism of the larynx, coupled with an increased incidence of oropharyngeal secretions once the patient is extubated, results in patients being at an increased risk of aspiration and subsequent pneumonia following prolonged endotracheal intubation (Solh et al., 2003).

Potential effects on swallowing function following prolonged endotracheal intubation include alterations in glottic anatomy, disruption of the swallowing reflex, muscle atrophy, suppression of the cough and gag reflexes, residual effects of narcotics, neuromuscular/neurological impacts, age, duration of intubation and traumatic intubation.

Objectives

The primary objective of this paper is to critically evaluate existing literature to determine the effects of prolonged intubation on swallowing function. The secondary objective is to propose evidence-based practice clinical recommendations regarding swallowing assessment protocol for patients receiving prolonged endotracheal intubation.

Methods

Search Strategy

Computerized databases, including Medline, PubMed, and Cochrane Library, were searched using the following search strategy:

((intubation) AND ((swallowing) OR (dysphagia) OR (swallow)).

The search was limited to articles written in English between 1985 and 2005.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to investigate the effects of prolonged endotracheal intubation on swallowing function. No limits were set on the demographics of research participants or outcome measures.

Data Collection

Results of the literature search yielded the following types of articles congruent with the aforementioned selection criteria: prospective observational clinical study (2), group comparison design (2) and randomized prospective clinical trial (1).

Results

Larminat, Montavers, Dureuil and Desmonts (1995) used a prospective, observational, clinical study in which latency in the swallowing reflex was evaluated following injection of saline into the epipharynx. Additionally, the effects of age and duration of intubation on the swallowing reflex were explored. The authors hypothesize that the presence of the endotracheal tube alters the mechanoreceptors and chemoreceptors of the pharyngeal and laryngeal mucosa causing dysfunction of the swallowing reflex. Swallowing latency post injection was measured using a submental electromyogram. This study demonstrated that prolonged endotracheal intubation impairs the swallowing reflex with improvement within one week, which could contribute to microinhalations and aspiration pneumonia post extubation ($P < .05$). The authors reported that there was no correlation between swallowing latency and either age of the patients or duration of endotracheal intubation. The authors identified that their patients were assessed using small volumes of liquid, thus these results cannot be directly compared with food taken orally.

Leder, Cohn and Moller (1998) used a prospective, observational, pilot study completed with twenty subjects requiring prolonged endotracheal intubation to explore the incidence of aspiration following extubation in critically ill trauma patients. Aspiration was measured using Fiberoptic Endoscopic Evaluation of Swallowing (FEES). This study demonstrated that 1) trauma patients had an increased risk of aspiration both overt and silent (aspiration was identified in 45% of their subjects), and 2) trauma patients who had a low Glasgow Coma Score on admission or traumatic intubation appeared to be at increased risk for aspiration. The authors reported that silent aspiration occurred in 20% of the subjects. While all patients were described as being alert they still did not swallow within normal limits. Therefore patients identified as being neurologically alert following extubation can exhibit different swallowing behaviours.

Solh, Okada, Bhat and Pietrantoni (2003) used a prospective, group comparison study completed with 84 subjects requiring prolonged endotracheal intubation, in which an elderly cohort was compared with younger controls in the assessment of the prevalence and recovery time of swallowing dysfunction following prolonged endotracheal intubation. Aspiration was measured using FEES. This study demonstrated that critically ill elderly patients exhibit delayed resolution of swallowing impairment post extubation compared to younger patients ($P < .05$).

Arjemian, Nirmul, Anderson, Zirlen and Kwasnik (2001) used a prospective clinical group study design with 51 subjects requiring prolonged endotracheal intubation in which swallowing function was compared to determine diet orders in the assessment of swallowing dysfunction following prolonged intubation and incidence of clinically significant aspiration following initiation of oral feeding. Aspiration was measured using FEES. The study demonstrated that FEES identified swallowing dysfunction in more than 50% of patients receiving prolonged endotracheal intubation many of whom were silent aspirators ($P <.05$). The authors reported that dietary recommendations based on FEES results prevented clinically significant aspiration.

Barquist, Brown, Cohn, Lundy and Jackowski (2001) used a randomized prospective clinical trial with 70 patients who required prolonged endotracheal intubation to determine whether performing a swallowing evaluation would reduce the incidence of post-extubation aspiration and subsequent pneumonia. Subjects were randomly assigned to receive either a bedside clinical evaluation or FEES to evaluate the presence or absence of aspiration. The presence of aspiration can lead to the development of aspiration pneumonia. The authors reported that patients with prolonged endotracheal intubation are at risk of aspiration following extubation ($P <.05$), but the addition of a FEES examination did not change the incidence of aspiration or post-extubation pneumonia.

Discussion

In reviewing this literature it is clear that prolonged endotracheal intubation increases the risk of aspiration in the patients being studied. However the literature did not pinpoint the exact cause of this dysphagia. Even more puzzling is that in the majority of cases this swallowing dysfunction resolves spontaneously, usually within a week. There are exceptions as Solh et al. (2003) found that the elderly exhibit delayed resolution of swallowing impairment. In fact some of their study participants never did return to oral feeding. It is therefore difficult, with our knowledge to date, to predict which patients receiving prolonged endotracheal intubation will suffer lifelong swallowing impairment and which patients will experience swallowing impairment that resolves within a short period of time. This has tremendous clinical implications which are addressed in the following recommendations section.

Recommendations

The above review has shown that there is a high incidence of dysphagia following prolonged endotracheal intubation. Thus clinically, it is recommended that:

1. Acute care trauma centers create a protocol for screening and/or assessing swallowing function in all patients who receive prolonged endotracheal intubation.
2. Included in this protocol oral intake should be delayed for at least 24-48 hours following extubation, as this is when patients are at the highest risk of aspiration.

Additionally further research is required to determine the exact cause of this swallowing dysfunction seen in patients receiving prolonged endotracheal intubation. Due to the fact that critically ill patients have many factors/variables which are difficult to control for, it is difficult to determine if it is the prolonged endotracheal intubation causing the dysphagia or one of the other factors or a combination. Future research should focus on determining this causation so that we may be able to predict those patients who will have swallowing impairment which we can manage before aspiration takes place, thus reducing the risk of patients developing potentially life threatening aspiration pneumonia.

Limitations

It should be noted that there are limitations to this critical review. The information reported in the literature and discussed above, can only be applied to critically ill patients receiving prolonged endotracheal intubation. Due to the fact that this is a very heterogeneous population it is difficult to generalize results. The methodology in this area of dysphagia assessment and management can be improved with replication of the above mentioned studies.

Conclusion

All of the studies have shown that patients receiving prolonged endotracheal intubation are at increased risk of aspiration following extubation. Until the exact mechanism contributing to this swallowing dysfunction is identified, it is important that our clinical practice encompass the evidence that is available to date. Thus, evidenced based practice should incorporate the screening and/or assessment of all patients receiving prolonged intubation and delaying oral intake in these patients for 24-48 hours post-extubation.

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Critical Review:
How can occlusion and ampclusion be alleviated?

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This critical review examines the techniques used to alleviate occlusion and ampclusion. Study designs include: one group pretest-posttest and a pretest-posttest deign with control. Overall, research suggests venting, longer canal length, modified canal of hearing instrument, different shell size, K-amp circuitry and shorter propagation time assist in alleviating occlusion and ampclusion to varying degrees at different frequencies.

Introduction

The occlusion effect occurs when the ear canal is filled by an object (i.e. hearing aid) and sound gets trapped between the earmould/hearing and the tympanic membrane. Under natural conditions the vibrations that are created by people's own voices or chewing escape through the unconcluded ear. However, when these sounds vibrate the cartilaginous portion of the ear canal and are trapped between the earmould/hearing aid and tympanic membrane, their sound pressure level increases relative to the level it would have been if the ear was open. The amount of increase can be up to 20 dB in the lower frequencies (Fegelson & Martin, 1998).

There is another phenomenon that masquerades as the occlusion effect. It is caused by the amplification of the hearing and is known as the ampclusion effect. A person hears the low frequencies in his or her voice much louder than other people's voices when the hearing aid is turned on and in the ear. The ampclusion effect can also cause an increase of 20dB in low frequencies like the occlusion effect (Painton, 1993; Sweetow et al., 2003). Both phenomena can occur alone or in combination causing discomfort of the hearing instrument user.

The occlusion effect has been clinically documented as far back as 1830's by the Weber test (Feldmann, 1997). However, many studies have not been completed considering the phenomena of the occlusion effect had been accepted for over a century ago. Clinicians frequently hear complaints such as "My voice sounds 'hollow', my voice sounds 'boomy,' my voice sounds 'loud,' and my voice sounds 'echoy' when I use my hearing aid." The increase in sound pressure level in the ear canal causes discomfort to the user (Biering-Sorensen, Pedersen & Parving, 1994). The discomfort of his/her own voice can lead to the hearing instrument user not using the device.

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the techniques used to alleviate occlusion and ampclusion effect. The secondary objective is to propose evidence-based practice recommendations regarding techniques to apply to hearing instruments to reduce occlusion and ampclusion effect increasing the comfort and acceptance of hearing instruments.

Methods

Search Strategy
Computerized databases, including CINAHL, PubMed, Medline and ComDis Dome, were searched using the following search strategy:

> ((occlusion effect) OR/AND (ampclusion effect)) AND ((hearing aid) OR (propagation delay) OR (venting))

The search had no limitations.

Selection Criteria
Studies selected for inclusion in this critical review paper were required to investigate the presence of the occlusion and ampclusion effect and effect of physical modifications or acoustical modification to the hearing instrument. No limits were set on the demographics of research participants, outcome measures or year of research.

Data Collection
Results of the literature search yielded the following types of articles congruent with the aforementioned selection criteria: one group pretest-posttest (6), and pretest-posttest design with control (1).

Research Design
There was a consistent methodology of pretest and posttest of the physical and acoustical modifications of the hearing instrument. There are several types of

modifications which were examined in the studies. The physical and acoustical modification made on hearing aids/earmoulds including the following:

- various venting sizes
- different hearing aid shell types (earmould verses ITC)
- modifying canal design (minimal contact theory* and tapering canal tip)
- different canal lengths
- different circuitry
- propagation times of hearing aid response

* Faceplate fits the canal and the hearing aid shell is tapered having minimal contact with the canal

Observed Electroacoustic Outcomes Methodologies: Kuk (1991), Mackenzie et al. (2004), Muller et al. (1996), Painton (1993), and Stuart et al. (1999) used electroacoustic outcome measures when evaluating either occlusion or ampclusion. The occlusion effects experiments used hearing aid shells with no electrical components; however the ampclusion effect experiments used functioning hearing aids. The pretest was measured on the occluded or unocclouded ear and the posttest was measured on the modified hearing aid or earmould in the ear. The measurements were obtained by two methods, either: (a) making real ear probe tube measurements while the subject vocalized /i/ (Kuk, 1991; Mackenzie et al., 2004; Mueller et al., 1996; Painton, 1993; Stuart et al., 1999) or (b) measuring speech recognition thresholds using a bone conduction transducer (Dempsey, 1990).

There are several advantages to using such electroacoustical measures. They are objective measurements that do not permit the clinician or participant to bias the result; therefore these results will be unbiased measures of ampclusion and occlusion. These objective measurements are also highly repeatable, and display direct evidence of the frequency and magnitude of earmolds/shell changes. However, the disadvantages of the electroacoustic approach include lack of information about subjective preference of the modifications.

Observed Perceptual Outcomes Methodologies: The Groth and Sondergaaurd (2004) study had subjects listen to random prorogation delays of different lengths (which may be relevant to ampclusion) and subjectively rate perceived sound quality of the participants' own voices (among other external stimuli) on a seven point disturbance scale. Obtaining subjective perceptual outcomes is advantageous because the correlation of subjective alleviation of ampclusion and/or occlusion and the necessary amount of decrease in decibels can be documented for clinical application.

Results

Across the studies examining the alleviation of the ampclusion and occlusion effects, both objective and subjective measurement tools are used. All studies showed promising and varying degrees of results depending on the individual.

Some experiments have a small sample size (Dempsey, 1999 n = 10; Groth and Sondergaard, 2004 n = 10; Kuk, 1991 n = 9; Mackenzie et al., 2004 n = 2004; Painton, 1993 n = 1; Stuart et al., 1999 n = 12) and used subjects with normal hearing (Dempsey, 1990; Mackenzie et al., 2004; Stuart et al., 1999) or did not report hearing status of subjects (Mueller et al., 1996; Painton, 1993). The studies demonstrate efficacy of the proposed physical and acoustically modified hearing aid/earmould. However, the results may not be generalizable to the clinical population.

The effects of signal processing on ampclusion

Processing Delay: Groth and Sondergaard (2004) used a pretest-posttest design with control design with appropriate experimental controls (blinded subjects, use of a control group) to examine the effect of processing delay on ampclusion using a perceptual outcome measure. Statistical analysis was appropriate. Findings indicated that the hearing impaired subjects results showed a significant increase in perceived ampclusion/poorer sound quality with a 10ms delay relative to a 4ms delay ($p<0.01$).

Noise Reduction/BILL: Painton (1993) chose not to perform a statistical analysis of their results. Rather, he showed raw change in electroacoustic measure of ampclusion across various hearing aid circuits in a repeated measures, within subjects design. Results revealed that a linear circuit intensified the ampclusion the most, averaging 6 to 19 dB. The ANP II (a noise-reduction hearing aid with a low frequency trim pot and a overall compression trim pot) proved to provide less ampclusion than the linear averaging 5 dB between 125 - 500 Hz and 6-10 dB between 500 -1000 Hz. The K-amp circuit demonstrated the least (2 dB) amount of ampclusion between 250 – 500 Hz and an average of 4 - 9 dB between 125 - 250 and 500 -1000 Hz.

The effects of shell/hearing aid modification on occlusion

Canal modifications: Mueller et al. (1996) also chose not to perform a statistical analysis of their results. Rather, they showed the average change in decibels and/or frequency response of their repeated measures, within subjects design to evaluate the effects of canal modifications on the occlusion effect using electroacoustic outcome measures. They examined the effect modifying the canal (Minimal Contact Technology (MCT) and tapering the canal tip) and the effect of the length of the canal. The results suggested that elongating the canal from 9 mm to 18 mm will reduce the effects of occlusion up to 8 dB (at 500 Hz) or as little as 2 dB (at 1000 Hz) depending on the individual. The MCT reduced the occlusion effect up to 6 dB (at 1000 Hz) or as little as 0.5 dB (at 250 Hz) when compared to a hearing aid which had the same canal length and did not use the MCT. As the length increased from 9 mm to 18 mm on a MCT hearing aid the occlusion effect decreased up to 8 dB (at 500 Hz). Tapering the canal tip revealed a decrease in the occlusion effect below 500 Hz by approximately 5 dB. The results indicated that increasing the canal length, using MCT and tapering the canal decreased the gain in the low frequencies.

Venting: Kuk (1991) did not perform a statistical analysis on the electroacoustical results; instead he showed the average decibel response. However Mackenzie et al. (2004) used ANOVA to determine if venting helped alleviate the occlusion effect. Stuart et al. (1999) used separate one-factor ANOVAs and Post hoc orthogonal signal–df comparison for repeated measures and a statistically significance was documented when increasing vent size a significant increase in the amount of low-frequency reduction.

All three studies (Kuk, 1991; Mackenzie et al., 2004; Stuart et al., 1999) used repeated measures, within subjects design to evaluate the effects of venting on the occlusion effect using electroacoustic outcome measures.

Kuk's (1991) results show that venting (2.2mm) can decrease the affects of occlusion by 17 dB at 250 Hz and 6 dB at 250 Hz. Mackenzie et al. (2004) revealed decreasing occlusion in steps of 1, 2, or 3 dB to 6 dB of gain between 200-470 Hz with a 2.0 mm. The experiment demonstrated with increasing vent diameter the gain also decreased. Stuart et al. (1999) study revealed when the vent size increased from 1 mm (-4.3 dB) to 2 mm on a in-the-ear hearing aid the gain decrease by 9 dB and, when the vent was further increased to 3mm the gain decreased another 5 dB. When examining a in-the-canal hearing aid the same changes occurred; 1mm (-2.4 dB) to 2 mm decreased the gain by 12 dB and when the vent was increased to 3 mm the gain decreased by other 4.7 dB. The venting size was examined on a completely-in-the-canal hearing aid however only a 1 mm vent and 2 mm could be physically made on this model. A 1 mm vent decreased the occlusion effect by 6.7 dB and the 2 mm vent decreased the occlusion effect by an additional 11 dB. As the vent size increased the vent cutoff frequency shifted higher. All studies (Kuk, 1991, Mackenzie et al. 2004; Stuart et al., 1999) demonstrate that as the vent increases the low frequency decreases and the most significant decrease occurs at a 2 mm vent size.

Shell size: Two studies (Dempsey, 1990; Stuart et al., 1999) used repeated measures, within subject design to evaluate the effects of shell size on occlusion effect. An experiment used (Dempsey, 1990) bone conduction speech recognition thresholds (SRT) with and without the hearing aid/earmould. However the hearing and earmould were not controlled for consistency. However, ANOVA and post hoc analysis were used to determine if there was a significant difference in the earmould with no vent and hearing aid shell with a vent. The results revealed a strong correlation with vent and occlusion effect. Stuart et al. (1999) used ANOVA and Post hoc orthogonal single-df comparisons to determine if the ITE and ITC hearing aid shell showed a significant difference.

Dempsey's (1990) mean bone conduction SRT revealed difference between occluded with an earmould was 5.4 dB and the difference between unoccluded and occlude with a vented custom hearing instrument was 8.6 dB. The results suggested a custom hearing instrument increased the occlusion effect. However Stuart et al.'s (1999) findings revealed all there shell styles (ITE, ITC and CIC) created similar amounts of gain when all other factors were kept constant.

None of the studies examining the occlusion effect evaluated whether such a reduction is sufficient to reduce or eliminate perceive annoyance caused by occlusion.

Conclusions

Research has demonstrated that several physical and acoustical modifications could be applied to a hearing aid to improve the affects of occlusion and ampclusion effect.

When examining the effects of circuitry (Painton, 1993) and propagation delay time (Groth and Sondergaard, 2004) on ampclusion the studies showed that the K-Amp circuit had the least amount of ampclusion and that up to 4 ms of propagation delay did not bother a hearing impaired listener. These factors should be considered by the manufacturers and also the clinician to increase the acoustic comfort for the hearing instrument user. However, Painton (1993) did not use hearing impaired participants nor did he gather data perceptual outcome data regarding the disturbance of ampclusion.

The studies which investigated the effects of venting, shell size, canal length and canal modification on the occlusion effect illustrated all the previously mentioned modifications will reduce the gain in the low frequencies to varying degrees. Increasing the vent size appears to decrease the most gain in the low frequencies compared to other modifications. The experiments investigating the affects of shell size on occlusion showed inconclusive evidence that one style reduced the affects of the occlusion more than another style. Elongating the canal and using the MCT appears to decrease the occlusion effect similarly. The clinician should be aware of these techniques/ modifications to reduce the occlusion effect.

A 2 - 3 mm vent helps to alleviate occlusion effect however it may induce feedback therefore the clinician should balance the application of venting against (a) known increased risk of feedback; (b) other modification options such as elongating the canal length or taper the canal tip to decrease the occlusion effect. The articles which have been reviewed have used electroacoustic measurement to quantify both ampclusion and occlusion. Such measures serve as accurate objective measures that can be applied clinical to evaluate treatments on an individual basis. The studies have demonstrated that up to 12 dB of gain could be reduced in the low frequencies with the modification of the hearing aid or earmould. However perceptual outcomes in this review were not measured on hearing impaired individuals. Therefore, studies have not demonstrated the amount of change in decibel is necessary for a hearing instrument user to feel comfortable with his/her device.

Clinicians frequently hear complaints from the patient regarding his/her own voice being uncomfortable and have hearing aids returned due to these discomforts therefore it is important for a clinician to know which modification are truly effective. The occlusion effect is a result of the physical hearing aid being situated in the ear therefore a shell modification is necessary to alleviate the acoustic discomfort. This critical review reveals venting reduces the affects of occlusion the most and canal length, modifying the canal also decreases the low frequency gain due to the hearing instrument in the ear. Ampclusion effect can be addressed by ensure the client does not have a linear circuit and the propagation delay is no greater than 4 ms to increase the acoustic comfort of the hearing instrument. When a patient is comfortable with the acoustics of a hearing instrument then he/she may be able it use the device more and reap more benefit.

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Critical Review: Does Occupational Noise Exposure during Pregnancy have an Adverse Effect on the Auditory System of the Developing Fetus?

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This critical review examined the effects noise exposure during pregnancy on the auditory system of the developing human fetus. Overall, research indicates that noise exposure during pregnancy may have an adverse effect on the auditory system of the fetus; however, the conditions used in the present research are not representative of conditions that would be encountered in daily life. Therefore, a concrete statement regarding the effect of occupational noise exposure on the auditory system of the fetus cannot be made at this time.

Introduction

Concerns have been raised regarding potential noise-induced hearing loss in the newborn resulting from occupational noise exposure during pregnancy.

It has long been thought that the fetus develops in a uterine environment without sound stimulation; however, this notion has now been replaced with the perception that the fetus develops in an environment rich in sound and noise. The fetal environment is composed of a variety of sounds, some of which are generated internally from the fetus, some are internal sounds from the mother associated with respiratory, cardiovascular, intestinal and laryngeal activity and physical movements and some are external sounds that penetrate into the uterus (Armitage et al. 1980, Walker et al. 1971). Sound pressure levels of sounds external to the fetal environment are very similar to that of sounds inside the uterus. (Vince et al. 1982, Gerhardt et al. 1990). Much of the research has suggested that the maternal tissues provide less attenuation to low frequency sounds and may even enhance such sounds (Armitage et al. 1980, Gerhardt et al. 1990, Richards et al. 1992).

Pregnant women working in industrial settings in which they are exposed to intense noise are able to protect their hearing; however the auditory system of the fetus cannot be protected. Stringent guidelines have been implemented to protect workers from excessive noise exposure, however, to date, little is known about the effects of noise exposure on the auditory system of the fetus and therefore, no guidelines have been proposed specifically for pregnant women.

Objectives

The primary objective of this paper was to critically evaluate existing literature regarding exposure to occupational noise during pregnancy and the resulting effects on the auditory system of the fetus. The secondary objective was to propose evidence-based recommendations for clinical purposes as well as future research purposes.

Methods

Search Strategy
Computerized databases, including MEDLINE-OVID, CINAHL and PubMed, were searched using the following search strategy:

> (pregnancy) AND ((neonate) OR (fetus) OR (foetus)) AND (noise exposure).

No limitations were applied to the searches.

Selection Criteria
Studies selected for inclusion in this critical review paper were required to investigate the effect of any type of noise exposure on the auditory system of the fetus. Studies using sheep as subjects were included for the following reasons: (1) the very limited research involving humans, and (2) the uterine environment of the fetal sheep is very similar to that of humans.

Data Collection
Results of the literature search yielded the following types of articles congruent with the aforementioned selection criteria: case-control (2), case study (1), cross-sectional (1).

Results

Animal Research

A study conducted by Gerhardt, Pierson, Huang, Abrams and Rarey (1999) was undertaken to evaluate the effects of intense noise exposures delivered to fetal sheep in utero during a time of rapid auditory development. Pregnant ewes, matched according to fetal gestational age were chosen as subjects. Several ewes were exposed to 120 dB SPL broadband noise for a period of 16 hours. Fetal Auditory Brainstem Responses (ABR) were obtained from both exposed and non-exposed pregnant ewes at specific fetal gestational ages. Results of the study revealed elevated fetal ABR thresholds 2 to 3 weeks after the noise exposure occurred.

Huang, Gerhardt, Abrams and Antonelli (1997), evaluated the effects of the spectral content of noise on ABR recordings from fetal sheep in utero. Twelve pregnant ewes (9 cases and 3 controls) carrying fetuses with gestational ages ranging from 119-128 days at time of surgical preparation were chosen as subjects. The noise exposure of 120 dB SPL was varied so that three ewes were first exposed to high-pass noise for 16 hours and then after a break of 48-72 hours, low-pass noise for 16 hours and six ewes were exposed the opposite way. ABR recordings to four stimuli were performed before, 10 minutes after exposure and 24-48 hours after exposure to assess recovery. Results indicated that following low-pass noise exposure, ABR thresholds and wave IV latencies increased significantly for 500 and 1000 Hz tone bursts. The high-pass noise exposure produced significant shifts in ABR thresholds and wave IV latencies for 1000 Hz tone bursts.

The impact of low-frequency impulse noise on ABR thresholds and latencies of fetal sheep in utero and those of unprotected adult sheep was investigated by Pierson, Gerhardt, Abrams, Griffiths and Peters (1994). Two ewes (one pregnant and one non-pregnant), were exposed to 10 impulses produced by blanks from a 105-mm howitzer. ABR recordings to four stimuli were obtained before, immediately after and 48 hours after the noise exposure. The fetus was sacrificed after the recovery ABR measurement, and the left cochlea was removed and prepared for histology.

Results from the post exposure and recovery ABR recordings revealed the eradication of the ABR in the non-pregnant adult ewe and only slight changes in the fetal ABR thresholds and latencies. Fetal post-exposure ABR thresholds were unchanged for click and 4000 Hz tone burst stimuli, however, a positive threshold shift was observed for 2000 Hz and 1000 Hz tone bursts. Fetal recovery ABR thresholds indicated positive threshold shifts ranging from 0 to 15 dB depending on the stimulus type. As well, fetal click-evoked ABR recordings at 70 dB showed shorter was II, III, and IV latencies in both post-exposure and recovery. Cytocochleograms prepared for the exposed fetus and an age-matched, non-exposed fetus both show minimal inner and outer hair cell loss, which is consistent with the limited changes seen in the ABR recordings.

Overall, these studies are generally strong, with the study by Gerhardt et al. (1999) increasing its strength by age matching and using independent observers to measure thresholds. The study performed by Pierson et al. (1994) was essentially weaker when compared to the latter two studies. Its weakness centers on the sample size chosen. The study only looked at one pregnant ewe and one non-pregnant ewe and compared pre-exposure ABR measurements to post-exposure ABR measurements within each subject. The results of the study found slight changes in the ABR of the fetus after noise exposure; however, no statistical analysis was performed to see whether the changes were significant.

Even though the abovementioned studies found fetal ABR changes after noise exposure, caution needs to be used when generalizing these results to the human population as the noise exposure levels and duration used in these studies is not at all representative of what would be seen in the workplace because Canadian and provincial labour laws restrict workplace noise exposures.

Retrospective Research

Very little research has been conducted looking at children born to mothers exposed to intense noise during pregnancy. The only study in English was performed by Lalande, Hetu and Lambert (1986). This study was undertaken to assess the possibility that the regulated daily noise exposure limit of 90 dBA-8h is not sufficiently stringent to protect the auditory system of the fetus, particularly in cases of low-frequency noise exposure.

The study took a cross-sectional form, looking at children aged 4-10 years, whose mothers had been exposed to industrial noise during pregnancy. Pure tone air conduction audiometry thresholds were obtained from each child and workplace noise levels were either measured using an integrating sound level meter or made available by employers.

The results of the study show that a noise exposure during the whole pregnancy to a daily dose of 85 to 95 dBA-8h increased the risk of having a child with a high-frequency hearing loss by a factor of three. As well, when the exposure included a strong low frequency component, the risk of having a hearing loss at 4000 Hz increased significantly.

Recommendations for Clinical Practice

The aforementioned animal research indicates that intense noise exposure during pregnancy does have the potential to adversely affect the auditory system of the fetus. It would be advisable for clinicians to inform women of child-bearing age of the possibility of fetal auditory system damage however, it must be stated that the test conditions are not representative of that which would be encountered in daily life, and therefore a concrete statement regarding specific effects and guidelines for pregnant women in the workplace should not be made at this time.

Recommendations for Further Research

Further research needs to be conducted to know whether workplace legislation needs to be implemented in order to protect the fetal auditory system. Such research endeavours, conducted with animal subjects, should employ realistic noise stimuli and exposure conditions to ensure that results can be applied to the human population. As well, future research projects should focus on currently pregnant women working in industrial jobsites where they are exposed to intense noise for lengthy periods and the following of their children.

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Critical Review:
The efficacy of pharyngeal flap and sphincter pharyngoplasty surgery on resonance in the treatment of velopharyngeal insufficiency

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This critical review examines the effects of pharyngeal flap and sphincter pharyngoplasty surgeries on resonance in the treatment of Velopharyngeal Insufficiency in children. Study designs include: critical review, randomized control trials, retrospective one group pre-test post-test designs, prospective longitudinal designs, as well as retrospective and prospective cohort designs. Overall, research suggests successful outcomes for resonance with the use of both pharyngeal flap and sphincter pharyngoplasty surgeries.

Introduction

Velopharyngeal Insufficiency (VPI) is defined as excess leakage of air through the nasal passage due to anatomical defects of the velum and/or posterior pharyngeal wall (Ysunza et al., 2001). This excess nasal leakage during oral sounds is termed hypernasality. Hypernasality can arise from a variety of etiologies, the most common being cleft palate (Ysunza et al., 2001).

Hypernasality resulting from true VPI is most commonly treated through surgical management (de Serres et al., 1999). Over the years pharyngeal flaps have been the primary surgical choice at most facilities, however, recent trends suggest that the use of sphincter pharyngoplasties are on the rise.

The first pharyngeal flap surgery was performed by Schoenborn in 1875, and since then has been modified several times resulting in superior and inferiorly based flaps, as well as "tailor-made" flaps (Sloan, 2000). During pharyngeal flap surgery, a flap is removed from the Posterior Pharyngeal Wall (PPW) (either superiorly or inferiorly depending on the method being used) and is attached to the soft palate. Many methods of attachment to the soft palate exist. The end result is a flap of tissue connecting the soft palate with the PPW, leaving two lateral ports, as opposed to one central port. It is anticipated that closure of the velopharyngeal port would be easier post-surgery as the two ports are smaller and would therefore require less PPW, soft palate, and lateral wall movement to close. This surgery is able to be tailored to the child's needs with regards to the width of the flap, so as to limit the impedance on respiration (Shprintzen & Bardach, 1995).

The second surgical method is sphincter pharyngoplasty. Although this surgery has existed since 1950 when first created by Hynes, it did not achieve credence in the literature until 1968, when Orticochea modified the procedure (Shprintzen & Bardach, 1995; Sloan, 2000). The Orticochea modification of the sphincter pharyngoplasty involves raising a short inferiorly based flap from the PPW. Bilateral posterior tonsilar pillar flaps are then raised and sutured to the PPW flap. The bed from the PPW flap, as well as the lower ends of the tonsilar flaps are all sutured, leaving one medial port smaller in diameter then the pre-surgical port. The objective is to decrease the port size therefore minimizing the amount of movement necessary from the soft palate, PPW and lateral pharyngeal walls, to achieve closure (Abyholm et al. 2005; Shprintzen & Bardach, 1995).

Controversy exists in the literature today as to which surgical procedure, and variations of that procedure, produce the best possible outcome. With facilities often choosing one surgical procedure to perform on all clients, it is essential to determine if both surgical procedures are successful and if in fact one has better success rates over the other.

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the efficacy of pharyngeal flap and sphincter pharyngoplasty surgeries on resonance. The secondary objective is to propose evidence-based practice recommendations for speech language pathologists and facilities treating VPI with regards to the most successful surgical techniques available.

Methods

Search Strategy
Computerized databases, including CINAHL, PubMed, and Web of Science, were searched using the following search strategy:

(cleft palate) OR (palatoplasty) OR (pharyngoplasty) OR (VP insufficiency) OR (VP inadequacy) OR (VP incompetence) OR (nasal*) OR (hypernasal) OR (resonance) OR (pharyngeal flap AND pharyngoplasty) OR (velopharyngeal dysfunction OR VP insufficiency OR VP inadequacy AND speech outcomes)

Selection Criteria

Studies selected for inclusion in this critical review paper were required to investigate success of either pharyngeal flap surgery, sphincter pharyngoplasty surgery, or both surgeries, with resonance as an outcome measure. Studies were limited to examining the surgical outcomes in children.

Data Collection

Results of the literature search produced eleven articles matching the above selection criteria. Two were prospective randomized block designs, six were retrospective single group pre-test post-test designs, one was a retro- and prospective cohort design, one was a prospective longitudinal design and the final study was a retrospective cohort study.

Results

Comparative Studies

Four articles were identified from the above search comparing pharyngeal flap surgery with sphincter pharyngoplasties. Of these, two studies were found to be methodologically sound, with only a few limitations (Abyholm et al., 2005; Ysunza et al., 2002). These studies were both randomized block designs, with random assignment to the two surgical treatment groups. Although Ysunza et al. (2002) used random assignment in their study, they chose to tailor the surgical procedure to each individual patient thus limiting the generalizability of their data. Both studies clearly stated and achieved their purposes. Each study used a power analysis to determine the required sample size. It should be noted that the study by Abyholm et al. (2005) did not meet the required sample size, thus limiting the generalizability and acceptability of their data. Kappa statistics to ensure concordance of rater reliability were used in both studies, however, Abyholm et al. (2005) utilized old data and failed to achieve acceptable concordance in some areas. Statistical analysis through the use of either a Mann-Whitney rank sum test, or a chi-squared test was used for each study. Not only were these tests appropriate, but sound statistical analysis was completed.

Ysunza et al. (2002) found that normal resonance was achieved in 88% of the pharyngeal flap subjects, and 84% of the sphincter pharyngoplasty subjects. No significant differences were found between the two procedures. Abyholm et al. (2005) found that at twelve months post-operative there were no significant differences between the two procedures. Normal resonance was achieved in 81% of the pharyngeal flaps subjects, compared with 76% of sphincter pharyngoplasty subjects. Three months post-operatively a statistically significant difference was noted with almost twice as many pharyngeal flap subjects achieving normal resonance over the sphincter pharyngoplasty subjects. However, these results were no longer significant at twelve months post-operative.

The final two studies comparing pharyngeal flap and sphincter pharyngoplasty surgeries were found to be methodologically weak (de Serres et al., 1999; Peat, Albery, Jones, & Pigott, 1994). Both were retrospective single group pre-test post-test designs. Some limitations of the retrospective designs used in the above studies are: the use of incomplete data, inability to control for confounds (e.g., standardization of surgical procedure), and the inability to randomly assign patients to particular treatment groups. Peat et al. (1994) failed to clearly identify and achieve the purpose of their study. Neither study calculated sample size rates through power analysis, nor controlled for inter-rater reliability. Although these studies used chi-square tests, or Mann-Whitney U tests, the data from the statistical analysis were not clearly reported. One study failed to control for missing data (de Serres et al., 1999). De Serres et al. (1999) also failed to report the resonance data separately in their results. Based on the lack of strong statistical data the results of these studies should be given less weight when determining recommendations.

Despite the flaws in these studies, no significant differences where found between the two treatment methods. Peat et al. (1994) reported “acceptable nasal resonance” in 63% of the pharyngeal flap subjects and 81% of the sphincter pharyngoplasty subjects. It is important to note that this definition included those subjects who had normal resonance, or mild hyper- or hyponasality. As mentioned above, de Serres et al (1999) failed to report nasality data separately, and thus included the data in the overall definition of resolution of VPI. Their results suggest that 22% of pharyngeal flap subjects and 50% of sphincter pharyngoplasty subjects achieved complete VPI resolution.

Pharyngeal Flap Studies

Four studies were identified which examined the efficacy of pharyngeal flaps on resonance, three of which were strong or had minor limitations, and one of which was weak. Canady, Cable, Karnell, and Karnell (2003) and Cable, Canady, Karnell, Karnell, and Mailick (2004) both carried out retrospective single group pre-test post-test designs. Cable et al. (2004) presented a clear identification of their purpose, whereas Canady et al. (2003) presented a much vaguer purpose. Despite the lack of power analysis in both studies, the strong statistical data made these studies methodologically sound. Both sets of authors used paired t-tests to analyze the data allowing for a more powerful statistical analysis. Canady et al. (2003) clearly separated their findings according to hypernasal and hyponasal results, which made the outcomes easy to understand. The results of this study were statistically significant for differences in the mean pre- and post-operative hypernasality scores. The major limitation of the Cable et al. (2004) study was that none of the pre-operative data were provided making it impossible to make pre and post-surgical comparisons.

Minor limitations were evident in the Meek, Coert, Hofer, Goorhuis-Brouwer, and Nicolai (2003) study. This study was also a retrospective single group pre-test post-test design, and had a clearly defined purpose. Power analysis and kappa statistics were not used in this study providing limitations in possible sample size and inter-rater reliability. This study also used paired t-tests strengthening the methodology. Unfortunately the final data were reported in bar graphs and were therefore difficult to read and interpret. Overall, the results should be interpreted with caution. Meek et al. (2003) found that hypernasality was absent or only slightly present in 96% of the subjects.

The final study by Morris, Bardach, Jones, Christiansen, and Gray (1995) was deemed weak due to flaws in the study design and statistical data. This study used a retro- and prospective design which was not clearly explained and therefore would be difficult to replicate. As well, the purpose was not clearly identified. Morris et al. (1995) did account for inter-rater reliability, which slightly strengthened the results. However, no statistical analysis was provided and therefore no data on statistical significance was given. Morris et al. (1995) found that 92.3% of the subjects achieved normal or near normal hypernasality post-operatively. However, due to the weak statistical data, the results should be interpreted with extreme caution.

Sphincter Pharyngoplasty Studies

Three studies examined the success of sphincter pharyngoplasty surgery on resonance. One study by Losken, Williams, Burstein, Malick, and Riski (2003) was considered to be methodologically and statistically stronger than the other two. This study was a retrospective single group pre-test post-test design. It used chi-square analysis, independent sample t-tests as well as multivariant analysis resulting in comprehensive statistical data. Unfortunately, the main focus of this study was on surgical revision, and thus the definition of success not only included improvement in perceptual speech (resonance) evaluation, but also defined success as foregoing the need for revision. They reported that 87% of the subjects achieved success.

The two other studies examining sphincter pharyngoplasties were deemed statistically and methodologically weak. One study was a retrospective single group pre-test post-test design (Sie et al., 1998), and the other study was a longitudinal prospective design (Riski, Ruff, Gerofiade, Barwick, & Edwards, 1992). Both studies failed to include power analysis, and Sie et al. (1998) had a small sample size reducing the generalizability and acceptability of the results. The purposes of both studies were clearly identified and achieved. Either Fisher's exact t-test or chi-squared tests were used appropriately. Riski et al. (1992) also used the Bonferroni correction slightly strengthening their results. Unfortunately, neither study reported the statistical significance of the changes in resonance.

Sie et al. (1998) reported normal resonance in 54% of their subjects post-operatively. However, as mentioned above data was reported via bar graphs and should therefore be interpreted with caution. Riski et al. (1992) reported improvements in resonance in 99% of subjects post-operatively.

Conclusions

Overall, the literature reviewed suggests that despite the surgical method used successful outcomes on resonance can be achieved. Specifically, the studies comparing pharyngeal flaps and sphincter pharyngoplasties suggest that no statistical differences exist between the outcomes of the two surgical procedures. The majority of the literature demonstrated that pharyngeal flaps and sphincter pharyngoplasties were successful in over half of all subjects tested. However, the commonly held view is that regardless of the surgical method chosen, each surgery should be tailored to the individual in order to achieve the best possible outcome.

The main flaw existing in the literature to date is a lack of a clear definition of success. Some studies consider post-operative hyponasality to be a successful outcome, whereas others would consider this to be a failure. It is suggested that a definition of success be created through discussion with patients, as they are the ones whom ultimately decide if their resulting resonance outcomes are successful. By using one clear definition of success accurate comparisons between surgical procedures can be made. Future research would also benefit from the use of prospective randomized block designs. This type of design would allow the researchers better control over confounds (e.g., standardization of surgical procedure) as well as random assignment to surgical groups. This would allow for results that are less susceptible to error and more generalizable to the population at large. Further research, such as that suggested above, can only help to further increase the success rates of surgery to improve resonance and velopharyngeal function.

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Critical Review:
Speech perception outcomes in children with cochlear implants compared to conventional hearing aids

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This critical review examines the differences in speech perception among children wearing a cochlear implant (CI) or conventional hearing aid. Study designs include: quasi-experimental, longitudinal and cross sectional. Overall, research shows that children with 90 dB HL or more wearing CI perform equal to or better than children with conventional hearing aids.

Introduction

Since the advent of universal infant hearing screening programs, earlier age at first identification of hearing loss has prompted earlier fitting of hearing aids and a growing trend of earlier age at implantation (Christiansen & Leigh, 2002). In Ontario alone, approximately 300 children are born with or acquire significant, permanent hearing impairment each year (Hyde, Freidberg, Price & Weber, 2004). Soon after identification, choices about habilitation are made. Although candidacy criteria for implantation exist, statements regarding the measurement of benefit are vague.

A child considered for a CI must minimally meet the following criteria: twelve months of age or older (although some clinics implant earlier), bilateral profound/severe to profound sensorineural hearing loss, no medical contraindications, spoken language as primary mode of communication, speech perception abilities that correspond to predicted aided potential, and little or no benefit from traditional amplification (London Health Sciences Centre: Cochlear Implant Program).

Measuring benefit among this population is challenging since reliable behavioural measures or subjective feedback is often difficult to obtain. Variables such as age at implantation/hearing aid fitting, configuration of loss, habilitative programs, mode of communication and quality of hearing aid fitting/cochlear implant will invariably have an effect on aided performance. Currently, amplification outcomes are assessed clinically in terms of speech perception, which is defined as the ability to identify and discriminate between the acoustic and phonetic features that comprise speech (Ferrand, pg. 253). Speech perception tests may comprise several different tasks which range from closed set word tests to open set word tests that require phoneme discrimination or pattern perception (Paatsch, Blamey, Sarant, Martin & Bow, 2004).

Decreased age at first identification coupled with a growing trend of implanting children with severe-profound hearing losses at less than twelve months of age calls into question current clinical protocols for determining candidacy. Given the high cost and permanency of implantation, a review of the current literature was conducted in order to assess how speech perception outcomes differ in children with CIs and conventional hearing aids.

Objectives

The primary objective of this paper is to critically evaluate existing evidence regarding the effects of implantation versus hearing aids on speech perception in children with hearing loss. The secondary objective is to propose evidence-based practice recommendations for the clinical assessment of CI candidacy.

Methods

Search Strategy
Computerized databases, including Medline OVID, PubMed, PsychINFO and ComDisDome, were searched using the following search strategy:

> ((hearing aid) AND (cochlear implant) OR (cochlear implantation) AND (speech perception) OR (speech reception) AND (prelingual) AND (child) AND (comparative study)).

To ensure that study participants were using the most recent amplification and CI technologies, the search was limited to articles written in English between 1997 and 2005.

Selection Criteria
Studies selected for inclusion in this critical review paper were required to compare measured speech perception outcomes in children with prelingual permanent hearing loss wearing CIs or hearing aids.

Data Collection
Results of the literature search yielded the following types of quasi-experimental studies congruent with the aforementioned selection criteria: longitudinal (2), one group pre-test, post-test (1), longitudinal and cross-sectional, non-equivalent groups (6).

Results

Support for conventional amplification
Miyamoto, Osberger, Robbins, Myers, Kessler, & Pope (1997) conducted a longitudinal study with 22 cochlear implant users (3M House n=11, Nucleus n=11) and 12 hearing aid users. Speech perception was measured among these children using a battery of tests that ranged from discrimination to recognition (Monosyllabic-Trochee-Spondee, Minimal Pairs Test and the Hoosier Auditory Visual Enhancement). Mean scores indicate that most children with pure tone thresholds in the 90-105 dB range and residual hearing throughout the frequency range derive more benefit from conventional amplification than CI. Although children were reportedly matched on age at onset, duration of deafness and device use, the hearing aid group had substantially more experience with their devices (5.7 years: 1.4years) than the CI group. This confounds the findings, as experience cannot be isolated as a contributing factor to the reported findings

In another study by Snik, Vermeulen, Brokx, Beijk and Van Den Broek (1997), a cross sectional speech perception measure was taken of children wearing conventional hearing aids (n=46) and compared (using an 'equivalent hearing loss concept') to the longitudinal scores of three cochlear implant users (only one of the three children had congenital deafness). Measurement tools included both closed and open set tests. Although the findings of this study show poor results with respect to CI users, the small sample size and discrepancy between age of implantation compared to hearing aid fitting (11 years to 4 years) weakens the generalizability of the results.

Once again, discrepancies with respect to length of experience with devices among the two groups weakens the findings of the study.

Support for cochlear implantation
Comparable and in some cases even better results with CIs than with conventional hearing aids lead researchers to support implantation in children with hearing losses of 78-80 dB HL or worse in two separate longitudinal studies which measured speech perception using both open-set and closed-set tests which include: Phonetically Balanced Words, Lexical Neighbourhood Test, and a Hearing In Noise Test for children (Eisenberg, Schaefer, Martinez, Sennaroglu & Osberger, 2000 & Eisenberg, Kirk, Martinez, Ying & Miyamoto, 2004). Similarly a longitudinal study by Blamey, Sarrant, Paatsch, Barry, Bow, Wales, Wright, Psarros, Rattigan & Tooher (2001), concluded that the average cochlear implant user with 106 dB HL performs like an average hearing aid user with 78 dB HL in their study which examined open set speech perception in 87 school aged children (47 with CI, 40 with hearing aid) over a three year period.

Experience with cochlear implant
In addition to improved performance with a CI, studies also report predicted improvements in speech perception with experience. The longitudinal and cross sectional studies conducted by Meyer, Svirsky, Kirk & Miyamoto on n=74 cochlear implant users and n=58 hearing aid users found that by one year of implant use, speech perception scores were higher for the CI users than those predicted for the children using hearing aids with 101-110 dB HL and approached the predicted scores for a group of children with 90-100 dB HL. Similar performance to the hearing aid users with 90-100 dB HL range by 12-18 months post-implantation was reported by Svirsky & Meyer (1999) in their longitudinal and cross-sectional study which compared a large group of cochlear implant users (n=222) to children wearing hearing aids (n=75). Performance comparable to hearing aid users in the 90-100 dB HL range was again reported in a subsequent study by Svirsky and Meyers (2000) which looked at speech perception scores measured by the Mr. Potato Head Test (a closed set test of word recognition) and the Phonetically Balanced Words speech perception tests on n=40 CI users and n=26 hearing aid users.

Additional support for the speech perception benefits of implantation is provided in the one group pre-test, post-test study by Dolan, Hodges, Butts & Balkany (2000), which compared speech perception scores with hearing aids pre implantation to post-operative CI scores. All thirteen borderline cochlear implant subjects included in this study received significant benefit from the CI compared to hearing aids.

Conclusions

It is evident that CIs cannot be equated to hearing aids because of the greater risk, time commitment and permanency of this surgical intervention option. The need to establish a strong probability for improvement is therefore emphasized. Although there were inconsistencies among the reviewed literature in terms of the measurement tools used to assess speech perception and the type of technologies compared, the majority of research has demonstrated that children in the 80-90 dB HL range and worse are likely to develop better auditory skills for speech perception with a CI than with a hearing aid. What is more, findings in the majority of studies confirm that the current procedure of using speech perception measures to assess candidacy (by measuring benefit from hearing aids) is a worthwhile means of prediction.

In addition to the overall benefit of CI in terms of speech perception, the reviewed literature also demonstrates experience with the device as a contributing factor to improvement in speech perception ability. This was not only supported by the studies with findings favourable to implantation, but also demonstrated in the two studies whose findings against implantation were mainly attributable to unequal experience between the CI and hearing aid groups. Technology is another factor that is apparent since more recent studies, with more advanced technologies, report findings that are more favourable to implantation. Although the search strategy attempted to control for level of technology by limiting studies to more recent ones, it cannot be ruled out as a contributing factor.

Recommendations

Although Audiologists may not be directly involved with implantation, it is important to remain knowledgeable about candidacy criteria as Audiologists are often the gatekeepers for referral to cochlear implant teams.

Future studies in this area of research conducted with larger sample sizes, control of length of experience with the device as well as the type of device and quality of fitting, and more controlled measures of speech perception (i.e., use of recorded stimuli rather than live voice), will serve to inform clinical practice guidelines as available technology continues to improve. Studies on children implanted at younger ages (<12months) are currently few and far between. The need for more investigation on this population is necessary to evaluate the outcomes of the current clinical trend for earlier implantation, which is essentially based on clinical experience and observed performance on older children and adults.

On a clinical level, revision of the definition of benefit and considerations of more children with residual hearing for cochlear implantation is warranted. The implementation of a standardized battery of testing for measuring benefit which includes speech perception measures that assess both closed and open set tasks will not only ensure accurate individual prediction, but will establish consistency across clinics.

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Critical Review:
Costs to workers' compensation systems for approved noise-induced hearing loss claims

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This critical review examines the costs incurred by workers' compensation boards for approved noise-induced hearing loss (NIHL) claims. The studies include cohort and cross-sectional designs. Overall, research shows that cost per claim generally increases over time while trends in number of claim submissions are inconsistent between the examined cohorts.

Introduction

Occupational noise-induced hearing loss (NIHL) is a highly preventable illness characterized by the causative relationship between noise exposure and hearing loss (Daniell, Swan, McDaniel, Stebbins, Seixas, & Morgan, 2002). Options for protecting workers against noise include engineering controls to reduce noise levels, reducing exposure time in noisy environments, and consistent use of personal hearing protection (Daniell et al., 2002). These components are adequately addressed in effective hearing conservation programs. Clinically, the degree of occupational hearing loss manifested in noise-exposed individuals can be quite variable, reflecting a number of factors. The hearing loss experienced is accompanied by tinnitus in the majority of cases (Daniell, Fulton-Kehoe, Smith-Weller, & Franklin, 1998).

Population-based methodologies have the advantage of being able to examine rates of hearing loss in industries, observe trends across occupations, and determine the effects of legislative interventions and the enforcement of regulations (McCall & Horowitz, 2004). Studies of this nature have generally remained industry-specific. Examination of broad worker populations are mainly conducted through government agencies and do not include much data beyond summary statistics (Daniell et al., 1998). Workers' compensation records provide an excellent data source for studying patterns of occupational hearing loss. They provide a relatively representative sample for the assessment of associated costs with occupational NIHL in a specified geographical area (Daniell et al., 1998). Costs can further be used to characterize trends in demographic, clinical or administrative variables pertaining to the incidence of hearing loss in noise-exposed individuals (Daniell et al., 2002).

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the costs to workers' compensation boards for approved hearing loss claims. The secondary objective is to identify trends in cost fluctuations that can be attributed to demographic, clinical or administrative variables.

Methods

Search Strategy

Computerized databases, including CINAHL, CommDisDome, PsychINFO, PubMed, and Web of Science were searched using the following search strategy:

> ((hearing loss) OR (noise-induced hearing loss) OR (occupational noise)) AND ((workers' compensation claims) OR (health care costs) OR (costs) OR (claim costs)).

Selection Criteria

Studies selected for inclusion in this appraisal were required to investigate an estimation of the monetary costs associated with submitted hearing loss claims to workers' compensation boards over a period of time. No limits were set on the demographics of research participants or outcome measures.

Data Collection

Results of the literature search yielded the following types of articles congruent with the aforementioned selection criteria: cohort study (4), cross-sectional design (1).

Results

Substantial Claim Cost Increases

Cohort studies examining average cost of accepted hearing loss claims to workers' compensation boards show that monetary costs are continually increasing.

Since the studies mainly observe fluctuations in costs over a specified period of time, researchers often speculate reasons for these noted changes. Several explanations account for the increase in compensation claim costs.

Daniell and colleagues (1998) attribute rising costs on the basis of the Hearing Conservation Amendment promulgated by AHSA in 1983, requiring employers to conduct baseline and annual audiometric assessment of employees exposed to excessive noise in the workplace. Contrary to an expected decrease in claim rates and costs, it is speculated that the observed increase is attributed to the number of hearing loss cases identified in newly implemented hearing conservation programs. A second policy influence on compensation costs occurred in 1986 when Washington state legislature increased the dollar value of work-related disability by 50%. A higher monetary value of compensable impairment may make it worthwhile for individuals to seek compensation, especially in those with only milder hearing losses (Daniell et al., 1998). Lastly, the adoption of a policy that allows individuals who suffer from work-related tinnitus as eligible for a percentage of compensation as determined by the degree of hearing loss. Disability settlements for the eight-year study period totaled $22,766,448 (Daniell et al., 1998).

Daniell and colleagues (2002) observed more than a twenty-fold increase in the annual summed cost for hearing loss compensation from 1984 to 1998. From 1992 to 1998 alone, the median disability settlement for a compensated claim was $7,180 and totaled $243,000,000 over seven years (Daniell et al., 2002). They observed that the amount of hearing impairment covered by disability compensation substantially over-estimates the amount of impairment attributed to noise solely encountered in the workplace. This is especially evident in older individuals who generally experience a high incidence of presbycusis (Daniell et al., 2002). Also, over-estimations in costs come from those with exposure to noise through recreational activities or noise outside the workplace for long periods of time.

McCall and Horowitz (2004) noted a doubling in average total cost per accepted hearing loss claim from 1984 to 1998. Over the 15-year study period, claim costs totaled $6,889,614 and averaged $5,054 per claim (McCall & Horowitz, 2004). The researchers attribute this to increases in benefit awards to those in Oregon state that were found to have workplace injuries resulting in permanent partial disability. An increase in expenses during the period of the study may be a reflection of an overall increase in associated with medical treatment.

Claim Rate Activity

The claim rates observed for each cohort have shown changes that vary both directly and inversely with escalating claim costs. Researchers have investigated reasons for claim rate increases at times when education regarding the preventability of hearing loss is occurring and conservation programs are rapidly emerging in workplaces.

Alleyne and colleagues (1989) noted that attitudes of employers may be to comply with the minimal regulation requirements. Since implementing controls for noise reduction as well as education and provision of hearing protection are costly to employers, financial resources allotted to this cause are likely insignificant.

Daniell and colleagues (2002) observed a striking increase in the number of claim submissions to the compensation system from 1984 to 1998. It is difficult for this study to establish causes for the increase. Authors indicate that claim submission activity may reflect an overall increase in disease incidence or changes in reporting to the compensation board over time. Further, it is noted that increased reporting was highest for older individuals beyond retirement age which may indicate that claim increases may have little to do with current work circumstances. Finally, when looking at industry-specific data pertaining to claim rates, increases were more pronounced for certain industries over others.

McCall and Horowitz (2004) noted a steady decrease in claim rate following the enactment of legislative safety reforms in 1987 and 1990. The large decline in hearing loss claim rate is believed to be attributed to the state's development of prevention programs and motivation for management to improve safety in the workplace (McCall & Horowitz, 2004). New legislation also required employers to show greater evidence that hearing loss is primarily due to occupational injuries. To ensure that the loss is compensable, workers may wait until the hearing loss is more severe before filing a claim. It is also suggested that after implementation of improved safety interventions, the actual impact this has on hearing is overestimated and individuals may delay seeking medical attention until the loss worsens.

Discussion

Study methodologies involved population-based samples of all identifiable workers' compensation claims accepted for noise-induced hearing loss. Quantitative analysis of the data obtained from workers' compensation systems for a particular state or province involve descriptive statistical summaries. Research has demonstrated that the cost per claim to workers' compensation systems increases as time progresses. A number of factors have contributed to this trend. Generally, these studies show that occupational hearing loss is in need of continued attention with respect to prevention in order to control costs. Although rising costs can be associated with legislative changes, medical expenses and increases in benefit awards, greater emphasis should be placed on developing further measures to establish safe working environments for employees (Daniell et al., 2002, McCall & Horowitz, 2004).

For purposes of examining cohort studies that consider costs of claims over time, corrections should be applied to account for changes in the market that occur during the period of study. Fluctuations seen in inflation rates, employment rates, economic growth of industries and technological advances will likely impact costs associated with hearing loss claims. Accounting for yearly changes in such factors would allow for a more accurate comparison of costs over an extended period of time.

Clinical implications for occupational hearing loss claims must be considered. Industrial audiologists are important in the planning and execution of conservation programs in workplaces (ASHA, 2005). Financial resources can be used effectively for consultation with industrial audiologists to determine necessary preventative action and noise control. Audiologists can also aid in the demonstration of cost savings to employers through appropriate methods of hearing loss prevention. Next, when delivering audiological services to those eligible for compensation, the audiologist should have a basic understanding of the costs incurred by workers' compensation systems. In general, audiologists will be providing services to those who suffer from an impairment caused by the work environment. McCall and Horowitz (2004) noted that noise exposure may be associated with job dissatisfaction. These employees may be more likely to exaggerate hearing loss and file false claims. Cases of malingering will likely be encountered and ultimately contribute to unnecessary rising compensation costs. Lastly, encouraging management and employees to improve safety in the workplace through prevention programs will likely contribute to a large decline in hearing loss claim rate (McCall & Horowitz, 2004).

Future directions for research pertaining to claim costs and rates should move beyond the analysis of descriptive summary statistics obtained by the workers' compensation system. Studies might focus on which interventions show the greatest impact in controlling claim costs and reducing the number of submitted claims, in reflection of a lower incidence of occupational hearing loss. The provision of tailored, industry-specific conservation programs will likely aid in assessing trends within industries and indicate which features work in favour of reducing occupational hearing loss rates over time. Finally, researchers may consider broadening studies that examine costs and claim rates for comparison with other compensation agencies. Determining the most cost-effective policies while prioritizing hearing health among individuals will aid compensation systems in making decisions for change.

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Critical Review:
Impact of Early Cochlear Implantation on Oral Language Development

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This critical review examines the effects of early cochlear implantation on oral language development outcomes. The research available provides limited information, but there is a general consensus that early cochlear implantation results in a more normal pattern of oral language development. So far, however, the research has not indicated a specific age of implantation for producing the most favourable results on oral language outcomes.

Introduction

The introduction of universal infant hearing screening programs has been integral in identifying infants with severe to profound hearing loss at an early age. This means that appropriate intervention can be determined much earlier than ever before. Cochlear implants (CI) have been on the rise as a method of intervention for almost 15 years (Manrique, Cervera-Paz, Huarte & Molina, 2004). Technology continues to evolve and has led to increased surgical success with CI. Children as young as 4-6 months have been implanted with CIs. Parents who choose this intervention do so because they wish to facilitate oral communication in their child.

We know that aural/oral language development cannot occur without sufficient auditory input. The first few years in a child's life are crucial for both receptive and expressive language development. So what is the outcome when a profoundly deaf child does not have sufficient auditory input in those critical years? Supporters of early cochlear implantation argue that the effects of deafness on language development in this period may be irreversible. Miyamoto, Houston, Kirk, Perdew and Svirsky (2003) state that children with profound hearing loss develop language at half the rate of normally hearing children. So, if these children are already at risk for disordered language development, why would a parent knowingly refuse an early cochlear implant?

There are various common concerns regarding cochlear implantation at a young age. The first of these being the surgical risk for such young children. Research has shown though, that it is safe to implant a child as young as 7 months with adequate anesthetic and postoperative support (James & Papsin, 2004). Other concerns include the effort required to confidently diagnose a child with profound sensorineural hearing loss (Manrique et al., 2004). More importantly though, Spencer (2004) states that there is evidence that the auditory system can effectively be organized if stimulation occurs before 3.5 years of age. If this is true, then the question needs to be raised: Why implant a child under the age of 3 years?

Objectives

The primary objective of this paper is to critically evaluate the available research regarding the impact of early cochlear implantation on oral language development. The secondary objective is to determine whether children implanted before the age of 3 years tend to have favourable oral language outcomes. Clinicians should be aware of the actual research findings to provide parents with reliable education on the subject.

Methods

Search Strategy
Computerized databases, including PubMed, PsycINFO and Medline-Ovid , were searched using the following search strategy:

> ((Cochlear implant) AND (language outcomes) OR (early) AND (cochlear implant) AND (language outcomes) OR (infant) AND (cochlear implant) OR (language development) OR (age) AND (cochlear implant) AND (language outcomes)

Five articles were reviewed, all of which were published between 2003 and 2005.

Selection Criteria
Studies selected for this review had to include at least one group of subjects implanted before the age of 3 years. They also had to investigate at least one aspect of oral language development, such as use of semantics, grammar, syntax, vocabulary, etc. Studies that focused on receptive language development were not included.

Data Collection

Results of the literature search yielded similar study designs: repeated measures, cohort studies and one single subject case comparison. The research either compared the subject (s) performance on the measures administered to normative data, or to subjects implanted at a later age. These are appropriate research designs for this research question. Randomized controlled trials would be unethical because withholding early implantation would be detrimental to the child's expressive and receptive language development.

Results

Svirsky, Teoh and Neuburger (2004) compared the outcomes for speech perception and language development in children implanted in the second, third and fourth year of life. They used a new method for assessing these outcomes called the Developmental Trajectory Analysis (DTA), and this showed that children implanted at 2 years had an advantage over the other children for oral language development. They used normative data as a standard to compare to the results of the subjects. Use of a control group or comparison group would have proven more effective in demonstrating how the patterns of development compared.

Spencer (2004) investigated the variations in language skills of children who received a cochlear implant before 3 years of age. She found that there was much variability in the language skills of her subjects. Overall, she found that children implanted earlier had better performance on syntax measures. She reported a slower rate of language progress with later ages of implantation. However, she did not find that children reached "normal" levels for expressive and receptive language skills. This study aimed to control for many confounding variables but failed to control for two very important confounds. Children with other disabilities were included, and they were not prelingual. This means that they had some access to auditory input and therefore had some oral language comprehension and production.

Manrique et al. (2004) aimed to determine what the differences were for children implanted before 2 years and children implanted between 2 and 6 years. Their research led them to conclude that the earlier an implant was performed, the better the child's language outcomes. In fact, they reported that vocabulary development followed a normal pattern in children implanted before 2 years. Children implanted later (2-6 years) showed a lag of approximately 2 years. On general oral expression tests, the younger children showed a lag of 1 year behind their normally hearing peers, while the older children reached almost a 3 year delay and progressed at a slower rate. This research, however, lacks important data, such as the mean, range and standard deviation in the scores of each group. There was also no mention of intervention received prior to or after the cochlear implant (such as parental involvement).

The research of Colletti, Carner, Miorelli, Guida, Colletti and Fiorino (2005) suggested that the age of implantation could be moved from 12 months to 4-6 months of age. They investigated the onset of babbling and babbling spurt in infants implanted under the age of 12 months. They found that the earlier the activation of the implant, the closer the results to normal hearing children. Minor flaws, however, included the lack of mention for control of confounding variables (such as residual hearing, and cognition). Also, follow up times for the children were various (between 12 and 24 months) and may not be long enough to determine the functional effects of the implant.

A comparison of one child implanted in infancy to children implanted at later ages was done by Miyamoto, et al. (2003). They found that the child implanted in infancy achieved levels of grammatical development at 2 years that the older children reached at 5 years. The young child was able to achieve age-equivalent scores for receptive and expressive language skills. A major limitation in this study was that the children in the older groups had been exposed to oral and total communication at an early age, while the younger child were not exposed to total communication and did not have early exposure to oral communication.

All of the researchers came to the same conclusion: children implanted under the age of 3 years have an advantage over children implanted later. That is, their oral language development occurs much more like that of normal children, and in some cases, it occurs much quicker than for later implanted children. However, as Spencer (2004) pointed out, they may never reach the level of completely normal language development.

Overall, there was a general lack of pertinent information provided in the literature. Measures of central tendency were often not provided. Few of the studies controlled for the confounding variables that existed in their research. No studies investigated the effects of hearing aids versus the effects of a cochlear implant. This would be useful to know in the future,

to determine the advantages of both types of intervention, and to provide parents with choices when appropriate. Finally, only one of the studies (by Spencer, 2004), specifically defined the aspect of language being investigated (e.g. semantics, syntax, vocabulary, etc.). When researching language, it is important to know exactly which part of language is under investigation.

Recommendations

To improve the research, the following recommendations have been made:

- *Prospective studies* to ensure that cochlear implant technology is equal across studies.
- *Longitudinal studies* that span from pre-implantation until the child reaches school to determine functional impact of the implant.
- *Summary of the data* made available in each study (mean, median, range, and standard deviation).
- *Comparison to hearing aid users* to determine whether one intervention provides an advantage to appropriate candidates.
- *Use of various* assessment tools to increase reliability. Many of these studies used the same measures to assess oral language, and variability would improve generalizability.
- *Better control of confounding variables* such as cognition, exposure to auditory stimuli, other disabilities, etc.

Conclusions

The current trend for cochlear implantation intervention in profoundly hearing impaired children presents with some limitations in the research, but is overall useful for parents and clinicians alike. Cochlear implantation is currently, and will continue to be, a popular choice for intervention because it provides the option of oral communication.

The research available on this topic overall is plagued by some minor methodological flaws. In the real world, however, researchers are limited by many variables including access to subjects, finances, time, etc. In order for the research to be improved, many of these variables would need to be adequate. The overall quality of the research available is acceptable, and provides some important information for parents and clinicians involved with hearing impaired children.

The general agreement in the research that cochlear implantation before the age of 3 years is beneficial to oral language development is confirmation for parents and clinicians alike; that this is a desirable procedure if the goal is oral communication.

Clinicians especially should approach the idea that early implantation equals better oral language outcomes with caution. Although the findings from the research are in agreement, the research also showed that individual differences do exist, and there is no way of pre-determining who will benefit from early implantation. Each case needs to be assessed and treated individually.

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Critical Review: The effectiveness of Lee Silverman Voice Treatment in patients with hypokinetic dysarthria

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This critical review examines the effectiveness of the Lee Silverman Voice Treatment (LSVT) on individuals with hypokinetic dysarthria. Studies employing group pretest-posttest with control subject designs were evaluated to determine the clinical effectiveness of LSVT. Overall research supports the clinical effectiveness of LSVT on increasing intensity in patients with hypokinetic dysarthria; however, effectiveness of the treatment is limited only to those speech tasks practiced in therapy while in a clinical setting.

Introduction

Hypokinetic dysarthria is a motor speech disorder associated with damage or disturbances to the basal ganglia. It can be caused by any process that can damage the basal ganglia control circuit including, but not limited to, metabolic diseases, vascular traumatic diseases and degenerative diseases (Duffy, 1995). Parkinson's disease (PD) is one such degenerative disease and is the most common cause of hypokinetic dysarthria. It is estimated that dysarthria occurs in half of all cases of Parkinson's disease and that PD accounts for 98% of cases of hypokinetic dysarthria seen in speech pathology practices. (Berry, 1983; as cited in Duffy, 1995).

Speech characteristics of individuals who have PD with hypokinetic dysarthria include monopitch, monoloudness, reduced stress, short rushes of speech, rapid rate, harsh or breathy voice quality, palilalia and reduced loudness level (Duffy, 1995). These characteristics may cause impairment in a person's ability to communicate and limit the person's ability to function in society (Ramig et. al, 2001). One treatment that is currently identified in the literature as increasing the intensity of speech in patients with hypokinetic dysarthria associated with Parkinson's disease is LSVT (Gage & Storey, 2004).

LSVT is a treatment program that focuses on increasing the amplitude of phonatory output as well as improving sensory perception of effort (Fox, Morrison, Ramig, & Sapir, 2002). LSVT is administered in an intensive treatment schedule. The individual undergoing this treatment receives 4 treatment sessions a week for 4 weeks. During treatment subjects practice producing maximum duration of a sustained vowel and producing a maximum fundamental frequency range. These tasks are thought to form the basis for producing a voice with maximum efficiency. After forming this base the subjects are taught to generalize their techniques into functional phrases (Ramig, 1998). Throughout all of these activities, the patient is trained to "feel the effort" and "think loud".

Due to the fact that there are few other treatment programs that focus on increasing intensity of voice in individuals with PD, and the negative impact a reduced loudness level can have on the quality of life of a individual with PD, it is important to investigate the LSVT and look at its effectiveness on increasing loudness. It is also essential to look at any potential weaknesses of the program, including generalizability.

Objectives

The objective of this paper is to critically evaluate existing literature pertaining to the effectiveness of the Lee Silverman Voice Treatment in increasing vocal intensity in subjects with hypokinetic dysarthria, secondary to Parkinson's disease. A second objective is to propose an evidence-based practice recommendation regarding LSVT for patients with hypokinetic dysarthria. Opportunities for future research will also be discussed.

Methods

Search Strategy
Computerized data bases were searched, including CINAHL, PubMed and Medline. Keywords used include:

> ((Parkinson's disease) OR (hypokinetic dysarthria)) AND (LSVT) AND (Intensity) OR (Loudness)).

The search was limited to articles written in English. One article was provided by Dr. Scott Adams of the University of Western Ontario.

Selection Criteria
The studies included in the critical appraisal were required to investigate the improvement in intensity of patients with hypokinetic dysarthria using LSVT. No restrictions were set on demographics of research participants or outcome measures.

Data Collection
Results of the literature search yielded 5 group pretest-posttest with control subject design studies.

Results

In their study, Sapir et al., (2002) hypothesized that LSVT would be more effective in increasing and maintaining increased loudness at one year post treatment, in patients with hypokinetic dysarthria than a control treatment. Tape recordings of the patients reading the "Rainbow Passage", pre- and post- treatment were perceptually presented to, and then rated by, 6 listeners. To analyze the data researchers used a chi-squared test which revealed a statistically significant increase in intensity in the LSVT group ($p<0.0001$), but not in the control group. This statistically significant increase was maintained at one year post treatment. Percent increase in loudness was reported in both groups. From the LSVT group 75% of subjectss were judged to be louder at 12 months post treatment, 21% were judged to be louder pre-treatment, and 4% were undecided. In the control group 39% of patients were judged to be louder at 12 months post treatment, 49% of patients were judged to be louder pre treatment, and 12% were undecided. These findings support the hypothesis of the authors.

Ramig, Horii and Bonitati (1991) also used perceptual measures to evaluate the effectiveness of LSVT in increasing intensity. Two groups of subjects, those receiving LSVT and those receiving a control therapy, along with their spouses, were invited to complete a perceptual rating scale before and after treatment. Two speech-language pathologists (SLPs) also completed the scale. Median percent improvement was used to identify if an increase in loudness was perceived from before treatment to after treatment. The median improvement as rated by 27 of the 40 subjects was 12% (range -41% to +47%), a statistically significant increase ($p<0.05$). The median improvement rated by 17 of the 40 spouses was 13%. This was not found to be statistically significant. The median improvement as rated individually by the two SLPs was 26.5% and 31.5%, both of which were statistically significant ($p<0.05$).

Ramig, Sapir, Fox, and Countryman (2001) used a three group comparison to evaluate the effectiveness of LSVT on increasing loudness from pre-treatment to immediately post treatment and 6 months post treatment. The three groups were: group 1- subjects with PD who received LSVT treatment; group 2- subjects with PD who received no treatment and group 3 – neurologically normal peers. They hypothesized that increases would be seen in intensity in group 1 following treatment, and that the other two groups would not display increases in intensity. If the effects seen with LSVT were seen in the untreated patients Ramig et. al hypothesized that increases in both groups with PD may be related to normal fluctuations within PD, and would not be treatment specific. If increases in intensity were seen in the neurologically normal control group, these results could be attributed to placebo effect. Researchers used the mean and standard deviations of the sound pressure level (SPL) measure for the three groups on different speech tasks to look at within group differences. Significance was only found from pre- to post- treatment for the PD group receiving treatment. A one-way analysis of variance comparing the mean SPL across the three groups and three times was also completed. Some measurements between the neurologically normal and untreated PD group were found to have no significant differences, which suggests similarities between the groups. Significant differences were found between the two subject groups with PD, showing that prior to treatment, the groups were not similar in all measures, as one would desire for the research. Overall the group receiving LSVT was found to have significant increases in intensity, while the two other groups displayed inconsistent increases in intensity for some of the measures.

The 1996 study by Ramig, Countryman, O'Brien, Hoehn and Thompson, and the follow up study by Ramig, Sapir, Countryman et. al (2001) looked at the short-term and long-term comparison of two forms of speech treatment, LSVT and a placebo, or respiration, treatment. Researchers were interested in determining if differences in intensity levels would occur between the two groups immediately after treatment, and at two years post treatment. Researchers reported p values after statistical analysis was done on the different speech tasks, and analysis of variances for main effects of time, and time by treatment interactions. Results showed that the LSVT group was found to have significantly higher

increases in SPL for three of four measures. The LVST group had an initial increase in intensity greater than that of the respiration group and at 2 years post treatment the LSVT group continued to have a higher vocal intensity than the respiration group.

Discussion

Appraisal of the Results

All of the studies reviewed in this critical appraisal indicate that LSVT is an effective treatment method to increase vocal intensity, measured either acoustically through sound pressure level, or perceptually through rating scales. At first glance it would appear that based on the conclusions of the authors LSVT is an effective and clinically acceptable therapy to use. However, numerous issues in regards to subject selection, methodology and performance on individual speech tasks exist in the literature. These issues negatively impact the strength of the evidence.

Subject Selection

The most prominent issue with regard to the subject selection that the researchers used in all of the studies is the lack of information on where subjects were recruited from. In some cases researchers imply that subjects volunteered for the study, but other information concerning the subject recruitment was missing. It is therefore unknown how the subjects became involved in these studies which may cause concern about the representativeness of the samples and generalizability of the results.

Methodology

It is necessary to be cautious when interpreting the results of each study. Methodological flaws exist within each study which may influence the evidence described. In one of the studies, (Ramig et al., 2001), information regarding how acoustic measures were gathered and analyzed was poorly described, making replication of the study impossible. The outcome measures in four of the five studies (Sapir et al., 2002; Ramig, Sapir, Countryman et al., 2001; Ramig et al., 1996 and Ramig et al., 2001) specifically the speech tasks that researchers used to signify significant increases in intensity, included only one measure of natural speech (a monologue). This measure did not increase significantly in these studies, whereas the three other measures, which were practiced throughout the therapy consistently increased.

There are also sources of bias that may have influenced the evidence described. Only two of the five studies (Sapir et al., 2002 and Ramig, Sapir, Countryman et al., 2001) state that blinding of raters/observers occurred. In the remaining articles it is either not stated whether this was completed, or it was stated that the researchers were directly involved. It is therefore possible that the researchers unconscious expectations could have influenced the differences displayed in the results. Patient attrition in long term studies (Ramig, Sapir, Countryman et al., 2001) was also not discussed and the effect of the loss of subjects was not taken into account in the results of the study.

A further concern that may have influenced the outcome of all of the papers is that Dr. Ramig was co-author/co-researcher on every paper. Many of the researchers on the papers also worked on more than one of the studies. As Dr. Ramig is the founder of the Lee Silverman Voice Treatment, is it possible that personal bias regarding her beliefs in the strength of LSVT may have influenced the outcome of the research.

Recommendations

Based on the critical analysis of the literature concerning the LSVT program, one is able to make statements regarding its effectiveness on increasing vocal intensity in individuals with hypokinetic dysarthria. The literature has shown that LSVT is an effective treatment to increase intensity, providing the participants are in controlled clinical setting and the speech material has been practiced during therapy. Several concerns regarding the research exist including; concerns about the recruitment of participants in all studies, difficulty in replication of studies, (Ramig et al., 2001), attrition of patients in long term studies (Ramig, Sapir, Countryman et al., 2001), lack of generalization and the fact that studies were conducted by a small group of researchers which included the founder of LSVT on each paper. It is therefore recommended that clinicians be cautious when deciding to implement LSVT in their clinical practice. LSVT is an intensive therapy that requires a large time commitment from the client, as well as a large financial commitment if this therapy is not covered through health insurance. Although LSVT was found to significantly increase intensity in limited speech tasks, these tasks were not functional for communication in an everyday setting.

It is also recommended that further research, including replication of previous studies, be conducted to investigate the efficacy of LSVT. Areas that require attention in future research studies include the following:

a) Explanation of recruitment and histories of participants of studies
b) Perceptual judgments following LSVT in a non-controlled (i.e. non-clinical) setting
c) Acoustic measures of participants following LSVT in a natural environment
d) Deviation from the intensive therapy schedule, including less therapy sessions per week, to evaluate if it is the intensive nature of the therapy that contributes to the statistically significant increases in loudness or if this is not a factor.

Conclusions

This literature review is of benefit to speech language pathologists intending to obtain a greater understanding of the effectiveness of the Lee Silverman Voice Therapy program for increasing intensity in individuals with hypokinetic dysarthria secondary to Parkinson's disease. It appears that, although LSVT has been shown to be effective in this area, this effectiveness is only in clinical settings with practiced speech tasks, and has not been shown to be generalizable to more naturalistic settings and conversational speech. With further research into this area, including research on the generalizability of LSVT and more rigorous control measures, speech language pathologists will be able to make more informed decisions regarding the efficacy of LSVT.

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Critical Review:
Efficacy of classroom intervention methods for children diagnosed with a permanent unilateral hearing loss.

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This critical review examines the efficacy of intervention methods for children diagnosed with a permanent unilateral hearing loss (PUHI). Study designs include: Longitudinal, case study, prospective within subjects, retrospective review of clinical cases and repeated measures within subjects. Overall, for children with a sensorineural PUHI the research indicates that an FM system enhances speech recognition in both background noise and quiet conditions within the classroom. However, this is provided that this amplification system is restricted to use in a classroom situation only and is not used in other listening situations. Further evidence states that a conventional hearing aid and CROS aid do not enhance speech recognition in noise for children with a PUHI. Given these limitations an FM system should be recommended for children with sensorineural PUHI in the classroom.

Introduction

For the purposes of this investigation permanent unilateral hearing impairment (PUHI) is defined as pure tone thresholds of 30 dB HL or greater at 500, 1000 and 2000 or 4000 Hz in one ear only, with the opposite ear being within normal limits for the same frequencies (Brookhouser, Worthington, Kelly, 1991). The American Speech Language and Hearing Association states that candidacy for amplification includes children 3 years of age or older, mild to moderately severe hearing loss in one ear and usable word recognition in the affected ear. PUHI presents as either sensorineural or conductive hearing impairment. The degree of PUHI varies among children from mild to profound and is dependent on etiology. Approximately, 16 to 19 out of every 1000 school aged children are diagnosed with a permanent unilateral hearing loss (McKay, Iyer, 2005). Therefore, it is important to determine an effective intervention method for managing children with permanent unilateral hearing loss.

It has been recognized that children diagnosed with a PUHI experience perceptual and educational difficulties (Bess 1986, Bovo 1988, Welsh 2004, Ruscetta 2005, Kenworthy 1990). These difficulties may be due to auditory deprivation caused by a PUHI (Scheffler 1998, Vasama 1995, 1997, Welsh 2004, Schmithorst 2005 & Ruscetta 2005). Children with a PUHI have difficulty understanding and recognizing speech in noisy environments and localizing a sound source, compared to those with normal hearing. These difficulties have been shown to lead to academic problems such as failing a grade or classroom behavioural problems (Bess, Tharpe 1988). In the past, the decision to treat a child with permanent unilateral hearing impairment has depended on whether the child is experiencing problems at school (Bess 1986, English 1986, Culbertson, 1986, Brookhouser 1991). Research suggests that this management strategy is not recommended and children with congenital permanent PUHI should be prescribed amplification as early as possible (Bess, Klee, Culbertson 1986). Existing research has yet to decide if a congenital PUHI has a negative impact on the development of communication skills. As a result, the decision to provide (re)habilitation/treatment to children diagnosed with a PUHI remains questionable. Several studies have examined the following management strategies for the treatment of children with a sensorineural PUHI: contralateral routing of signal aid (CROS), FM system only, and conventional hearing instrument (Bess 1986, Kentworthy,O., 1994, Kiese-Himmel, 2002**,** Updike 1994). A bone anchored hearing aid (BAHA) has recently been shown to be effective in treating children who present with a conductive PUHI (Priwin, Granstrom, 2005). However, research has not yet identified the most effective intervention method for improving speech recognition, speech understanding in noise, and sound localization for children diagnosed with a PUHI.

Objectives

The primary objective of this investigation is to critically evaluate the existing literature regarding the efficacy of intervention options available for children diagnosed with a PUHI. The secondary objective is to propose evidence-based recommendations about

the effectiveness of management strategies for this population.

Methods

Search Strategy
Computerized databases, including Medline, CINAHL, PubMed, Scopus were searched using the following strategy:

> ((exp Hearing Loss) AND (children) OR (Pediatrics) OR (infants) AND (unilateral.tw.) OR (single-sided deafness) OR (asymmetrical hearing loss) AND (bone anchored hearing aid) OR (BAHA) AND (hearing aid) OR (hearing instrument) OR (amplification) OR (intervention) OR (management) AND (Contralateral Routing of Signal) OR (CROS aid) AND (FM system) OR (auditory trainer) OR (assistive technology) OR (assistive device)).

The search was limited to articles written in English.

Selection Criteria
Studies selected for inclusion in this critical review paper were required to investigate or review the effectiveness of intervention methods for children with any type or degree of permanent unilateral hearing loss. No limits were placed on the type of intervention method or outcome measure.

Data Collection
Results of the literature search yielded the following types of articles congruent with the aforementioned selection criteria: Longitudinal (1), Retrospective Review of Clinical Cases (1), Prospective within subjects (1), Case Study (1), and Repeated Measures within Subjects(1).

Results

The literature included in this critical review was analyzed based on the reliability, validity and generalizability of the study results for use within a clinical setting. The efficacy of treatment methods for PUHI in children is measured on speech recognition ability, which evaluates its improvement in quiet and noise conditions. Subjective outcome measures are also used to evaluate benefit of the amplification method. Speech recognition ability was tested using the Glodman-Fristoe-Woodcock Test of Auditory Discrimination (GFWTAD), Nonsense syllable Test (NST) and the Bamford-Kowal-Bench Standard Sentence Lists (BKB) sentences. Improvement was measured using the Raffin and Thorton (1980) Model.

Contralateral Routing of Signal (CROS)
The research evaluating the effectiveness of the CROS aid for children with a PUHI consists of well controlled experimental design studies; however, the small sample size weakens the generalizability. The CROS aid is a hearing instrument with an active microphone on the unaidable (poor) ear, which transmits a signal to a receiver on the aidable (good) ear. The microphone on the aidable ear has an open mold with the microphone turned off. Updike (1994) evaluated the effectiveness of the CROS aid against an FM system, and conventional hearing instrument on the word recognition ability of children with PUHI of varying degrees (n=6). Aided and unaided word recognition ability was assessed under simulated conditions of speech in quiet and in noise. The conventional hearing aid was fit on the poorer ear, the CROS aid was fit appropriately and the FM system was aided bilaterally. Results of the GFWTAD showed that speech recognition scores were poor when the child used a hearing aid or CROS especially if they presented with a moderate hearing loss. The CROS aid on its own was most beneficial in noise if the child presented with a mild hearing loss only. These devices seemed to make the listening more difficult in the classroom, especially if noisy.

Kentworthy, Klee and Tharpe (1990) also observed that many children with a PUHI do not benefit from the use of CROS amplification with preferential seating. This study compared preferential seating with no amplification, a CROS aid and a personal FM system. The speech recognition ability of children (N=6) with varying degrees of unilateral sensorineural hearing loss was evaluated. Each treatment was tested under three listening conditions encountered in a classroom [monaural direct (MD), monaural indirect (MI) and centre/omnidirectional]. The results of the NST and the BKB sentence tests showed that the CROS aid enhanced speech recognition and understanding in the MI condition (good ear to noise, bad ear to signal), but degraded speech recognition in the MD (bad ear to noise, good ear to signal) condition. A limitation of this study is the small range of hearing losses and the non-classroom setting. Overall, moderate level of evidence is provided that CROS technology improves speech recognition in noise if the child has a mild unilateral hearing loss. Primarily, if the target talker is on the child's impaired side. Therefore, general recommendation for use of the CROS may be

warranted but the specific listening conditions should be explained to the users of this technology.

FM System

Updike (1994) in a study compared the effectiveness of a FM auditory trainer, a CROS aid, and personal amplification for PUHI children in the classroom. The FM system showed significant improvement in word recognition scores, especially in noise. The greater the degree of impairment showed a greater benefit in noise. A moderate hearing impairment showed the least benefit in noisy conditions.

In a study mentioned previously, Kentworthy (1990) also showed that five of six scores on speech recognition tests improved significantly with an FM system for all three listening conditions weighted equally. However, the child with moderate impairment did not show significant improvement with the FM system. Analysis of the results indicated that children performed significantly better with the FM system and even in unaided conditions than with the CROS aid in the MD (bad ear to noise, good ear to signal) condition. The FM system was the only recommendation that did not produce a marked reduction in speech recognition in at least one listening environment.

Heinz (2005) evaluated the performance of a Phonak FM Edulink system (in their good ear) used with a hearing aid (in the poorer ear) in the classroom. This case was an eight year old girl with mild to moderate hearing loss in her right ear and a mild hearing loss in her left ear. Although, this study showed a significant improvement in speech recognition scores while wearing a hearing instrument (poor ear) and a FM system (good ear) the results should be considered with caution. Due to the single subject case study design and that the FM system and hearing aid were not tested independently, it is not known which amplification system provided an advantage. The results of this study suggest that both ears have to be taken into account to overcome the limitations imposed by lack of binaural summation and the head shadow effect. Therefore, the suggested aim of fitting should be the equalization of both ears.

A reasonable amount of evidence is provided to support that FM systems improve speech recognition in a simulated classroom environment. This improvement is evident as the degree of hearing impairment worsens. However, children's speech recognition performance seems to decrease for children with moderate hearing loss.

Conventional Hearing Instrument

Updike (1994) found that neither a conventional hearing aid nor a CROS aid provided enhanced speech recognition in quiet or noise for children with more than a mild hearing loss.

Kiese-Himmel (2002) evaluated whether a child with a PUHI wearing a hearing instrument on their poorer ear would show delays in non-verbal intelligence, onset of spoken language, size of vocabulary and selected tasks of verbal cognitive performance. The cases presented with varying degrees and types of hearing impairment. All children were fit unilaterally with an analogue linear behind the ear hearing aid.

This study showed that traditional amplification may only be successful with PUHI children if the hearing sensitivity difference between 2 ears is not large. Several children with severe to profound PUHI did not seem to benefit from their hearing aid. However, the parent interview revealed almost 81% of the children accepted their hearing aid. Unfortunately, these results may be subject to recall bias.

The authors concluded that children with PUHI may be at risk for delay in language development, but negative consequences for later vocabulary size are not definite. The interpretation of these results should be treated with caution as the subjective outcome measure may involve bias to recall the information due to a retrospective interview. In addition, the age norms of the standardized language and cognitive verbal tests were only provided for children over the age of four. A moderate to weak amount of evidence shows that children may benefit from a hearing instrument fit on their poor ear if the degree of difference between their ears is not significant. Furthermore, hearing aids alone may only provide benefit for speech recognition in noise for children with a mild hearing loss in one ear.

Bone anchored hearing aid (BAHA)

The output of the bone anchored hearing aid causes a mechanical vibration and transmits through the skull via a titanium screw embedded in the mastoid. The screw osteointegrates (bonds) to the bone. This titanium screw is anchored during minor surgery. The hearing aid portion (the vibrator) is attached to a plastic bayonet and is inserted into a titanium abutment that passes through the skin and is connected to the outer end of the titanium screw (Stenfelt 2005). Candidacy of a BAHA for children with a conductive PUHI is based on some type of malformation of the ear e.g. microtia (Priwin, Granstor, 2005). This type of amplification device was chosen for critical review, as the majority of the

research on conductive PUHI is focused on this type of ear symptom.

Priwin, et al. (2005) reviewed surgical techniques, problems seen in children with bone-anchored hearing aids (BAHA), and children's attitudes toward BAHA (N=41). The number of children implanted with a BAHA device is rare as it is still a new procedure in this population. All of the subjects presented with a conductive loss and good cochlear function. Only 3 had a unilateral hearing loss. The data was derived from surgical records and a retrospective survey. A follow-up questionnaire evaluated the children's opinion and usage of BAHA. The subjective effectiveness of BAHA was compared to a conventional bone conduction hearing aid on variables such as: teacher in noise vs. quiet, and in other situations.

Overall, the children seemed content with the BAHA. The most common response was that the BAHA seemed to work better in quiet surroundings than in noisy surrounding. 12 out of 41 patients or their parents believed their language improved. The rest of the sample believed hearing ability did not change. The final results of this study concluded that BAHA has the same function pattern, frequency of implant failures and skin reactions in children as in adults. BAHA may be an appropriate intervention method for children with unilateral maximal conductive loss. However, as only 3 out of the 41 subjects were diagnosed with a PUHI, these results cannot be generalized to children with other unilateral hearing losses.

Conclusions

Research evidence supports that a unilateral hearing loss negatively effects speech recognition in both noise and quiet listening situations (Bess 1986, Kentworthy, 1994, Kiese-Himmel 2002**,** Priwin, 2005, Updike, 1994). As mentioned above, the effectiveness of intervention methods for children with PUHI depends on their ability to improve speech recognition in quiet and noise and sound localization in everyday listening situations. These intervention methods may be detrimental to a child's speech and language development and academic performance (Bess 1986, Bovo 1988, Kenworthy 1990, Oyler, Oyler, Matkin, 1988, Updike, 1994). However, not all PUHI are managed in the same way. Intervention methods for sensorineural hearing loss involve FM system, conventional hearing aids and the CROS aid. A critical review of the literature suggests that an FM system may be the most effective intervention method to enhance speech recognition for children with sensorineural PUHI in either noise or quiet listening environments. Furthermore, a greater degree of impairment showed a greater benefit of speech recognition in noise, regardless of seating position in the classroom. However, moderate impairment derived the least benefit. (Kentworthy 1990, Heinz 2005, Updike 1994**).** A reasonable amount of evidence showed that the CROS aid provided benefit for speech recognition in noise under specific conditions. If the child presented with a mild hearing loss and was seated with his/her impaired ear towards the target talker the CROS aid was efficacious (Kentworthy 1990, Updike 1994). In general, the majority of studies showed that for a moderate hearing loss all of the devices derived the least benefit for speech recognition in noise for all seating positions. Children with conductive PUHI derived the most benefit for speech recognition and head shadow found with the bone anchored hearing aid (BAHA). It is also important to note that the majority of the studies tested speech recognition ability in noise under simulated classroom conditions; therefore, real life improvement has not necessarily been evaluated (Heinz 2005, Kentworthy 1994, Kiese-Himmel 2002**,** Updike, 1994).

Recommendations for clinical practice

The most effective intervention method can not be defined at this time due to lack of evidence based research in this area. However, several recommendations may be derived from the literature regarding the management of children with sensorineural UHI in the classroom. First, an FM system should be used in conjunction with preferential seating to enhance speech recognition in noise regardless of the degree of impairment (Kentworthy et al., 1990, Kiese-Himmel 2002, Updike 1994). FM systems should be considered as an effective intervention method for children with moderate to severe PUHI in the classroom (Updike 1994, Kentworthy et al., 1990). Second, a wireless CROS aid or conventional hearing aid fit on the bad ear used in conjunction with an FM system may be effective at improving the signal to noise ratio however further research is required. The conventional hearing aid worn on the poor ear degraded speech recognition in background noise and in quiet (Kentworthy et al., 1990, Kiese-Himmel 2002, Updike 1994). However, benefit was shown if the hearing loss was mild and the difference between the 2 ears was not significant (Keise-Himmel 2002, Heinz 2005). Therefore, avoidance of the use of a hearing aid on its own in the classroom may be warranted. The CROS aid was found to enhance speech recognition in noise when the target talker is

on the child's impaired side. However, all other conditions seemed to degrade listening in noise (Kentworthy et al., 1990). Therefore, a general recommendation for use of the CROS may be warranted but the specific listening condition should be explained to the user of this device.

BAHA devices may be recommended for to school-aged children with a conductive PUHI. One study found an overall benefit of BAHA on improving localization, headshadow, and speech recognition scores (Priwin et al. 2005). As this is a new procedure, further objective research is required to investigate the long term effects of this device for this particular population.

Hearing healthcare should be included in the treatment plan for children with PUHI of either type. The child hears normally from only one ear so, preventing damage or infection to the good ear is crucial. Close monitoring of hearing loss in the better ear is also important to make sure no further progression of impairment occurs in the good ear. Routine monitoring of every six months or more is also recommended. In addition, counselling families and the school on the impact and management of PUHI is important. The school may be encouraged to provide preferential seating, instruction on communication strategies and control of listening environment as well as assistive listening devices.

Recommendations for further research

The evidence base regarding the prevalence, progression, impact and the effectiveness of intervention for PUHI in children is extremely limited. The majority of the evidence is anecdotal and refers to school-aged children in the classroom. Furthermore, as the majority of the studies tested speech recognition ability in noise under simulated classroom conditions (Heinz 2005, Kentworthy 1994, Kiese-Himmel 2002**,** Updike, 1994) as a result, further research is required to study the real life effectiveness of these intervention methods in the classroom.

Therefore, there is currently little basis to identify the most effective intervention method for PUHI and all recommendations are discretionary; therefore, the following recommendations for further research are: additional research is required to investigate the effects of PUHI on infant development. To date, no definitive protocol exists for the appropriate intervention strategy, and habilitation for infants diagnosed with PUHI. Secondly, further research is needed on the effective management of PUHI and its consequence on infant speech and language development overtime. Finally, research evaluating the effectiveness rather than the efficacy of intervention methods for infants and children presenting a conductive PUHI should be performed. This option may also provide a viable temporary solution for cases presenting with a conductive overlay in the better ear.

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Critical Review:
The effectiveness of pulse oximetry in detecting aspiration.

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This critical review examines the effectiveness of pulse oximetry in detecting aspiration. Studies using non-random prospective designs were analyzed to determine the clinical effectiveness of using pulse oximetry in the assessment of aspiration. Overall, the literature does not support using pulse oximetry alone in the detection of apsiration.

Introduction

In an acute care hospital setting, speech-language pathologists (SLPs) are often called to evaluate a patient's swallowing function. This evaluation typically involves a clinical bedside examination followed (if necessary) by a videofluoroscopy of swallowing (VFSS). Clinical bedside evaluations alone have been shown to provide questionable results in the identification of aspiration (Sherman, Nisenboum, Byschelle, Jesberger, Morrow, & Jesberger, 1999). Overt signs of aspiration may be easily identified; however, silent aspiration often goes undetected during a standard bedside examination. Between 20-40% of patients identified as having normal bedside swallows have been shown to aspirate upon VFSS evaluation (Sherman et al., 1999). A VFSS is regarded as the most reliable and effective assessment tool in detecting aspiration. Its limitations, however, are clearly acknowledged. Performing a VFSS on every patient presents impracticalities in that it requires time for a patient to receive a booking, exposes patients to radiation, requires access to the technology, and is not suitable for routine clinical assessment and re-assessment.

Pulse oximetry has recently been studied in the literature with attempts to provide a non-invasive and objective tool that can be used in the assessment of aspiration. Pulse oximetry is a tool that provides an accurate measure of a patient's arterial oxygen saturation level (SpO2). SpO2 values are reported to drop when material is aspirated, resulting from a reflex bronchospasm which leads to ventilation-perfusion mismatch, and thus, oxygen desaturation (Wang, Chang, Chen, & Hsiao, 2005). Normal oxygen saturation values range from approximately 97-99%, and a significant drop in SpO2 is generally accepted to be 3-4% when both natural fluctuations and instrument error are considered (Wang et al., 2005, Sellars, Dunnet, & Carter, 1998). Therefore, in theory, it is believed that pulse oximetry can be used to detect significant drops in SpO2, indicating that a patient has aspirated, in order to improve the accuracy of swallowing assessments performed at the bedside. Several benefits will ensue if pulse oximetry is adopted as an effective tool in detecting aspiration at the bedside. Wait times for VFSS will decrease, patients will be less likely to remain unnecessarily on modified diets, reassessments will occur more often allowing diet modifications to be made accordingly, fewer patients will be referred for VFSS without cause, and bedside clinical examinations will become more objective in nature.

Objectives

The objective of this review is to critically examine the literature to determine the effectiveness of using pulse oximetry in detecting aspiration. Recommendations regarding the use of pulse oximetry in the assessment of aspiration will be provided based on the literature reviewed.

Methods

Search Strategy

Computerized databases, including CINAHL, Medline, and PubMed were searched using the following search strategy:

> ((aspiration OR aspirat*) AND (pulse oximet*) OR (oxygen desaturation) OR (oxygen saturation))

The search was limited to articles that compared the pulse oximetry to results obtained through VFSS.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to examine the effectiveness or reliability of using pulse oximetry in the detection of aspiration in comparison to the results obtained with VFSS.

Data Collection
Results of the literature search yielded five non-random prospective design studies.

Results

Sherman et al. (1999) describe a prospective within subject design completed with 46 subjects with possible dysphagia in which pulse oximetry was compared with videofluoroscopy in the detection of aspiration. The study demonstrated a significant association between oxygen desaturation and VFSS outcomes ($p<0.002$). Comparisons showed that patients who aspirated had a significantly greater declince in SpO2 ($p<0.05$) than did patients who either penetrated and subsequently cleared the material, or did not penetrate at all. Patients who penetrated and did not subsequently clear the material had a significantly greater decline in SpO2 than did patients who did not penetrate. Overall, Sherman et al. reported that bedside pulse oximetry may be a useful tool in the evaluation of aspiration.

Sellars et al. (1998) describe a prospective group comparison design completed with 6 subjects with known dysphagia and a comparison group of 5 normal subjects. Pulse oximetry results were compared with videofluoroscopy in the assessment of aspiration for the patient group, and pulse oximetry was used alone in the control group. The authors report that following feeding, there is a small but significant drop in SpO2 levels in the patient groups compared to the controls when the minimum SpO2 following each procedure is recorded ($p<0.05$). The authors reported some support to findings that respiratory status in dysphasic individuals may be altered at times during oral feedings; however, no firm conclusion can be drawn at this stage in research concerning the role of aspiration in inducing changes in SpO2. They stress caution in using pulse oximetry as an assessment tool with any degree of reliability.

Higo, Tayama, and Watanabe (2003) describe a prospective group comparison design completed with 141 subjects with symptoms of dysphagia and a control group consisting of 63 subjects in which pulse oximetry was compared with videofluoroscopy in the assessment of aspiration. SpO2 was measured using pulse oximetry and the results were analyzed using the Mann-Whitney U-test. The study demonstrated that when a 2% drop in SpO2 was considered significant, SpO2 decline sensitivity and specificity were 84.6% and 82.5% respectively. These values drop even more when a higher significant cutoff is applied (3% or 4% - reported to be internationally accepted as significant). The authors reported that aspiration cannot be predicted or detected accurately by oxygen desaturation data obtained from pulse oximetry measurements. Many more factors such as breath holding, coughing, and posture change were reported to be possible contributors to the decline in oxygen desaturation.

Collins and Bakheit (1997) describe a prospective within subject design completed with 54 subjects with possible dysphagia in which pulse oximetry was compared with videofluoroscopy in the assessment of aspiration. Reliability of SpO2 in identifying aspiration was analyzed using kappa statistics. The authors reported the correlation of pulse oximetry results with VFSS showed that 55% of patients who aspirated had a significant degree of oxygen desaturation at the point of the swallow/aspiration. The agreement between VFSS and pulse oximetry increased when results at the time of the swallow and results two minutes after the swallow were combined (73%). In total, it was reported that 81.5% of patients were accurately predicted to aspirate with pulse oximetry. The authors conclude that pulse oximetry reliably detects aspiration in most patients with dysphagia; however, that these results should be interpreted with caution.

Wang et al. (2005) describe a prospective within subject design completed with 60 subjects with possible dysphagia in which pulse oximetry was compared with videofluoroscopy in the assessment of aspiration. The authors reported no significant findings between SpO2 decline on pulse oximetry and aspiration on VFSS in the present study ($p = .87$) and suggested that further study be completed in the area before sufficient stock can be placed in the science.

Discussion

Subject Selection
Exclusion criteria were included in three of the five studies (Collins & Bakheit, 1997, Sherman et al., 1999, Wang et al., 2005); however, exclusion criteria in two of these studies did not succeed in excluding patients who potentially skewed results (Collins & Bakheit, 1997, Sherman et al., 1999). For example, Collins and Bakheit (1997) included 1 individual who smoked and 13 subjects with chronic obstructive airway disease, making their conclusions supporting the use of pulse oximetry less reliable. Appropriate exclusion criteria should have included co-morbid diseases that alter SpO2 levels without the occurrence of aspiration (e.g. chronic obstructive airway disease, peripheral vascular disease, etc.). Accurate

interpretation of study results is difficult without such criteria in place.

Methodology

Interpretation of each study should be done with caution as methodological weaknesses can be found in each of the studies. One methodological flaw that could have lead to researcher bias during the analysis of the pulse oximetry readings as well as the VFSS results is a lack of appropriate researcher blinding. In the studies reviewed, one researcher analyzed the results taken via pulse oximetry while another researcher (or radiologist) analyzed the results of the VFSS. Two of the five studies used single blinding resulting in the opportunity for researcher bias in that one of the researchers was not blinded to the results of the other assessment tool while analyzing the one at hand (Collins and Bakheit, 1997, Sherman et al. 1999). Two of the studies made no mention of any use of blinding, rendering the results of the studies less valid. These studies also evaluated and compared control groups to the patient group providing another reason for the implementation of blinding to control for researcher bias (Sellars et al. 1998, Higo et al. 2003). Only one of the studies used double blinding, thus controlling for researcher bias (Wang et al., 2005).

Another common concern among the studies reviewed includes a lack of information regarding the timing of aspiration as seen on VFSS and the amount of time before decreases were noted via pulse oximetry. Each study monitored SpO2 values for different lengths of time following the swallow which leads one to question whether the timing of pulse oximetry monitoring is a factor when detecting aspiration. Information is lacking concerning when SpO2 values can be expected to drop in comparison to when the aspiration actually occurs. This flaw in the methodology creates less reliable results and provides challenges in making comparisons between studies.

Recommendations

It is recommended that pulse oximetry not be used alone in the detection of aspiration during a swallowing assessment at this time. Two of the five studies accept pulse oximetry as an effective tool in detecting aspiration; however, these results should be considered with caution due to methodological flaws (Collins and Bakheit, 1997, Sherman et al. 1999). Although the other three studies demonstrate methodological weaknesses, their conclusions that pulse oximetry not be used in the detection of aspiration at this time is supported in this critical review (Higo et al, 2003, Sellars et al, 1998, Wang et al. 2005).

Further study with regards to the timing of aspiration and the interpretation of pulse oximetry is necessary before the reliability/effectiveness of pulse oximetry can be conclusively evaluated. Once clear timing guidelines are in place, the use of pulse oximetry during clinical examinations will become more effective.

It is also recommended that should pulse oximetry be used in the clinical setting, that it be used with great caution. Thorough patient history should be explored in order to rule out the existence of other co-morbid diseases that could affect SpO2 levels and thus pulse oximetry results.

Conclusions

Pulse oximetry should not be used alone in the detection of aspiration during a swallowing assessment until further research regarding the effects of aspirated material on arterial oxygen saturation is completed. It can be used as a supplement to the clinical bedside evaluation if used with caution and all of its weaknesses are taken into consideration upon the interpretation of results.

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Critical Review:
The Impact of Otitis Media on the Development of Language in the Preschool Child

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This critical review examines the relationship between Otitis Media (OM) and early language development in children under the age of 5 years. Study designs include: prospective observational studies; a prospective longitudinal study, which included a randomized clinical control component, and survey design. Each of the studies indicated little to no direct relationship between OM and early language development, however, many of the studies examined contained methodological and measurement flaws. Therefore, there is an inadequate basis for determining whether it is a necessity for children with a history of OM to receive speech and language services.

Introduction

One of the most commonly diagnosed of childhood illnesses is that of otitis media with effusion (Feldman et al., 2003). Nearly all children are reported to have at least one episode, with approximately 80% presenting with three or more cases of OME prior to the age of three years (Robert & Hunter, 2002). Accompanying these bouts of fluid in the middle ear is a fluctuating mild-moderate conductive hearing loss, characterized by a dampening affect on the sound waves being transmitted from the child's surroundings (Feldman et al., 2003). Studies have shown that hearing levels can be affected by OME by as much as 50 dBHL or as little as 0 dBHL, with the average loss being 20-25 dBHL (Roberts & Hunter, 2002; Roberts et al., 2004). Since OME can be present for weeks, or even months, there is concern that the co-occurring hearing loss may negatively impact on a child's rapidly developing language system, affecting both comprehension and production in areas such as syntax, morphology, and vocabulary (Feldman et al., 2003, Roberts & Hunter, 2002; Roberts et al., 2004; Casby, 2001).

During language processing, a child must analyze a sound wave for known phonemes, and then search long-term memory for words corresponding to the phonemes perceived in the waveform. Frequent and persistent mild to moderate hearing loss associated with fluid in the middle ear is thought to interfere with these stages of processing, resulting in inefficient, incomplete, or inaccurate encoding of information (Roberts et al., 2004). Roberts et al. (2004) further suggest that if a child's ability to process single words is impaired, difficulties with working memory may develop, which would limit the ability to keep information active for processing more complex linguistic stimuli, such as sentences.

The question is, then, does persistent otitis media with effusion result in delayed early language development in the preschool years? The answer to this question has huge implications for how these children are serviced in the medical and allied health professions, particularly audiology, and speech-language pathology. With over $4 billion annually reportedly spent on the diagnosis and treatment of middle ear problems (Roberts et al., 2004), the question of whether OME and its associated loss cause language impairment is an important one. One of the main reasons for medical and surgical management is to prevent any developmental consequences related to OME (Paradise et al., 2003; Roberts & Hunter, 2002). If, in fact, this is the case protocols for how these children should be treated are an important consideration; such as amplifying the hearing loss as to not deny a child the opportunity to hear linguistic stimuli, continued medical treatment of antibiotics, myringotomy, and the insertion of typanostomy tubes, as well as the introduction of intensive language intervention and special education programs to combat the impending impairment. If, however, OME and its associated hearing loss do not significantly impact on a child's early language development, then is medical/surgical treatment and language intervention necessary, a consideration that considerably impacts healthcare dollars.

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the impact of OM on the early developing language skills of preschool children. The secondary objective is to propose an evidence-based clinical recommendation regarding the necessity of speech-language pathology intervention.

Methods

Search Strategy
Studies were found using computerized databases, including CINAHL, Medline, PsychINFO, and Cochrane Library. The key words used for the search are as follows:

[(otitis media) OR (OM)]
[(otitis media with effusion) OR (OME)]
[(language development) OR (language)]
[(child) OR (children) OR (preschool)]

The search was limited to articles written in English between 1995 and 2005.

Selection Criteria
All studies selected for inclusion in this critical review paper examined the impact of chronic OM or OME on language development in the first 5 years of life. No other restrictions were applied.

Data Collection
Results of the literature search yielded the following types of research congruent with the search criteria selected: prospective observational studies without controls (n=5); prospective longitudinal studies which included a randomized clinical control trial (1); and survey design (1).

Results

Impact of Otitis Media on Early Developing Language Skills
In a long-term prospective observational study that included a randomized control component, Paradise et al. (2003) examined whether persistent OM in the first three years of life resulted in impairments of children's language development at age 4, and whether prompt or delayed insertion of tympanostomy tubes prevents or lessons the degree of any such impairment.

Paradise et al. (2000) examined the effects of early-life OM on language development. The authors tested the relationship between children's cumulative duration with OME in their first 3 years of life and their scores on measure of language development (as well as articulation and cognition) at 3 years of age.

The effects of OM and quality of daycare on children's language development were examined by Vernon-Feagans, Emanuel, and Blood (1997). This study followed 67 infants attending both high and low quality daycares. At 24 months of age all children were administered a standardized test by a speech-language pathology graduate student. Comparisons were made between children with chronic and non-chronic OM and also between those children in low vs. high quality daycares.

Roberts et al. (1998) followed 86 African-American infants who attended centre-based childcare programs until the age of 2 years. Between 6 and 24 months of age the children were regularly examined for OME and hearing levels, and two separate ratings of the child's home and daycare environments were made. At the age of 2 years, language and cognitive measures were gathered.

To examine the relationship between early-life OM and preschool language and school readiness skills at age 3 years, 4 years, and upon entry into kindergarten Roberts et al. (2000) continued to study the same population from their 1998 study. The children were from predominantly low-income families and all the children attended a centre-based childcare program. Overall receptive and expressive language abilities were measured using standardized assessment tools and language samples.

As part of a larger prospective study Feldman et al. (2003) examined the degree of association between parent-reported language scores at ages 1, 2, and 3 years and the cumulative duration of middle-ear effusion. Parents completed an expressive and receptive vocabulary and gesture inventory when children were aged 1, 2, and 3 years. Maternal education was used as an indication of socioeconomic status, and was factored into the interpretation of parent reports.

To examine pediatrician's opinions about otitis media and speech, language, and hearing development, Sonnenschein and Cascella (2004) developed a 16-item survey based on information in the medical and speech-language literature about OM. From the 25 professionals who responded it was found that.

With respect to the sample population exclusion criteria for each study were generally acceptable. No children who were already suspected to be at risk for language delay, for example children with genetic abnormalities or those born with suspected cognitive delay, were included in the samples. Many studies however (Feldman et al. 2003; Roberts et al. 2000, Roberts et al. 1998; Roberts et al., 2000) included children from low socioeconomic environments. One could argue that this alone puts children at an increased risk for poor language development, and since these children were not compared to any control group, it is unclear whether any correlations

that are found are due to OME or sociodemographic variables. It is also difficult to generalize the findings of these studies to the general population.

The premise behind all of the research is that the hearing loss associated with OME is what puts children at risk for language delay. All of the present studies, with the exception of the parental report and survey studies included regular hearing evaluations as part of their methodology. The hearing levels, along with the cumulative duration of OME, were compared with language measures at different ages. Most of the language tests and measures used in these studies have been global measures of receptive and expressive language abilities. They did not determine whether differences exist in specific components of language functioning, such as syntax, morphology, semantics or pragmatics.

In many of these studies measures used to assess language functioning have been global measures of receptive and expressive language abilities. They did not determine whether differences exist in specific components of language functioning, such as syntax, morphology, semantics, or pragmatics. Conducting such an examination would offer some insight into whether hearing loss associated with OME has subtle affects on certain aspects of language. Combining this with sociodemongraphic variables would also be important since the use of language is variable, albeit still considered normal, among different demographic areas (e.g. Black English).

It can be assumed, if it was not directly addressed, that participants in these studies were treated medically when OME was present. None of the present studies acknowledged the type of treatment (with the exception of the randomized control study, and that information only involved children over the age of 3 years) children received, the duration of that treatment or its success at clearing the effusion. It is difficult to determine then, whether the medical treatment of OME played a role in the weak correlations found between OME and language outcomes.

Recommendations Regarding the Necessity for Speech-Language Pathology Intervention

Based on the methodological and measurement flaws found in the reviewed literature it is difficult to say with certainty that a child with a history of OM is at risk for delayed language development in the preschool years. This is not to say, however, that other variables, such as those of a sociodemographic nature, may not play a significant role. From the literature it was discovered that when socioecomic status, maternal education, and parent-child/daycare-child interactions are considered, significant relationships do exist.

From this it may be appropriate to suggest that children with such a history, accompanied by these sociodemographic variables be referred for speech and language therapy. Although at the young age of 1 or 2 direct therapy may not be appropriate, steps can be taken to train parents, caregivers, and daycare staff on how to best facilitate early language development.

Conclusions

Although none of the reviewed studies have found an OM history to be significantly related to early developing language skills, one should consider that all of the studies reviewed presented with methodological and measurement weaknesses. It is appropriate to suggest that future research should be conducted before the null hypothesis is presumed.

Future studies may want to consider using standardized measurement tools that examine specific components of language functioning. Also, examining the relationship between the levels of hearing loss, rather than cumulative duration of OM, may provide more information about any existing link between OM and language, since cumulative duration of OM alone does not take into account actual hearing levels. Finally, a more rigorous method of examining sociodemographic and parent-child interactions should be undertaken to partial out the true cause of potential language impairments.

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Critical Review:
Does Cochlear Implantation Improve Speech Perception in the Geriatric Population?

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This critical review examines the effects of cochlear implantation in improving speech perception in the geriatric population. Study designs include retrospective and case control studies. Overall, research supports that seniors demonstrate an improvement in speech perception following cochlear implantation. The majority of the reviewed literature also supports that geriatric recipients experience a similar degree of speech perception improvement in comparison to younger adult implant users.

Introduction

Cochlear implantation (CI) was introduced over 25 years ago, and is now regarded as an option for those with severe-to-profound sensorineural hearing loss that have had little or no benefit from personal amplification (Labadie et al., 2000). Cochlear implants directly stimulate the auditory nerve and are proven to enhance sound awareness and improve speech recognition (Chatelin et al., 2004).

A wide range of research has been published on the benefits of CI in the pediatric and adult population, however respectively less focus has been given to implantation in the geriatric population (Chatelin et al., 2004).

A higher incidence of hearing loss is present among seniors in comparison to any other age group. When left unmanaged, hearing loss in the elderly results in feelings of isolation from society, and a reduction in quality of life (Labadie et al., 2000). As hearing sensitivity decreases with age, an increasing amount of seniors will meet the criteria for CI. Therefore, measurable outcomes are very important for this specific population (Vermeire et al., 2005).

In terms of candidacy for CI, the main criteria for seniors includes a bilateral severe-to-profound sensorineural hearing loss greater than 70 dB HL (Labadie et al., 2000). Based on quality of life questionnaires, "[t]he majority of elderly patients reported improved social life, confidence, and overall quality of life after implantation" (Vermeire et al., 2005). In addition to improvements in speech perception, cochlear implants may offer seniors an increased awareness of environmental sounds which enhances their safety and security (Pasanisi et al., 2003). In general, minimal surgical risk occurs in CI surgery, with the outcome of significant auditory improvements (Chatelin et al., 2004).

For the purpose of this review, the geriatric population is defined as those 60 years of age and older.

Objectives

The primary objective of this review was to critically evaluate existing literature regarding the effect of CI in improving speech perception in the geriatric population. The secondary objective was to propose evidence-based practice recommendations regarding counseling seniors that are potential candidates for CI.

Methods

Search Strategy

Computerized databases, including PubMed and ComDisDome, were searched using the following search strategy:

> ((cochlear implant) OR (cochlear implantation)) AND ((elderly) OR (seniors)) AND ((speech perception) OR (speech recognition)).

The search was limited to articles written in English between 1990 and 2005.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to investigate the impact of CI on speech perception among the elderly. Limits were set on the age of research participants (60 years and older), however not for other demographics or outcome measures.

Data Collection

Results of the literature search yielded the following types of articles congruent with the aforementioned selection criteria: review (2), and retrospective or case control study (11).

Methodological Components
With regards to research design, all of the reviewed literature took the form of retrospective or case control studies. Sampling frames were based on cochlear implant patient records from various university hospitals and medical centers in the United States of America and Europe.

Speech perception improvement was objectively measured using various speech recognition tests. Examples of these test materials included Consonant-Nucleus-Consonant (CNC) monosyllabic words, Central Institute for the Deaf (CID) sentences, Hearing in Noise Test (HINT) sentences, Northwestern University Test No. 6, Four-Choice Spondee Test, and W-22 words.

The literature either solely compared geriatric pre- and postoperative speech test scores, or they additionally evaluated the differences in test outcomes between implanted seniors and a comparative group of younger adult implant patients.

Results

The reviewed articles consistently showed that CI does improve speech perception in the geriatric population as demonstrated by an improvement in postoperative speech recognition test scores. The majority of the literature also demonstrated no statistically significant differences in postoperative test outcomes between geriatric recipients and younger adult implant users.

Comparison of Geriatric Pre- and Postoperative Speech Recognition Test Outcomes
Two studies specifically focused on evaluating the differences in speech recognition test scores pre-and postoperatively to determine the geriatric population's benefit from CI (Sterkers et al., 2004; Waltzman, Cohen, & Shapiro, 1993). Speech recognition was assessed using the Four-choice Spondee Test, W-22 words, NU-6 words, and CID sentences. Subjects were aided in both pre- and postoperative testing conditions, confirming substantial experimental control.

Results were statistically analyzed appropriately using the Student's *t*-test, and the Mann-Whitney test to compare pre- and postoperative test scores. Research outcomes demonstrated an improvement in postoperative speech recognition test scores among seniors, therefore showing speech perception benefit from cochlear implants (Sterkers et al., 2004; Waltzman, Cohen, & Shapiro, 1993).

Comparison of Geriatric Pre- and Postoperative Speech Recognition Test Outcomes to Younger Adult Implant Patients
Eight studies evaluated geriatric pre- and postoperative speech test scores, as well as additionally comparing test outcomes with those of a comparative group of younger adult implant patients (Chatelin et al., 2004; Djalilian et al., 2002; Haensel et al., 2005; Kelsall, Shallop, & Burnelli, 1995; Labadie et al., 2000; Pasanisi et al., 2003; Shin et al., 2000; Vermeire et al., 2005). Speech perception was measured using numerous speech recognition tests, including the Hearing in Noise Test (HINT), CID sentences, NU-6 words, and Consonant-Nucleus-Consonant (CNC) monosyllabic words. Results were statistically analyzed appropriately using various measures, including the one-way analysis of variance (ANOVA) test, Student's *t*-test, Tukey multiple comparison test, and two-tailed chi-square analysis to compare differences in test outcomes within and between the two age groups.

Upon critical analysis of research results, it is evident that elderly cochlear implant users postoperative test outcomes are similar to a matched group of younger implant patients (Kelsall, Shallop, & Burnelli, 1995). While Chatelin et al. (2004) and Vermeire et al. (2005) demonstrated an improvement in postoperative test outcomes in the geriatric group, it was shown that the elderly group test scores were "slightly poorer" in comparison to the younger control group (Chatelin et al., 2004). With the exception of the above two studies, the majority of the reviewed literature demonstrated no statistically significant differences in postoperative test scores between adult recipients and geriatric recipients (Djalilian et al., 2002; Haensel et al., 2005; Labadie et al., 2000; Pasanisi et al., 2003; Shin et al., 2000).

Recommendations for Future Research

Five of the ten reviewed studies were considered to be lower levels of evidence caused by certain methodological flaws (Djalilian et al., 2002; Haensel et al., 2005; Shin et al., 2000; Sterkers et al., 2004; Vermeire et al., 2005). Addressing these methodological weaknesses will aid in providing recommendations for future research.

In terms of measuring speech perception improvement, recorded speech testing material should be utilized to control for clinician variability during speech recognition testing. Also, speech recognition tests must be implemented that are more representative of real-life listening situations (ex. the HINT) and consistent testing conditions should be

undertaken pre- and postoperatively (ex. aided, sound field) to strengthen the generalizability of research outcomes. Finally, it is crucial to control for age of onset of hearing loss, and duration of deafness, as speech perception ability is directly related to these factors.

With regards to areas of future investigation, there are currently limited data available on the specific problems that seniors with cochlear implants may experience while communicating with others in everyday listening environments (Hay-McCutcheon et al., 2005). Another topic of further research may also include the effects of "central auditory processing deficits, which could increase with age" on the "performance of elderly recipients of cochlear implants after several years of implant use" (Shin et al., 2000).

Recommendations for Clinical Practice

Based on pre- and postoperative speech test outcomes, CI should be considered as an option to improve speech perception in the elderly (provided that all candidacy requirements have been met and candidates are medically stable to undergo surgery). Clinicians should provide information regarding the benefits of CI to seniors with severe-to-profound sensorineural hearing loss who have experienced minimal or no success from personal amplification. During counseling audiologists should disclose that there is large individual variability in performance outcomes, and that similarly to hearing aids, time, adjustment, and practice with the implant is needed to experience optimal improvements.

Conclusions

Based on the literature reviewed, the general finding is that CI does improve speech perception in the geriatric population, as demonstrated by pre- and postoperative outcomes on speech recognition tests. The majority of the literature also supported that there are no significant differences in postoperative test scores between geriatric recipients and younger adult cochlear implant users. It is imperative that as clinicians, thorough information and counseling regarding the expectations and benefits of CI is relayed to all necessary patients, irrespective of age.

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Critical Review:
The effectiveness of Functional Communication Training (FCT) in reducing behavior problems in autistic or developmentally disabled persons

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This critical review examines the effectiveness of Functional Communication Training (FCT) in reducing behavior problems in persons with autism and other developmental disorders. All of the reviewed studies were identified as single subject, multiple baseline designs. The communication disorders examined in these studies included autism, mental retardation and developmental disabilities. Based on this review, there is evidence to suggest that FCT is effective in reducing behavior problems in these persons. The results of the review should be interpreted with consideration of the inherent limitations of the methodology and the statistical analysis used in the reviewed studies.

Introduction

Functional Communication Training is a reinforcement-based intervention approach that relies on the notion that behavior problems can be viewed as a form of communication (Durand, 1990; Durand & Merges, 2001). Once the underlying messages or functions of these behaviors are identified through a variety of assessment processes, socially more appropriate communicative alternatives can be taught to replace the behavior problems (Carr & Durand, 1985; Day, Horner, & O'Neill, 1994; Horner & Budd, 1985; Wacker, Steege, Nothup, Sasso, Berg, Reimers, 1990). In order for these new behaviors to be effective, they must be functionally equivalent to the problem behavior (response mastery), and produce more immediate and consistent reinforcement with less physical effort (response efficiency). Different modes of communication have been successfully implemented in FCT including verbalization (Durand, 1999), manual signs (Drasgow, Halle, & Ostrosky, 1998), word or picture cards (Frea, Arnold and Vittimberga, 2001), gestures (Kennedy, Meyer, Knowles, & Shulka, 2000), and augmentative and alternative communication (AAC) devices such as microswitches (Wacker et al, 1990). For example, in a study done by Sigafoos and Meikle (1996) two boys who were nonverbal and had been diagnosed with autism, engaged in a variety of problem behaviors including aggression (e.g., hitting, pushing, biting, pinching and throwing objects at others), self-injury (e.g., hitting, scratching, and biting self), property destruction (e.g., breaking, ripping, and throwing objects), stereotyped movements (e.g., body rocking, sniffing objects, twirling pieces of string) as well as other disruptive acts such as making inappropriate noises, yelling and crying. The functional analysis identified attention and tangible as the main underlying motivations for these behaviors. These two boys were taught to use gestures (e.g., tapping the adults' hands) and pointing to line drawings to demand attention and say words such as "want" or "drink" for the tangible contingencies. The results of intervention indicated that the problem behaviors reduced considerably once these children learned to express themselves through their new behavior consistently.

Objectives

The primary aim of this paper is to critically evaluate the existing literature regarding the effectiveness of FCT in reducing the behavior problems of individuals with autism or developmental disability. The secondary objective is to provide evidence-based recommendations about the adoption of FCT with particular client populations in clinical settings.

Methods

Search Strategy
The studies were found using a computerized database search, including PubMed, PsychINFO, and Web of Science. The following key terms were used:

> (Functional Communication Training OR FCT) OR (behav* AND (autis* OR mentally challenged OR mental disab* OR mental retard* OR developmental disab* OR pervasive developmental OR PDD))

The search was limited to articles written in the English language.

Selection Criteria

Studies that were selected for inclusion in this critical review paper examined the effectiveness of FCT in reducing the behavior problems in individuals with autism or developmental disability. The literature search yielded ten articles that employed a single subject, multiple baseline design. There were no restrictions related to subject demographics or outcome measures.

Results

All studies were found to support the conclusion that FCT can be effective in reducing the behavior problems in individuals with autism or developmental disability. Drasgow, Halle, and Ostrosky (1998), Kennedy, Meyer, Knowles, and Shulka (2000), and Day, Horner and O'Neill (1994) studied individuals with autism who exhibited a variety of problem behaviors to express tangible, attention, and escape functional motivations. They taught new verbal and gestural mands to their participants to replace their problem behaviors with more socially appropriate behaviors. The results of these studies, although supportive of their theories, should be taken with a grain of salt. Drasgow et al. (1998) studied variables that might influence generalization and as such focused on the "tangible" function, which they believed could manifest itself in different topographies depending on the contexts in which it occurred. The functional analysis and the initial baseline assessment were both conducted in one short session. The validity of these fundamental assessments is questionable.

Kennedy et al. (2000), in contrast, tried to relate similar topographies to different functions. They believed that stereotypy although maintained by different functions may be highly similar. Their results further suggested that the causes of stereotype are complex and that the presumed association between response topography and behavioral function may not be easily recognized. This study also had the same methodological flaw as Drasgow et al. study.

Day et al. (1994) studied two problem behaviors of self-injury or aggression under two conditions of escape and tangible. They taught their participants two different mands for these two different functions and could successfully reduce the problem behaviors. Although the number of participants was quite small, the study enjoyed a sound methodological basis and yielded reliable results.

The participants of other studies had other co-morbidities such as developmental disability, mental retardation, and fragile X. Some participants were verbal and some nonverbal. These participants were accommodated by different communication modalities ranging from gestures, manual signs, and pictures to AAC devices.

Durand (1999), and Durand and Merges (2001) studied children with autism and sever mental retardation. These children were taught to use assistive communication devices instead of aggressive behaviors such as hitting, face slapping and head banging to attain attention and escape functions. These children were further assessed in unfamiliar settings and during interaction with untrained community members to see to what extent they generalized their newly acquired behaviors. This study was quite reliable as it was carried out within a sound methodological framework: the functional analysis was quite thorough and included questionnaires as well as interviews and observation sessions; the parents, teachers, caregivers and family members were involved and trainings and assessments were conducted under the supervision of trained professionals.

Wacker et al. (1990) added the components of efficacy, history and control of reinforcement to their study which aimed at evaluation of FCT for severely handicapped persons. This study had a baseline intervention design and followed a case report format and as such provided lesser quality evidence.

Frea et al. (2001) studied the efficiency of picture exchange as a means of reducing the classroom aggression of preschoolers and found the results to be quite satisfactory. They also hypothesized that this reduction was related to the fact that picture exchange increased children's ability to exert choice and control in their activity.

Brown, Wacker, Derby, Peck, Richman, Sasso and Knutson (2000) wanted to use FCT to determine if a mand that was matched to the function of problem behavior and reinforced only when the relevant establishing operation (EO) was present would result in decreased problem behavior and increased manding. Their study appeared to prove the efficiency of FCT in reducing the problem behaviors in the presence and absence of Eos.

The participants in these studies all demonstrated a significant reduction in their problem behaviors and were able to use their new communication behaviors effectively and efficiently. However, the studies in

the present review were found to have some methodological and statistical weaknesses when examined, which limit the strength of the evidence.

The sample size was one of the main flaws of all of the studies reviewed. The number of participants in each study did not exceed five. Such small number definitely affected the external validity of these studies.

The issues of maintenance and generalization of the new behaviors were not addressed in any studies except those carried out by Durand (1999) and Wacker et.al. (1990). Furthermore, none of the studies reported any follow-up data to support generalizations and to demonstrate long-term effects of such interventions.

Single-subject design allows the researcher to evaluate whether a behavior change has occurred and analyze whether the change happened in response to the treatment. Most commonly, researchers plot the data points on a graph and visually analyze the result. It is also possible to statistically analyze the data in order to gain a more quantitative perspective of the data. Of the ten research-oriented articles published in the literature, none used statistical analysis. Considering the variability of real data the unreliability of subjective determinations, it is a concern that visual inferences may not be reliable enough to support all clinical decisions (Portney & Watkins, 2000).

Mean values should always be shown on a graph of the raw data to reduce misinterpretation in this type of design (Portney & Watkins, 2000). None of the studies met this criterion.

Baseline data should be stable or moving in a trend that is either in a direction opposition to that expected during intervention before the intervention begins, or in the same direction but the level of target behavior changes (Portney & Watkins, 2000). Frea, Arnold and Vittimberga (2001), Wacker, et al. (1990), and Day et al. (1994) did not report sufficient baseline data for the reader to determine if this criterion was accurately met. Similarly, Horner and Day (1991) referred to a brief functional analysis without any further details, whereas other studies such as Durand (1999), Durand and Merges (2001) conducted long, thorough assessments to reach the stable baseline required.

All studies reported inter-rater reliability using either point-to-point reliability (Sigafoos & Meikle, 1996) or mean inter-observer percent agreement (Drasgow et.al., 1998; Durand, 1999; Kennedy et.al., 2000; Wacker et.al., 1990; Day et.al., 1994). The latter type is not considered to be a methodologically reliable measure (Portney & Watkins, 2000).

Single-subject designs are limited in their external validity. It is difficult to generalize the results of these kinds of studies beyond the behavior of the single individual. The only way to demonstrate external validity in single subject research is by way of replication using other similar subjects in different settings (Portney & Watkins, 2000). The exisiting literature was lacking in this area. More research needs to be done and published on the topic to increase its external validity.

Recommendations

Based on the literature reviewed, it appears that a recommendation for the application of FCT for reducing the behavior problems in individuals with autism or developmental disability is warranted. However, further research on this topic, which improves on the methodological and statistical weaknesses of past studies and promotes longitudinal studies that investigate maintenance and long-term effect of FCT, would provide clinicians with greater confidence in using this approach.

Conclusions

The present review is of benefit to clinical speech-language pathologists who hope to gain a better understanding of the efficacy of FCT and the populations appropriate for its application.

It appears that FCT has been effective in reducing behavior problems of individuals with autism or developmental disability. It would be worthwhile to explore whether individuals with other communication disorders that involve problem behaviors may also benefit from the application of FCT such as those with seizure disorders or Rett's syndrome.

Future research should strive to include optimal methodological design and robust statistical analysis. It is also important, especially in single subject design, that enough methodological and measurement information be presented in publications so that other researchers can have a frame of reference to compare and increase the validity of their conclusions (Portney & Watkins, 2000).

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Critical Review: Drawing therapy and its effect as a means of communication in patients with severe non-fluent aphasia

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This critical review examines the effect of drawing therapy on communication in patients with severe non-fluent aphasia. The studies include: a case report, a one-group pretest-posttest design and a non-randomized group comparison design. Currently, some research supports drawing therapy as being an effective method to improving non-verbal communication in patients with severe non-fluent aphasia.

Introduction

The effectiveness of treatments for aphasia has received much attention in the literature. Butfield and Zangwill (1946) were among the first to demonstrate the efficacy of aphasia therapy, a conclusion that has been supported by many other studies since (Brookshire, 2003)

Several therapy programs are provided for people with severe aphasia. Many of these programs focus on techniques that can improve verbal language, while other programs focus on providing different means of non-verbal communication (Brookshire, 2003).

People with severe non-fluent aphasia are "expressively restricted" (Lyon & Helm-Estabrooks, 1987). They usually respond poorly to intervention that focuses on improvement of language function (Sacchett et al., 1999). Hence, other methods such as using gestures, pantomime or a visual symbol system (Sacchett et al., 1999) have been used in treatment to improve the communication of those patients. While these methods have been shown to be beneficial for some individuals, researchers have continued to explore other means through which communication can be maximized for individuals with severe non-fluent aphasia. One such method under investigation is the use of drawing in treating severe non-fluent aphasia. (Sacchett et al., 1999).

Drawing can serve as a nonlinguistic means of communication for a person with severe non-fluent aphasia, who demonstrates significant limited expressive language (Lyon & Helm-Estabrooks, 1987). Drawing abilities can be used as a means of language re-education, an alternative way of communicating, a means of self-expression or a social activity (Cubelli, 1991). Only one study by Pillon et. al (1980) attempted to use drawing as a means of re-educating spoken and written language (Cubelli, 1991). The graphic productions of the single subject who was under examination, enhanced his linguistic capacities, and he learned to communicate well through drawing (Cubelli, 1991). His speech however, remained severely reduced and "was not as effective as drawing as a means of communication" (Cubelli, 1991).

The effectiveness of communication accomplished through drawing by patients with severe non-fluent aphasia, is less known (Lyon & Sims, 1989).

For drawing to serve as means of communication, the adult with severe non-fluent aphasia must either retain the necessary residual graphic skills, or have the ability to acquire these skills through a systematic treatment program (Lyon & Helm-Estabrooks, 1987).

Formal drawing approaches used in the treatment of non-fluent severe aphasia include: Visual Action Therapy (VAT; Helm-Estabrooks et al., 1982), Promoting Aphasics' Communicative Effectiveness (PACE; Davis & Wilcox's 1981), and Back to the Drawing Board (BDB; Morgan & Helm-Estabrook's 1987) as cited in the study by Ward-Lonergan & Nicholas (1995).

The modified VAT program involves tracing of tasks, matching tasks, independently drawing pictures in response to object presentation, and requesting objects by drawing (Ward-Lonergan & Nicholas, 1995). In the PACE approach, the patient is asked to convey unknown information to the clinician through drawing. The approach begins by providing the patient with pictured objects, followed by stick-figure action drawings as stimuli, and finally photographs as stimuli

(Ward-Lonergan & Nicholas, 1995). The BDB is a systematic approach, in which patients learn to improve their ability to portray sequential events (Ward-Lonergan & Nicholas, 1995). The patient begins by copying a simple black and white one-panel cartoon. Eventually, the patient with non-fluent severe aphasia draws the picture from memory and advances to more complex two- and three-panel cartoons (Ward-Lonergan & Nicholas, 1995).

Some of the drawing therapy programs encourage caregivers of patients with non-fluent severe aphasia to take part in the treatment approach (Sacchett et al., 1999). The caregivers receive specific training about the aims of the drawing program and are taught strategies designed to assist them in the interpretation of unclear drawings produced by their partners with non-fluent severe aphasia (Sacchett et al., 1999). They are also required to keep records of conversations in which the subject took part while using alternative methods of communication such as drawing (Sacchett et al., 1999).

Objectives

The purpose of this critical evaluation is to examine some of the literature to determine whether drawing is an effective therapy program to enhance non-verbal communication (via drawing) for people with severe non-fluent aphasia.

Recommendations regarding the use of drawing therapy in the field of speech language pathology will be addressed, as well as some possible directions for future research.

Methods

Search Strategy
Computerized databases, including AMED, CINAHL, EMBASE, MEDLINE-OVID and PubMed were searched using the following keywords: (Drawing therapy) OR (drawing) AND (Severe aphasia) OR (non-fluent aphasia).

Selection Criteria
The studies included in this critical appraisal were necessary to examine the effect of drawing therapy as a means of non-verbal communication among individuals with severe non-fluent aphasia.

Data Collection
The results of the literature search yielded the following study types: case study, a non-randomized group comparison design and a one-group pretest-posttest design.

Results

In their study, Morgan and Helm-Estabrooks (1987) used a case study to evaluate the treatment program "Back to the Drawing Board (BDB)" across two individuals with severe non-fluent aphasia. The researchers used descriptive statistics to evaluate recognizability and accuracy of the drawings, which were the outcome measures of the study. The authors reported that patient A's performance exceeded patient B's performance in all areas of the drawing program. Nevertheless, both patients improved remarkably after the treatment program.

Lyon and Sims (1989) implemented a non-randomized group comparison design to evaluate drawing as a communicative aid with eight patients who had severe non-fluent aphasia and eight healthy adults. The results of the measurements of communicative effectiveness and recognition of the drawings were analysed by using the Wilcoxon-Signed Ranks test. The authors reported that a substantial communicative effectiveness gain ($p < .02$) was realized after drawing therapy was introduced to the patients with severe non-fluent aphasia. Following three months of treatment, were therapy sessions were held three times per week, further improvement was noticeable ($p < .05$) (Lyon & Sims, 1989). Due to the fact that drawing provides a permanent static representation of the messages being conveyed, as compared to other transient forms of therapy such as verbal and gestural symbols, the researchers reported that their data suggested that drawing might serve as an important facilitator in therapy to enhance communication in patients with severe non-fluent aphasia (aiding especially in short-term retention of concepts).

In their study, Sacchett et al. (1999) used a one-group pretest-posttest design that consisted of seven subjects with severe non-fluent aphasia. The authors hypothesised that the generative drawing ability of patients with severe aphasia can be improved as a result of drawing therapy. The results of the study demonstrated significant improvement in the recognizability of the drawings after a twelve-week therapy program.

The researchers used a three-factor within-subject ANOVA to analyse the recognizability of the drawings (the three factors being: time, rater condition and stimulus condition). It was reported that there was a significant main effect of time of assessment ($F=4.521$, $P=0.0157$). A comparison between the means indicated that the effect (improvement of drawings) occurred during therapy, and was not due to spontaneous recovery. In addition, a second main effect was the rater condition. The results demonstrated that raters' knowledge of the context significantly improved their identification of the drawings ($F= 16.265$, $p = 0.0069$). In summary the subjects' drawings were significantly more recognizable after therapy and this gain was maintained at follow-up sessions. A Wilcoxon one-tailed test was used to analyze the quality of the drawings. The quality was of the drawings was significantly improved following therapy ($p=0.05$).

Discussion

Appraisal of the results

The research evidence appears to indicate that drawing therapy has a positive effect on improving the ability of patients with severe non-fluent aphasia to communicate. In particular, quality and accuracy in drawing has been shown to improve through various drawing therapy programs. However, several issues with respect to study methodology such as subject selection, sample size, and statistical analysis, impact negatively on the strength of the evidence of the literature that was appraised.

Subject selection

Sampling concerns that were notable in the literature include lack of random selection of subjects with severe non-fluent aphasia and the use of small sample sizes. These factors may cause the results of the study to not be representative of the responses of other individuals in the general population of patients with severe non-fluent aphasia, hence limiting generalization.

Methodology

Interpretation of the results in the studies needs to be completed with caution due to the fact that some researchers may have some flaws in carrying their methodology. Some studies lacked control groups, such as the study by Morgan & Helm-Estabrooks (1987). In their study they only used two subjects and did not compare them to a control group (patients with severe non-fluent aphasia who did not go through the therapy program "Back to the Drawing Board (BDB)"). In the study by Lyon and Sims (1989) the matched group of healthy adults served as the control group. A better control group would have been one that included patients with severe non-fluent aphasia who did not go through the three-month "PACE-approach" drawing therapy program. A well-chosen control group would have ruled out the issue of spontaneous recovery in the patients with severe non-fluent aphasia, and hence would have yielded more reliable results. Other studies included sources of bias that may have influenced the results of the study. For instance, in the study by Morgan and Helm-Estabrooks (1987) the judges who rated the overall accuracy of the drawings had prior knowledge of what was being drawn. This might have created bias in the results provided. In addition, the outcome measures (e.g. recognizability and quality of drawings) that were analysed needed to be examined further in order to ensure whether or not they are sufficient and essential for functional communication. Also, the tools used in research have to be scrutinized for reliability and validity. Some tools that were used in the studies (Lyon and Sims, 1989) included ordinal scales, which are subjective and may create bias. On the other hand, the study by Lyon and Sims (1989) made use of standardised tests such as the PICA and the BDAE, which are known to be more reliable.

Statistical Analysis

Some researchers provided descriptive data analysis only in combination with their study design that does not usually allow for generalization to the general population of patients with severe non-fluent aphasia.

Recommendations

While the various limitations in research design and methodology lead us to exercise caution in interpreting the results of these studies, it is important to note that these early exploratory efforts have provided evidence of change in communication following drawing therapy. Further research should include the following:

- Studies that have a large number of randomly selected and randomly assigned subjects.
- Appropriate statistical measures.
- The use of reliable and valid tools.
- The participation of caregivers in the studies to encourage carry-over.
- Control groups.

Conclusion

From the evidence in the literature that was appraised, it can be concluded that drawing therapy is a helpful approach in treatment for patients with severe non-fluent aphasia. The researchers reported significant positive results in the improvement of the subjects' abilities to communicate via drawing. However, more caution in regards to sampling and methodology needs to be taken into consideration to further support this area that is under investigation. Also, further research that investigates the integration between this approach and other treatment methods would be an asset to the field.

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Critical Review:
The effectiveness of tinnitus retraining therapy for treating hyperacusis

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This critical review examines the effects of using Tinnitus Retraining Therapy (TRT) to treat individuals suffering from hyperacusis. Study designs include: a one group pretest-posttest study, a case series study, and a quasi-experiment. The results of these papers provide a good starting point to support the effectiveness of TRT when treating patients with sound tolerance problems.

Introduction

Hyperacusis has been defined as an increased sensitivity to low and/or moderate sound levels. Clinically, individuals are established as having hyperacusis if they have abnormally reduced loudness discomfort levels across frequencies, and experience physical pain or troublesome sensations when exposed to everyday sounds (Formby & Gold, 2002). There is a lack of epidemiological data published on hyperacusis. However, available literature indicates that approximately 5 percent of Americans have clinically significant tinnitus, and 40 percent of these patients suffer from hyperacusis (Coles & Sood, 1988; Jastreboff, Gray, & Gold, 1996; Jastreboff & Jastreboff, 2000). As well, not only are published etiologies regarding loudness discomfort problems diverse, but in many cases no underlying medical conditions have been found (Baguley, 2003; Sammeth, Preves & Brandy, 2000). This has made it difficult to establish a definitive cause-effect relationship regarding hyperacusis. What is known is that this health condition severely and aversely affects a patient's emotional, occupational, and social well-being (Sammeth et al., 2000). It is therefore important for clinicians to understand and implement appropriate treatment for this population.

To date, the treatment of hyperacusis is not universally agreed upon. Over the past decade strategies have changed from traditional sound attenuating interventions that encourage sound avoidance, to desensitization methods that promote exposure to background noise (Formby, Sherlock & Gold, 2003; Jastreboff, Gray & Gold, 1996; Sandlin & Olsson, 1999). Tinnitus Retraining Therapy (TRT) is a habituation based treatment protocol that evolved from a neurophysiological model of tinnitus (Gold, Formby, & Gray, 2000). It combines directive counselling with sound therapy to habituate away awareness and annoyance of hyperacusis. The purpose of retraining counselling is to educate patients about their disorder, neutralize negative emotional associations with the hyperacusis, and discuss treatment options. Noise generators are used to present bilateral low-level broadband sound into clients' ears over an 18 to 24 month time period. TRT assumes that there is a central gain control process in the auditory system that enables supra-threshold sensitivity to gradually reset in response to long-term changes in auditory input. Thus, the attempt of sound therapy is to desensitize clients by gradually increasing the levels produced by noise generators.

The aims of the following paper are to provide a qualitative review regarding the effectiveness of TRT for treating individuals with hyperacusis, and to present future research and clinical recommendations.

Methods

Search Strategy

A search was performed on the following computerized databases: CINAHL, MEDLINE, and PubMed. The subject headings used were hyperacusis, phonophobia, Tinnitus Retraining Therapy, TRT, treatments, therapy, sound tolerance, habituation, noise generators, and loudness perception.

Data Collection

Initial studies were selected after reading through abstracts. Secondary sources from Formby, Sherlock, and Gold, 2003; Nelsen and Chen, 2004, and Valente et al, 2000 were also obtained. This literature search resulted in 16 articles. Several papers discussed hyperacusis, and proposed mechanisms and theories involved in the disorder. However, articles that were solely descriptive and did not include evidenced based findings were excluded from the current paper. As well, articles addressing hyperacusic treatments other than TRT were also omitted. Three studies were found to be relevant for

Table 1. Criteria for categories of treatment (Bartnik, Fabijanska, and Rogowski, 2001)

Treatment Category	Hyperacusis	Noise Exposure	Subjective hearing loss	Treatment
O	Absent	No prolonged effect*	Irrelevant	Counselling only; avoid silence
I	Absent	No prolonged effect	Irrelevant	Noise generators set at level close to 'mixing point'
II	Absent	No prolonged effect	Significant	Environmental sounds amplified by hearing aids
III	Present	No prolonged effect	Irrelevant or significant	Noise generators set close to threshold of hearing with the sound level gradually increased during the treatment
IV	Present	Present	Irrelevant or significant	Noise generators set at threshold with the level gradually increased during the treatment

* Prolonged effect refers to worsening of hyperacusis as a result of noise exposure.

the aims of the current paper: a one group pretest-posttest study, a case series study, and a quasi-experiment.

Results

Study 1: Experiences in the treatment of patients with tinnitus and/or hyperacusis using the habituation method (Bartnik, Fabijanska, and Rogowski, 2001)

The purpose of Bartnik, Fabijanska, and Rogowski's study (2001) was to analyze and summarize the effects of TRT on hyperacusic patients treated at a clinic in Warsaw. Clients with tinnitus and/or hyperacusis were placed into 1 of 5 categories depending on the characteristics of their disorder (refer to Table 1).

The protocol for TRT treatment was based on the knowledge of the "world's leading centres" and also the experiences of the researchers. The protocol included the following: case history, audiological evaluation, medical evaluation, diagnosis and selection for the treatment category, directive counselling, selection and fitting of the most suitable hearing aids or noise generators, and follow-up counselling according to the individual needs of a patient. However, the article's description of the administered protocol is vague, and the papers that are referenced provide little additional information.

Measurements were gathered through a questionnaire (developed by the researchers) and evaluation of uncomfortable loudness levels (UCLs). However, they fail to include details that could affect reliability and validity of results, such as the specific questions asked, and how the UCLs were taken.

For Bartnik et al.'s study, 20 patients from each of the 5 categories were randomly chosen from a total of 516 patients, and controlled analyses were confined to each category. More specifically, a one group pretest-posttest design was employed in which clients' files were retrospectively analyzed by comparing measurements taken before and after treatment.

The Fisher Exact Test was used to statistically compare pre- and post-treatment responses of each client. Across all categories clients showed a significant improvement in about 70% of cases. However, the results are very different for each group. TRT was less effective for patients suffering from hyperacusis (i.e. those individuals from categories III and IV). Patients in group III showed a significant improvement of 55% and those in group IV showed a significant improvement of 60%.

The percentage of significance in these 2 categories is not large. However, Bartnik et al. collected data after a maximum of 12 months of therapy. The full period of TRT takes about 18-24 months (Jastreboff and Hazell, 1998). Thus, Bartnik et al. predicted that the significance of successful treatments at their clinic would improve with longer periods of treatment. Further studies are needed to support this statement.

Study 2: Modification of loudness discomfort level: Evidence for adaptive chronic auditory gain and its clinical relevance (Formby and Gold, 2002)

A study by Formby and Gold (2002) addresses the use of TRT in modifying sound tolerance and expanding dynamic ranges of hyperacusic and hearing impaired patients. As well, a detailed characterization of an adaptive chronic auditory gain

process is described. This process is a key theory underlying TRT treatment.

A case series study design was used in which collections of reports of hyperacusic patients treated with TRT are described. Formby and Gold retrospectively summarize results from clients' subjective interviews and from a longitudinal series of LDL measurements taken pre-, inter-, and post-treatment. However, the method used to select these cases is not explained, and little information is provided regarding how the specific clinical measurements were completed. Thus, it is difficult to evaluate generalizability of findings and whether treatment effects were accurately assessed to minimize bias.

Nonetheless, Formby and Gold's study presents strong and convincing associations between treatment and outcome (i.e. large differences in UCL and subjective reports when comparing pre- and post-treatments). An extreme example of such a patient is JL, who initially reported bilateral hyperacusis and normal hearing levels. After 17 months of TRT he showed about 50 to 60 dB HL shifts in UCL bilaterally, and subjective discomfort to loud sounds were resolved.

The next three examples described by the authors are cases with hearing losses and reduced dynamic ranges. After TRT therapy, these clients showed an average increase in sound tolerance levels of about 27 dB HL across audiometric frequencies. In each case, dynamic ranges were expanded to allow clients to successfully benefit from hearing aids that previously caused discomfort.

The final case is of a woman, MN, who complained of tinnitus, as well as discomfort to many different sounds, and hearing loss in the left ear. After only 1 month of TRT, MN revealed stable elevated UCLs of about 25 to 30 dB HL. This client suggests that treatment effects may be rapid for some patients.

The above observations show large and consistent shifts in sound tolerance for patients receiving TRT. These results support the viability of TRT for alleviating hyperacusis, as well as possibly expanding hearing impaired listeners' reduced dynamic range.

Study 3: Adaptive plasticity of loudness induced by chronic attenuation and enhancement of the acoustic background (Formby, Sherlock, and Gold, 2003)

The purpose of Formby, Sherlock, and Gold's (2003) quasi-experiment was to support the theoretical gain control mechanism involved in hyperacusis and TRT. The researchers predicted that with continuous use of earplugs over 2 weeks, subjects would become more sensitive to sounds, while listeners exposed to continuous noise generators would become less sensitive to sounds.

The study examined 10 volunteers with normal hearing thresholds and normal loudness perceptions. Five subjects were in a noise instrument (NI) group, 5 were in an earplug (EP) group, and 5 out of all 10 participants were evaluated for both treatments. Possible confounds were checked by separating the end of the first treatment and the onset of the second treatment by at least a week (when subjects' perception levels were statistically equivalent to baseline).

Large changes in mean loudness judgments at 500 and 2000 Hz were observed. Generally, listeners needed more (+4 to +8 dB) and less (-5 to –9 dB) intense tones after the noise generator and attenuator treatments, respectively, to achieve the same baseline loudness judgments. These results are quite impressive, especially since the devices were worn over a short 2-week period.

The authors used t-tests and Wilcoxon rank sum tests to statistically evaluate their data. These findings may be inaccurate due to the large number of tests conducted, which could have caused type II errors. Although the authors' statistical analysis may not be the most appropriate, the graphed raw data clearly show large treatment effects. Thus, the article provides some support for the concept that absolute loudness ratings can be affected by listening experience as modified by real life use of noise generators and attenuators.

Recommendations

Bartnik et al.'s (2001) study provides some support for the viability of using TRT to clinically treat hyperacusis. As aforementioned, since habituation treatments are argued to be most successful when used over 18 to 24 months (Jastreboff & Hazel, 1993), the researchers predicted that if they had increased the duration of treatment they would have observed greater improvements. Further research on clinical results is recommended to confirm the impact of duration on the effectiveness of treatment.

Formby and Gold (2002) present noteworthy clinical findings suggesting that LDL shifts with TRT treatments can be experienced not only by patients with abnormally reduced tolerance levels, but also for

hearing impaired patients with restricted dynamic range and normal LDLs. Patients with hearing loss with significantly reduced dynamic ranges may not be considered good candidates for amplification, or if hearing aids are tried they may not be successful. Thus, it seems logical to extend TRT principles clinically to this difficult to treat population. With support from future research in this area, TRT may be extended beyond the treatment of tinnitus and hyperacusis.

Although there are several papers that provide expert opinions and assumptions regarding the auditory gain control theory, little research is available to support or refute it. Formby, Sherlock, and Gold's (2003) investigational study, however, presents raw data that follow predictions of the model. Their findings may indicate that traditional treatments (such as sound attenuators or earplugs) can cause further problems for hyperacusic patients, and should not be used clinically, although this effect remains to be tested on the hyperacusic population. However, sound exposure therapies (such as TRT) can significantly alleviate hyperacusis, and may therefore be implemented in practical settings. There are no other data that directly compare sound attenuating and sound enhancing therapies. Thus, specific research in this area is needed to support TRT and the auditory theory that underlies it. Future studies could replicate Formby et al.'s research since the authors include detailed descriptions of instruments and fitting procedures.

An increasing number of centres around the world are using TRT to treat hyperacusis. The studies mentioned above were conducted at specialized tinnitus and hyperacusis centres that likely used trained clinicians. In each paper, the authors do not clearly state their protocols and the treatments undertaken. However, treatment benefits may or may not generalize to novice clinicians, therefore, seeking comprehensive training in TRT may help facilitate generalization of these benefits by other clinicians. Support for using TRT clinically could be enhanced if centres continue to assess patient outcomes in their own clinics, and if these outcomes show the aforementioned findings demonstrated by the specialist centres. It will be interesting to observe if patient results in these centres are as successful as those run by experts in the field.

All the above research addresses patient outcomes after exposure to both components of TRT (i.e. directive counselling and noise therapy). Another area for future research is to have more controlled studies that evaluate the efficacy of the individual treatment components of TRT. That is, program evaluation data reported to date show significant benefit, but they all employed a multi-strategy treatment approach. It is not currently possible to determine which treatment element generated the observed change following therapy. Future studies should evaluate specific components of TRT to determine which may be responsible, or if all elements are necessary for all patients.

Conclusion

TRT is certainly not the only method available to treat hyperacusis. Although there are few scientific studies available to support the effectiveness of TRT to alleviate hyperacusis, the 3 papers reviewed are generally well conducted and provide a good starting point.

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Critical Review:
What Evidence is there to Support the Bilingual-Bicultural Model of Literacy Education for the Deaf?

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This critical review examines the research evidence supporting the use of the bilingual-bicultural model to teach literacy skills to deaf students. Articles found include both quantitative and qualitative research designs. Quantitative study designs include posttest-only designs. Qualitative study designs include: grounded theory, phenomenology, and an ethnographically inspired methodology. Overall, research supports the use of the bilingual-bicultural model of education to improve literacy skill development in deaf students.

Introduction

Sign Language is a nonverbal mode of communication where information is exchanged between conversation partners using hand signs, gestures, body language and facial expressions. There is no written code in Sign Language (Evans, 2004). As such, those who communicate through sign language do not use writing, nor do they read. In order to help deaf individuals develop literacy skills, the orthographic code of a written language must be taught. In the majority of the articles researched for this paper, the written code taught to deaf students was English. Deaf children who use Sign Language (most commonly, American Sign Language), as their first language, are taught to read and write in English, which is considered to be their second language. This is known as the bilingual-bicultural model, as students of the approach are taught to become fluent in a second language in addition to their first language (Evans, 2004).

The critical reason for substantiation of research in support of the bilingual-bicultural model of deaf literacy education lies in the fact that this model is already being applied in the curriculum of schools for the Deaf. The application of this model is worldwide, including schools in Canada (Evans, 2004), the United States (Prinz & Strong, 1998), Australia (Komesaroff, 2001), and Sweden (Bagga-Gupta, 2002). As this model is already being used to teach literacy skills globally, it is important to determine what evidence there is to support this method. Since the development of literacy skills is of such importance today, the method by which these skills are taught must be critically evaluated to determine its effectiveness.

Objectives

The primary objective of this paper is to critically evaluate the existing literature on the use of the bilingual-bicultural model to teach literacy skills in Deaf education. The secondary objective is to make recommendations regarding future research to add to the evidence base for the bilingual-bicultural method.

Methods

Search Strategy

Computerized databases, including CINAHL and Medline, were searched using the following search strategy:

> (literacy) AND (deaf) OR (hard of hearing) OR (hearing impaired) AND (bilingual-bicultural).

The search was limited to articles written in English.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to investigate the development of literacy skills in students being taught via the bilingual-bicultural education model. There were no limits set on the demographics of research participants or outcome measures.

Data Collection

Results of the literature search yielded both quantitative and qualitative studies matching the previously described selection criteria: posttest-only comparisons (3), grounded theory (1), phenomenology (1), an ethnographically inspired methodology (1), and a critical review (1).

Results

Three studies used posttest-only designs to examine American Sign Language (ASL) abilities and English literacy of Deaf students (Padden & Ramsey, 1998; Prinz & Strong, 1998; Singleton, Supalla, Litchfield, & Schley, 1998).

Prinz and Strong (1998) used a one-group posttest-only design to compare 155 students enrolled in a bilingual-bicultural school setting. Students were compared with regard to their ASL abilities and their literacy abilities. Students were classified according to their ASL proficiency (low, medium or high). Comparisons were then made to determine if increased ASL proficiency resulted in higher scores on literacy measures. ASL abilities were determined using a measure designed by the study's authors called the Test of ASL (TASL). English literacy abilities were determined using subtests of the Woodcock-Johnson Psychoeducational Test Battery, Revised (WJ-R), the Test of Written Language (TOWL), and a written narrative based on a wordless story (also used to assess ASL skills).

Prinz and Strong (1998) reported a statistically significant correlation between the students' ASL proficiency and their English literacy skills, but they did not report the Pearson r correlation results. The authors interpreted the findings to indicate that "ASL skill may predict greater English literacy performance" (p. 53).

Padden and Ramsey (1998) used a posttest-only design with non-equivalent groups to compare 31 deaf children, 13 of which attended a public school (i.e. Total Communication approach), and 18 of which attended a residential school (i.e. bilingual-bicultural approach). ASL abilities were measured using two subtests from a battery designed to measure skills in ASL morphology and syntax (Supalla, Singleton, Newport, Supalla, Coulter and Metlay, in press): the Verb Agreement Production subtests and the Sentence Order Comprehension subtest. A third test was developed and administered to measure memory for ASL sentences. The authors did not cite a source for this test. Reading ability (i.e., literacy skills), was measured using the reading comprehension subtest of the Stanford Achievement Test normed for hearing impaired students (SAT-HI).

Padden and Ramsey (1998) found a correlation between ASL test scores and reading comprehension test scores ($r=0.46$ for reading comprehension and ASL imitation, $r=0.51$ for reading comprehension and ASL verb agreement, and $r=0.76$ for reading comprehension and ASL sentence order comprehension, $p<0.05$ or $p<0.01$). The authors concluded that there was a relationship between ASL skills and reading skills among certain populations of deaf children.

Singleton, Supalla, Litchfield, and Schley (1998) used a posttest-only design with nonequivalent groups to study 53 profoundly deaf students from three different educational settings: 26 from ASL/English bilingual residential school who used the bilingual-bicultural approach (i.e., high exposure to ASL), 11 from a traditional residential school using Total Communication, where English-based signing with spoken English was used in school, and exposure to ASL occurred outside of the school setting (i.e., some exposure to ASL), and 16 from self-contained classrooms in public schools (i.e., virtually no exposure to ASL). ASL abilities were assessed using the American Sign Language Proficiency Assessment (ASL-PA). The results indicated that there was a significant difference ($p<0.001$), between ASL skills in the students across the three school settings, with a higher percentage of ASL/English bilingual students scoring in the high ASL proficiency group than the traditional residential school students. Those students attending public school scored poorly on the authors' test of ASL skills.

Singleton, Supalla, Litchfield, and Schley (1998) concluded that ASL proficiency is positively associated with English proficiency, with greater mastery of ASL being correlated with higher English proficiency. Evidence for this conclusion is cited from their previous work and the work of other authors (Hoffmeister, 1996; Padden and Ramsey, 1997; Schley, 1994; Singleton et. al, 1997; Singleton et. al, 1998; Strong and Prinz, 1997), but they do not provide evidence from their results to support this.

The remaining three studies used qualitative methodologies to examine ASL abilities and English literacy in Deaf students (Komesaroff, 2001; Evans 2004; and Bagga-Gupta, 2002).

Komesaroff (2001) used a phenomenological approach to document her work with an Australian Deaf school and her efforts to change their educational model from one dominated by English-based teaching to one that adopts Auslan (Australian Sign Language) and the bilingual-bicultural model of education. The author used interviews, classroom participation, observation, and formal and informal group meetings to determine and address the level of teacher and parent satisfaction with the English-based

model of education. At the conclusion of her research, the teachers and parents endorsed the commencement of a bilingual-bicultural approach within their school setting.

Evans (2004) used grounded theory to gather research on literacy skill development within a bilingual-bicultural learning environment. Evans used interviews, observation, and informal and formal assessment measures to gather information. Study participants included three deaf students, their parents, and their teachers. From her research, two themes emerged: teaching strategies that support a bilingual-bicultural approach, and inconsistencies within the bilingual-bicultural approach.

Bagga-Gupta (2002) used an ethnographically inspired methodology to gather information regarding bilingual instructional interactions and everyday language use within two Deaf upper secondary schools in Sweden. In this population, Swedish Sign Language (SSL) is considered the 'first language' and Swedish is considered their second language. Information was gathered through various informal means including: videotaped classes, field notes, informal discussion, and the written reflections of teachers. Bagga-Gupta concluded that by offering students the opportunity to access and participate in a bilingual-bicultural atmosphere, this extends the students' Swedish language competencies and presents opportunities to participate in literacy activities.

Recommendations

All evidence retrieved supports the use of the bilingual-bicultural model for teaching literacy skills to deaf students. Due to the methodological flaws evident in these studies, the following recommendations are offered based on weaknesses inherent in the research. These recommendations can be used in future studies to increase the strength of research evidence.

Quantitative Research

Study Design

None of the authors clearly defined their study's design. It appears that all authors used a posttest-only design, where assessment results of comparison groups were collected and compared on only one occasion. It is recommended that future research apply a prospective longitudinal design, in which data is collected and compared between study groups on more than one occasion. This would allow for comparison of literacy skill development at progressively more difficult levels within the school setting.

Sampling

Ethically, randomization of the study participants would not be possible for this population, as it would mean assigning a child to an entire education system that adopts one teaching method over another. Allocation into a school program that employs a bilingual-bicultural approach, an English-only mainstreamed approach, or another approach, remains the choice of the child's family, and should not be compromised for research purposes.

However, increased effort should have been put forth by the authors of these studies to ensure that results were generalizable. The study participants to date have been children from only one or two schools at the most. As such, it is recommended that future research include deaf students from multiple "mainstreamed" schools, multiple schools using the bilingual-bicultural model, and multiple schools adopting any other approaches. This would allow for study results to be generalized to a larger population of deaf students, as well as improve external validity of the study conclusions.

Inclusion/Exclusion Criteria

Only one of the quantitative studies (Prinz & Strong, 1998) listed the inclusion/exclusion criteria for its participants. It is recommended that future researchers clearly state their inclusion and exclusion criteria, and only include study participants classified as profoundly deaf (i.e., hearing loss of 90dBHL or greater). The classification of "profoundly deaf" ensures participants do not possess the ability to acquire their second language (e.g., English) through aural means. Researchers should also report the results and the criteria used for the label of "profoundly deaf", (e.g., pure tone average at 500, 1000, 2000 Hz greater than 90 dBHL), as well as provide information regarding the onset of the hearing loss (i.e., pre-lingual or post-lingual), the use of amplification, and whether each study participant had a "hearing" or a Deaf family. Information regarding family involvement and Socioeconomic Status (SES) should also be provided. It is also recommended that participants with cognitive and/or learning disabilities be excluded from future research conducted on "typically developing" deaf children. As literacy is the dependent variable being measured, the exclusion of participants who have cognitive and/or learning deficits prevents results from being skewed.

Measurement Tools

For the most part, the authors used well-known, standardized tests to assess English literacy skills. However, due to the shortage of available tests to assess ASL abilities, the authors often created their own tests to assess ASL skills (e.g., Prinz & Strong, 1998). While this practice is acceptable, multiple authors (i.e. Prinz & Strong, 1998; Padden & Ramsey, 1998) provided the reader with little evidence of the psychometric properties of their tests. Modest information related to test construction was available within the body of their papers, and when a reference was provided to confirm psychometric qualities, it was discovered that this information was only available through "unpublished manuscripts". This left the reader with no available source to confirm the reliability and validity of the tests being used. It is recommended that future researchers ensure that there is detailed information available to the reader concerning test construction and the psychometric qualities of the test in question.

Study Results

Of the articles evaluated, very little information was presented to the reader in terms of numerical results of testing. Very few charts or tables were used to present study results, and very few numerical results (if any) were published within the body of many of the papers. As such, replication of the study results would be impossible for future researchers. It is recommended that future research include a clear description of the numerical results, especially when claims of statistical significance are being made.

Qualitative Research

Description of Sampling Methods

The sampling methods employed in each study were not clearly defined by the authors. It is recommended that future research clearly describe how and why study participants were chosen.

Potential for Bias

Strategies used by some of the authors to control for bias included member checking, transcripts, and the recording field notes immediately after observations to ensure accuracy of information. However, in all of the qualitative studies evaluated for this paper, the research was both conducted and interpreted by the study author. It is recommended that future research also have a second person interpret the results in addition to the author.

Conclusions

The development of literacy skills is important for all students, including those who are deaf. At present, there are several different educational approaches in use to teach literacy skills, including: mainstreaming deaf students into "regular" schools, the bilingual-bicultural approach, and a mixture of both of these education strategies. The research presented in this paper argues for the implementation of the bilingual-bicultural approach to aid the development of literacy skills in the deaf population.

The research collected for this paper demonstrates that there is limited published evidence available at present to support the bilingual-bicultural approach for literacy education of the Deaf population. That being said, there was no published information found that opposed the bilingual-bicultural approach. While the research articles evaluated in this paper do possess methodological failings, they remain the only evidence available to date to support the use of this educational model. As such, the results of this search must be taken to represent some support for the use of the bilingual-bicultural model, and its use as a strategy to promote literacy development. Future research, which utilizes stronger methodological study designs, is needed in order to strengthen the existing evidence for the bilingual-bicultural model.

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Critical Review: Does Speech Perception Training Improve Sound Production for Children with Articulation or Phonological Disorders?

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This critical review examines the efficacy of using speech perception training in the treatment of children with articulation or phonological disorders. Study designs include: Between subjects pre-test post test control, within subjects pre-test post test, multiple baseline and cross over designs. Overall, the majority of research supports the inclusion of speech perception training as an important component in the management of articulation or phonological disorders; however, the value of speech perception training in isolation from speech production training components requires further investigation.

Introduction

Phonological disorders affect 10% of preschool and school age children and are among the most prevalent of diagnosed communication disorders in childhood (Gierut, 1998). A phonological disorder can result in an inability to produce speech sounds accurately or may also affect the child's mental representation and storage of speech sounds. Both the child's articulation and internalized knowledge of the sound system may be compromised if a phonological disorder is present (Gierut, 1998). For the purpose of this review, the term 'articulation disorder' falls under the umbrella term of phonological disorders.

Speech perception training is one approach that is used in the treatment of phonological disorders. Speech perception training is a general term, referring to treatment approaches that focus on identification and discrimination of the child's error sound from the standard speech sound (Wolfe, Presley & Mesaris, 2003). The goal is to help the child hear the difference between his or her current sound production and the correct sound production, creating an internalized target to use as a guide. This may improve the child's ability to self-monitor his or her productions, which is a crucial component of intervention (Rvachew, 1994).

Throughout the history of Speech-Language Pathology, speech perception training has been a controversial issue, and has received criticism in favour of more traditional sound production training approaches, which focus on the motoric aspects of producing sounds (Rvachew, 1994). Considering the increased pressure placed on treatment accountability and therapy outcomes, as well as the high prevalence of phonological disorders, a critical examination of the use of speech perception techniques in the treatment of phonological disorders holds important clinical implications.

Objectives

The primary objective of this paper is to critically evaluate the existing literature regarding the impact of speech perception training in the treatment of children with phonological disorders. The secondary objective is to propose evidence-based practice recommendations concerning the inclusion of speech perception training in the treatment of phonological disorders.

Methods

Search Strategy

Computerized databases, including CINAHL, PubMed, and Web of Science, were searched using the following search strategy:

> ((speech perception training) OR (sound identification training) OR (phonemic perception) OR (speech discrimination) OR (auditory training) OR (ear training) OR (distinctive features training) OR (articulat* therapy) OR (phonolog* therapy) AND ((articulat*) OR (phonolog*) OR (speech) OR (delay*) OR (discrim*) OR (impair*))

The search was limited to articles written in English.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to investigate the impact of any type of speech perception training program on the sound production abilities of children with

phonological disorders. Treatment programs that included mixed training (i.e., speech perception training and sound production training concurrently) as well as programs that focused on speech perception training as the sole component of therapy were included. No limits were set on the demographics of research participants or outcome measures.

Data Collection

Results of the literature search yielded the following types of articles congruent with the aforementioned selection criteria: between subjects pre-test post-test control (4), within subjects pre-test post-test (4), multiple baseline (1), and cross-over (1) designs.

Results

Wolfe, Presley and Mesaris (2003) and Rvachew, Nowak, and Cloutier (2004) each conducted a study to examine the effects of using a perceptual approach in the treatment of preschoolers with phonological disorders. The authors compared a program of concurrent speech perception and sound production training (i.e., mixed training) to a sound production training program to determine the impact that adding a perceptual component to treatment has on sound production abilities.

A between-subjects pre-test post-test control design was used by Wolfe et al. (2003) and Rvachew et al. (2004), which was an appropriate choice of design to answer the authors' stated purposes. To ensure that there were no significant differences between the groups that may confound the results, Wolfe et al. (2003) and Rvachew et al. (2004) randomly assigned their participants to groups. The control groups used in the studies provided an excellent comparison group as they received a traditional form of sound production training. Appropriate statistical analysis were completed. A non-parametric Mann-Whitney U test was completed to account for the small sample size in the study completed by Wolfe et al. (2003). Rvachew et al. (2004) used ANCOVA to determine the variance of the participant's pre-treatment performance, and also conducted a t-test to determine that no statistical difference existed between groups. A large effect size was reported for speech perception training (Rvachew, 2004).

A small sample size and the fact that some of the conclusions were drawn from previous data were limitations in the study conducted by Wolfe et al. (2003). Rvachew et al. (2004) failed to control for the fact that some members of the control group may have been exposed previously to some perceptual training components. Despite these limitations, these studies relied on appropriate methodology, allowing them to fully address their stated purposes.

Rvachew et al. (2004) found that greater gains in sound production were made for the children receiving mixed training compared to those who received sound production training only. Wolfe et al. (2003) found that mixed training was more effective only for those children who had difficulty with sound perception prior to the initiation of therapy. No significant difference was found between treatment types for those children who had strong speech perception skills prior to treatment.

Four of the ten research studies reviewed (Rvachew, 1994; Rvachew & Jamieson, 1992; Weiner, 1981; Williams & McReynolds, 1975) were found to have moderate methodological limitations that decrease the strength of their findings. Weiner (1981) and Williams and McReynolds (1975) both conducted descriptive research studies, and did not include statistical analysis, making it difficult to determine if changes were attributable to treatment. Weiner (1981) sought to examine the efficacy of minimal pairs therapy as treatment for unintelligible speech. Using a multiple baseline design to control for lack of comparison groups, Weiner (1981) was able to answer his stated purpose, concluding that minimal pairs treatment was an effective approach to use in the remediation of phonological disorders. Although the results of this study provide support for the use of speech perception training, it would have been more effective to compare minimal pairs therapy against the alternative of sound production therapy. The small sample size included in this study further limits the impact of the author's results.

Williams and McReynolds (1975) examined the effect of speech perception training on articulation using a cross-over design to control for any effects the order of treatment may have. Although the research design was appropriate, participants were not randomly assigned to groups and information was not provided on how the various sounds were chosen for treatment. A final methodological weakness was that participants were trained to produce sounds incorrectly, which is not currently an ethical practice, and may have influenced the authors' results. Results from this study indicated that speech perception training was effective only in improving the child's ability to perceive sounds with no accompanying improvement in sound production, whereas, sound production training was effective in improving a child's production and perception of the sound.

Two other studies (Rvachew & Jamieson, 1992; Rvachew, 1994) can also be classified as mediocre in design and methodology. Rvachew and Jamieson (1992) investigated whether speech perception training alone could facilitate sound production learning in children with articulation disorders. The purpose of the study by Rvachew (1994) was to further demonstrate that speech perception training does improve sound production. Rvachew and Jamieson (1992) employed a within subjects pre-test, post-test design with randomization tests to account for individual responses to the treatment. Rvachew conducted a between-subjects pre-test, post-test design. Both of these designs were capable of answering the purpose outlined by the authors and statistical analysis was performed appropriately. Rvachew and Jamieson (1992) reported p-values and pooled p-values, and Rvachew (1994) used ANOVA to determine that there were no significant differences between groups. Rvachew and Jamieson (1992) used a small sample size and considerable variability was noted between subjects. Although Rvachew (1994) had a large sample size, outliers were discovered and upon removal of the outliers from the data, significant differences were noted between the groups. Results from Rvachew and Jamieson (1992) indicated that speech perception training was effective in improving sound production for children who display both abnormal sound perception and production. Rvachew (1994) concluded that speech perception training, when provided concurrently with sound production training, can facilitate sound production for some children.

The remaining four research studies included in this critical review (Rvachew, Raffaat, & Martin, 1999; Saben & Ingham, 1991; Shelton, Johnson & Ruscello, 1978; Tyler, Edwards & Saxman, 1987) had many methodological limitations and provided weak support to answer the question of whether speech perception training improves sound production in children with phonological disorders. Two of the studies (Saben & Ingham, 1991; Tyler et al., 1987) had very small sample sizes limiting the generalizability of their results. Saben and Ingham (1991) and Tyler et al. (1987) were descriptive studies with no statistical analysis, however the authors did utilize an appropriate within subjects pre-test, post-test design. Saben and Ingham (1991) sought to establish the success of using a minimal pairs treatment without a motoric component to change sound production in two preschool children. The authors were not able to fully achieve their purpose as motoric components were added to the treatment in order for the children to achieve success. Results were not calculated prior to the addition of the motoric component, therefore, it can only be determined that minimal pairs that incorporate both speech perception and speech production components, were successful in improving sound production.

Tyler et al. (1987) conducted a study to determine how a minimal pairs and a cycles treatment approach could be used to remediate articulation disorders in four preschool children. Both the minimal pairs and the cycles program include a perceptual component as well as training in sound production. One of the main limitations of this research was that the treatment groups were carefully chosen based on each individual child's appropriateness for the treatment. This may have confounded the study's results, as participants were carefully selected to 'succeed' in a specific treatment program. Based on the results, the authors proposed that both minimal pairs and cycles approaches were effective therapy programs in the treatment of children with phonological disorders. The evidence for the use of speech perception training would have been significantly stronger had the authors included a comparison group receiving only speech production therapy.

Using a within subjects pre-test post-test design, Rvachew (1999) conducted a research study attempting to describe the relationship between pre-treatment stimulability and speech perception training, and their impact on sound production. Little information was provided on the characteristics of the participants, therefore, confounds such as whether the children had previously received treatment and whether they were stimulable for the target sounds were not controlled. The results revealed that when stimulability and speech perception skills were targeted specifically, gains were observed for most sounds, including those that were unstimulable or poorly perceived prior to treatment. Although Rvachew (1999) may have achieved her stated purpose, this study provides weak evidence to answer the specific research question of this review as the influence of speech perception training on sound production was not isolated from the influence of stimulability training.

The final study included within this review was conducted by Shelton et al. (1978), who evaluated the effect of parent administered listening procedures on the participants' responses to articulation training. The participants were chosen for this study based on their availability from a previous study also conducted by the authors. The authors determined

that the study results were confounded due to lack of equivalence between groups due to loss of participants. Furthermore, the fact that the listening procedures were administered by parents, rather than by clinicians as in the previous literature, may also have confounded the results. The authors made strong statements that the listening training procedures had no effect on the child's response to articulation training. However, due to the considerable methodological constraints, more caution should have been exercised in making such claims.

Recommendations

The important issue of whether speech perception training is a useful therapy procedure in the treatment of children with phonological disorders has been carefully scrutinized through a critical review of the literature surrounding this topic. Of the ten research studies that were examined, eight of the studies (Rvachew et al., 2004; Rvachew et al., 1999; Rvachew, 1994; Rvachew & Jamieson, 1992; Saben & Ingham, 1991; Tyler et al., 1987; Weiner, 1981; Wolfe et al., 2003) were in support of using speech perception training either in isolation or in combination with other sound production training techniques to improve the accuracy of sound production. Two of the research studies (Williams & McReynolds, 1975; Shelton et al. 1978) were against the use of speech perception techniques, as improvement in sound accuracy was not achieved in their samples.

Upon critical review of the methodology of these studies, the quality of much of the evidence was found to be questionable. Although Wolfe et al. (2003) and Rvachew et al. (2004) completed methodologically solid studies, many of the other studies examined were found to possess some significant methodological flaws and weaknesses. Although the quality of the evidence of the research may be mediocre, the fact that 80% of the available literature supports the use of speech perception training is a difficult factor to ignore. The two studies that were not in support of using speech perception in the treatment of phonological disorders were found to be seriously flawed in methodology, providing little support against the use of speech perception training.

Based on the findings of this critical review, it is recommended that speech perception training be used only in combination with traditional sound production training methods to improve sound production in preschool children with phonological disorders. Common therapy approaches such as minimal pairs and cycles approach that incorporate both perception and production components are effective choices of therapy techniques. There is not yet consistent and sufficient evidence to support the use of speech perception training in isolation as a therapy technique in the treatment of phonological disorders and therefore, this is not recommended at this time.

Conclusion

To fully resolve the controversy over the use of speech perception training in the treatment of phonological disorders, further research into this field is necessary. Research that compares a group of children receiving speech perception training alone to a group receiving only mixed training would be effective in determining if speech perception training alone can sufficiently treat phonological disorders. Further research should also include comparison groups that receive either mixed training or production only training, thereby, isolating the component of perception training. This would present clear and strong evidence for or against the use of this technique.

The majority of the research conducted within this field focuses on the use of speech perception training in preschool children. Including older children in this research would be an appropriate way to determine if expanding this technique to early school-age children would be appropriate. Future research is also needed to better understand the influence of pre-treatment sound perception ability on the efficacy of speech perception training. Current evidence on this point is equivocal. Wolfe et al. (2003) reported that speech perception training was not effective in improving articulation when sounds were poorly perceived prior to treatment, however; Rvachew et al. (1999) claim that speech perception training is effective regardless of prior perception ability. If research were available to determine that pre-treatment sound perception ability influences the success of speech perception training, an assessment of sound perception prior to treatment would be an important factor to consider when choosing treatment approaches for each individual child. Conflicting evidence also exists about the influence of pre-treatment stimulability on the effectiveness of speech perception training, and more extensive research is needed to conclude whether this factor plays a significant role in treatment outcome.

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Critical Review:
Is the modified barium swallow a reliable method of assessing swallowing function?

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This critical review examines the interrater reliability of measures of swallowing function using modified barium swallow examinations. Study designs include 8 diagnostic test studies. At this time, the interrater reliability appears to be low when independent observers are using unfamiliar rating tools. Reliability appears to improve when judges are given information regarding how to use the appropriate scales.

Introduction

Swallowing disorders occur across the lifespan and can be caused by a variety of factors, including congenital anomalies, acute or chronic medical conditions, and structural damage (Logemann, 1998). The assessment and management of swallowing disorders fall within the practice of speech-language pathologists (Wilcox, Liss, & Sigel, 1996). As such, speech-language pathologists have the primary responsibility of ensuring that the methods, techniques, and tools used to assess and manage dysphagia are valid, reliable and efficacious (Wilcox, Liss, & Sigel, 1996). One such method frequently used in the assessment of dysphagia is the modified barium swallow (MBS) study.

Swallowing is a complex activity, composed of a series of quick and intricate movements. Direct observation of these integrated movements of swallowing is difficult, if not impossible, during a clinical bedside examination (Scott, Perry, & Bench, 1998). The introduction of videofluoroscopic techniques into the field of swallowing disorders allows for direct visualization of these rapid and dynamic movements as a moving x-ray of the swallow. Videofluoroscopic methods have greatly enhanced the understanding of the swallowing process (Scott, Perry, & Bench, 1998).

The modified barium swallow (MBS) is the assessment tool frequently used to evaluate the swallowing structures and physiology of individuals with dysphagia through the use of videofluoroscopy (Wilcox, Liss, & Sigel, 1996; Gibson, Phyland, & Marschner, 1995). The MBS serves two major purposes in the assessment and management of dysphagia: 1) identification and characterization of structural or physiological abnormalities accounting for the swallowing pathology, and 2) identification and assessment of possible treatment or compensatory strategies that will allow a patient to resume oral intake safely (Logemann, 1998). While alternative procedures for examination of swallowing dysfunction do exist (e.g., ultrasound, cervical auscultation, fiberoptic endoscopic examination of swallowing (FEES), clinical bedside evaluation), none of these techniques can provide the same quality and amount of diagnostic information as the MBS (Wilcox, Liss, & Siegal, 1996). As such, the MBS has become the "gold standard" technique for assessment and management of dysphagia.

The MBS has become the "gold standard" in the assessment and treatment of deglutition disorders on the basis that it provides "objective" support to alternative forms of evaluation (Gibson, Phyland, & Marschner, 1995). However, the interpretation of the MBS in fact depends on clinicians making subtle, subjective judgments about the structure and function of the swallowing mechanism. As such, the degree to which clinicians consistently and reliably rate MBS assessments must be examined (Gibson, Phyland, & Marschner, 1995)

If patients are to be followed over time to assess changes in functioning, and if different professionals or clinicians will be providing re-assessment of patients, test reliability and interrater reliability are of particular importance. A difference in patient functioning can be assumed to be the result of real change in patient status *only* if the reliability of the test is high. If the reliability of the assessment tool is low, a difference in patient score cannot be attributed confidently to actual change in functioning (Lambert, Gisel, & Wood-Dauphinee, 2001).

Poor dysphagia management can have potentially fatal consequences, such as aspiration pneumonia or occlusion of airway. Decisions based on the results of an initial MBS (e.g., cessation of oral intake, surgical intervention, postural compensations), as well as successive MBS studies (rating the appropriateness and effectiveness of treatment, rating

progress of dysphagia) require accurate, consistent observations of swallowing function. The subjective nature of the assessment and the potentially life threatening consequences of these clinical ratings demand that the degree of rater consistency and reliability be examined (Gibson, Phyland, & Marschner, 1995).

Objectives

The primary objective of this paper is to critically evaluate existing literature regarding the interrater reliability of swallowing function using the MBS.

Methods

Search Strategy

Computerized databases, including CINAHL, Ovid Medline, and AMED, were searched using the following search strategy:

> ((videofluoroscopy) OR (modified barium swallow) AND ((reliability) OR (interrater reliability) OR (observer reliability) AND (dysphagia) OR (swallowing) OR (deglutition)).

Selection Criteria

Studies selected for inclusion in this critical review paper were required to specifically investigate the interrater reliability of at least one measure of swallowing function using ratings from a MBS assessment. Results of the literature search yielded eight diagnostic test studies.

Results

One of the first investigations attempting to assess interrater reliability of swallowing observations was conducted by Ekberg, Nylander, Fort, Sjoberg, Birch-Iensen, and Hillarp (1988). In their study, Ekberg and colleagues (1988) assessed the reliability of cinderadiographic ratings of pharyngeal swallowing function of 72 patients with dysphagia of varying severity using 6 radiologists. Independent, binary ratings were made regarding a number of aspects of the pharyngeal swallow following instructional sessions regarding how to use the rating scales. The authors reported that ratings across all 6 radiologists were generally acceptable (kappa coefficients ranging from 0.22 to 0.84) with high agreement for presence of Zenker's diverticulum (kappa = 0.84) and laryngeal penetration (kappa = 0.83). Ratings of normal pharyngeal function and web in cervical esophagus also reached high levels of agreement (kappa = 0.70).

Gibson, Phyland, and Marschner (1995) attempted to address observer agreement on modified barium swallow ratings with 4 speech-language pathologists within the same hospital department. Eight patients referred for dysphagia assessment were evaluated across 6 variables relevant to a Parkinsonian swallow. Almost all raters agreed that only mild aspiration occurred on any of the swallows. Gibson and colleagues (1995) reported that interrater reliability was high for other variables, including oral and pharyngeal phase time (correlation of 0.99 and 0.98 for first and second ratings) and number of swallows (kappa of 0.87 and 0.89). Good reliability was further reported for tongue elevations (correlation of 0.74 and 0.68) and place of bolus at initiation of swallow (kappa of 0.64 and .037)

Wilcox, Liss, and Siegal (1996) investigated the interobserver agreement of 10 hospital speech language pathologists with a range of professional experience. The interrater reliability of videofluoroscopic measures of swallowing function was assessed with 3 patients diagnosed with dysphagia. Binary ratings of swallowing function in both the oral and pharyngeal stages of swallowing were conducted subsequent to raters receiving detailed information regarding patient history, bedside swallowing examination results, and outcomes of oral-facial and oral motor examinations. Results were analyzed using a self-determined method for reliability calculation (i.e., agreement defined as a category that received 7 or more tallies out of 10 observer ratings) to individually assess 'agreement of absence' and 'agreement of presence' individually for each patient across all variables. Agreement was variable across all patients and despite the "lenient" agreement criteria, "instances of high agreement among the clinicians were not abundant" (Wilcox, Liss, & Siegel, 1996, p. 151).

Kuhlemeier, Yates, and Palmer (1998) assessed the reliability of ratings across 9 different judges (4 physicians and 5 speech-language pathologists) using 20 patients with varying degrees of swallowing difficulties, from normal swallowing physiology to severely impaired swallowing. Different aspects of swallowing physiology in both oral and pharyngeal stages were observed and measured using a 4-point rating scale. Results were analyzed using positive and negative reliability ratios with the authors reporting adequate interrater reliability for observations relating to the oral stage, laryngeal penetration/aspiration, and pharyngeal retention (Kuhlemeier, Yates, and Palmer, 1998). Greater agreement occurred between judges when a swallow was rated as 'normal' as compared to reliability

ratings for 'abnormal' swallows for both oral stage and laryngeal penetration/aspiration observations. Interrater reliability was questionable for all other functional measures (e.g., laryngeal elevation, epiglottic tilt; Kuhlemeir, Yates, & Palmer, 1998).

Scott, Perry, and Bench (1998) assessed the reliability of videofluoroscopic measures of swallowing function with 9 speech-language pathologists. Three patients were assessed (2 with dysphagia relating to motor neuron disease and one patient without dysphagia), and ratings were compared across three conditions: independent ratings without knowledge of the rating scales, consensus ratings with colleagues after discussion of the scales, and a second independent rating after knowledge of the scales. Different aspects of swallowing physiology in both oral and pharyngeal stages were observed and measured by blinded raters using a 5-point rating scale. Scott and colleagues reported the highest level of agreement of ratings when judges were permitted to collaborate with colleagues to achieve ratings. Reliability of ratings in Condition 2 (where collaboration was allowed) was significantly better than in both Condition 1 (independent ratings) and Condition 3 (independent ratings following discussion of scales; Scott, Perry, & Bench, 1998).

McCullough, Wertz, Rosenbeck, Mills, Webb, and Ross (2001) describe a study completed with 3 speech-language pathologists in which the interrater reliability of videofluoroscopic measures of swallowing function was assessed with 20 patients post-stroke with varying degrees of dysphagia. Different aspects of swallowing physiology were measured by raters blinded to patient condition using binary, duration, and 8-point ratings scales. The authors reported the interrater reliability for most ratings were variable and unacceptable. One exception was the interjudge agreement on one particular binary rating of aspiration (i.e., presence/absence of aspiration for 10cc's of thin liquid), which reached 'moderate agreement' (kappa = 0.415).

Stoekli, Huisman, Seifert, and Martin-Harrin (2003) completed a prospective study with 9 'independent experienced observers' in which interrater reliability was assessed with 51 patients of nonspecified dysphagia. Different aspects of swallowing physiology in both the oral and pharyngeal stages were observed and measured by raters blinded to patient diagnosis. Assessments included binary ratings (e.g., presence/absence of lip closure), 3-point ratings (e.g., none, weak, or normal soft palate elevation), 8-point aspiration/penetration ratings, and measures of location and percentage of residue. Estimates of residual bolus were not statistically analyzed and most parameters, with the exception of 8-point aspiration/penetration scale were changed to binary ratings (e.g., normal versus pathologic) for statistical treatment. The authors reported poor interrater reliability for all measures (kappa coefficients for oralpharyngeal parameters ranging from 0.01 to 0.56) with the exception of acceptable agreement on the 8-point penetration/aspiration scale (Stoekli et al., 2003).

The most recent study attempting to look at reliability measurements across speech-language pathologists using modified barium swallows was conducted by Becker, McLeroy, and Carpenter (2005). Ten speech-language pathologists measured the swallowing function of 10 patients with neurogenic dysphagia resulting from a left cerebral cardiovascular accident. Different aspects of swallowing functioning in the pharyngeal stage were observed and measured by blinded raters using a 4-point clinical rating protocol. The authors cite 'acceptable level of agreement' for dichotomous clinical ratings (i.e., when 4-point scale collapsed into 'normal' versus 'abnormal'; kappa = 0.62 for all observations). However, individual clinical ratings within some contexts were questionable (e.g., aspiration and laryngeal elevation, kappa = 0.41; Becker, McLeroy, & Carpenter, 2005).

Discussion

Appraisal of the Results

The body of literature investigating the interrater reliability of ratings using the MBS have variable and often conflicting results. Many methodological issues need to be taken into consideration when evaluating the evidence.

Patients Analyzed

Because reliability is based on the "proportion of the total observed variance that is attributable to error", reliability measures will be more accurate as the total variance increases (Portney & Watkins, 2000, p. 559). Therefore, it is important in studies assessing the reliability of dysphagia assessment tools that patients with varying degrees of severity, from 'normal' to 'severely impaired' functioning and all degrees of functioning in between be included. Only 2 studies included patients of variable severity levels that represented the span from normal to severe (Ekberg et al., 1988; Kuhlemeier, Yates, & Palmer, 1998). The investigation completed by McCullough and collaborators (2001) included both patients with normal swallows and those with dysphagia, but it is

likely that those with the most severe forms of dysphagia were excluded from the analyzed data sample. Those patients who could not complete the entire MBS protocol due to 'bailout' criteria were not included for evaluation. Likely, these patients represented those individuals with the most severe form of dysphagia. The investigation by Scott and colleagues (1998) included 1 patient with a normal swallow and 2 patients with dysphagia as a result of motor neuron disease. It can be assumed that the entire range of swallowing functioning was not assessed with only 3 patients, two of which had the same diagnosis. The study by Wilcox et al. (1996) provided no information on the severity of dysphagia of their 3 patients, and did not included any patients without dysphagia. Similarly, Gibson and colleagues (1995) did not include anyone with a normal swallow, but did include 8 patients with dysphagia with varying diagnoses, suggesting possible variability in swallowing functioning in terms of degree and severity. Becker et al.'s (2005) study only analyzed patients with similar diagnoses limiting variability and did not include any patients with normal swallows. The evaluation of the appropriateness of the patients in the Stoeckli et al. (2003) study could not be assessed due to lack of information regarding the type of diagnoses of the patients.

Design

Only 3 of the eight studies critiqued used a prospective design (McCullough et al., 2001; Stoeckli et al., 2003; Wilcox, Liss, & Siegel, 1996), while four studies were retrospective in design (Becker, McLeroy, & Carpenter, 2005; Ekberg et al., 1988; Gibson, Phyland; Marschner, 1995; Kuhlemeier et al. 1998), limiting the methodological control of how the data was collected. The study by Scott and colleagues in 1998 provided no information about whether the data was collected prospectively or whether tapes were selected retrospectively for analysis.

Methods

Whether the participants rating the MBS studies were blinded to diagnoses of the patients they were rating was also a significant methodological concern. Those with prior insight into the diagnoses of patients provide weaker evidence. Ratings collected from non-blinded participants may be influenced by prior knowledge and expectations of swallowing functioning based on known etiology. Participants in 5 of the eight studies were blinded to the etiology and diagnoses of the patients to be rated (Becker, McLeroy, & Carpenter, 2005; Gibson, Phyland, & Marschner, 1995; McCullough et al., 2001; Scott, Perry, & Bench, 1998; & Stoeckli et al., 2003). Whether information was provided to participants regarding patient diagnoses was not addressed in the studies by Ekberg and colleagues (1988) and Kuhlemeier et al. (1998). In the Wilcox et al. (1996) investigation, all participants were given each patient's medical history and the results of clinical swallowing examinations (i.e., bedside, oral-facial, and oral motor) prior to viewing the swallowing function on the MBS. Although this study was conducted in such a way as to mimic actual clinical practice, the question of whether the MBS in itself is a reliable assessment tool was not addressed in this study.

The amount of time each rater was given to assess each videotape varied greatly across each study. Only two of the studies demonstrated tight control over the number of times, and for what period of time, each participant could view the individual swallows (Becker, McLeroy, & Carpenter, 2005; Kuhlemeier, Yates, & Palmer, 1998) suggesting a methodological improvement over those that allowed unlimited or less restricted time for viewing the swallows (Ekberg et al., 1988; Scott, Perry, & Bench, 1998; Stoeckli at al., 2003; Wilcox, Liss, & Siegel, 1996). The investigations conducted by McCullough et al. (2001) and Gibson and colleagues (1995) did not address time allowed for viewing. The studies that controlled viewing time (Becker, McLeroy, & Carpenter, 2005; Kuhlemeier, Yates, & Palmer, 1998) provide stronger evidence regarding the reliability of ratings. Any differences in judgments between participants in these studies can be attributed to true differences in clinician ratings, not the result of differing amounts of time given to view the swallows.

Finally, whether participants were given information regarding how to use the rating scales varied across all the studies. Three of the eight studies provided explanation or training to participants on how to use the particular rating scales (Becker, McLeroy, & Carpenter, 2005; Ekberg et al., 1988; Gibson, Phyland, & Marschner, 1995). Wilcox and colleagues (1996) used observation forms that were reportedly similar to those their clinicians used in swallowing practice, although no formal training sessions or explanations were provided. McCullough and colleagues (2001) provided no information to the judges pertaining to how their rating scales were to be used, while two other groups only provided explanations regarding the aspiration and penetration scales (Kuhlemeier, Yates, & Palmer, 1998; Stoeckli et al., 2003). The investigation conducted by Scott, Perry, and Bench (1998) assessed reliability across three conditions (no knowledge of rating scales,

collaborative ratings with colleagues, and judgments with knowledge of ratings scales) to assess whether having prior knowledge relating to how to use the observational scales improves reliability. While investigators have argued that lack of training increases clinical utility (e.g., McCullough et al., 2001), observers cannot be expected to exhibit high interrater reliability if they do not initially agree on how to use the rating scale.

Recommendations

It is difficult to have confidence in the evidence because of the number of methodological concerns. As well, comparison across studies becomes very difficult due to numerous methodological differences across all studies (e.g., different scales used, different rating scales used, different instructions given regarding how to use scales, different levels of experience and designation of judges and varied population of patient swallows analyzed). It is recommended that more research be conducted to assess the reliability of measurements made using MBS studies. Additionally, researchers are strongly encouraged to:

a) Assess swallowing function with a clinically appropriate/universal rating scale.
b) Ensure that all judges are trained on how to use the rating scales.
c) Randomly select patients for inclusion in the study that reflect the full range of swallowing functioning, including normal swallows.
d) Ensure raters are blinded to diagnoses of patients being assessed.
e) Extend research to investigate the reliability of clinical recommendations/treatments implemented using results from the modified barium swallow study to improve clinical importance of the research question.

Conclusions

It is difficult to assess the interrater reliability of judgments from a modified barium swallow based on the current evidence. Those investigations with the most sound experimental designs suggest that when raters are not trained on how to use rating scales, agreement of observations remains low. However, when judges are given adequate information on how to use different rating scales, reliability between raters improves. Such evidence suggests that a universal rating scale must be developed and used consistently and accurately across medical settings. Clinically, it is suggested that within institutions, speech-language pathologists all use the same, agreed upon rating scales.

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Critical Review:
What evidence is there that auditory verbal therapy is effective?

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This critical review examines the evidence available regarding the effectiveness of auditory verbal therapy. Study designs include a quasi-experimental design and survey studies. Overall, there is support that auditory verbal therapy is an effective intervention approach for children with hearing impairment; however, the literature does not compare its effectiveness to other auditory-oral approaches. The results of the present review should be interpreted with consideration of the inherent limitations of the methodology used in the reviewed studies.

Introduction

Auditory verbal therapy (AVT) is a specialized intervention approach for children who are deaf or hard-of-hearing. The auditory verbal philosophy has a logical and critical set of guiding principles (Goldberg, 1993). These principles delineate the requirements that are needed for young children with hearing impairments to be educated to use their residual hearing, regardless of how limited their residual hearing may be. AVT purports to teach these children to use any amplified residual hearing to learn to listen, to process verbal language and to speak. AVT stresses the importance of early identification of hearing loss, provision of the earliest and most beneficial amplification technology and intensive speech and language therapy. The goal of auditory verbal intervention is that children with hearing impairments can grow up in regular learning and living environments that enable them to become independent, participating, and contributing citizens in mainstream society (Goldberg, 1993).

AVT places an emphasis on the primary caregivers of children who are educated using this approach. Instruction is given to caregivers of their role as the primary models for spoken language and how to provide maximal acoustic stimulation within meaningful contexts. Caregivers are also given instruction for the implementation of one-to-one teaching which they would employ with their children (Goldberg, 1993). In light of this information, AVT is not a therapy that is solely provided within a therapy clinic a few hours per week but a therapy approach that must be practiced daily and infused into the child's lifestyle.

The importance of conducting research that evaluates the effectiveness of therapy approaches used by professionals is becoming rapidly apparent. Health care cutbacks, pay-for-service, patients' rights and the fact that AVT is the approach used within Ontario's Infant Hearing Program highlight a few of the many reasons why documented outcomes are of such significance.

Objectives

The primary objective of this review is to critically evaluate the current literature regarding what evidence there is that auditory verbal therapy is an effective intervention approach for children with hearing impairments. The secondary objective is to provide evidence-based practice recommendations for future research.

Methods

Search Strategy

Computerized databases, including CINAHL, PsychInfo, PubMed, and Web of Science, were searched using the following search strategy:

> ((Hearing Impairment) OR (Hard of Hearing) OR (hearing disabled) OR (Deaf)) AND ((Auditory Verbal) OR (Auditory Verbal Therapy) OR (AVT)) OR (auditory therapy) OR (Aural Rehabilitation) OR (therapy) OR (intervention) OR (treatment)

The search was limited to articles written in the English language.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to provide evidence of the effectiveness of auditory verbal therapy. No restrictions were made related to the demographics of the research participants or to the outcome measures.

Data Collection

Results of the literature search yielded the following types of articles in congruence with the chosen selection criteria: quasi-experimental design (1), and survey designs (6).

Results

Evidence of the Effectiveness of Auditory Verbal Therapy

Goldberg & Flexer (1993) documented the status of graduates of AVT programs. The investigation included 157 participants (aged 18-47) who responded to a questionnaire using self-reports and self-perceptions of their current level of functioning. The sample used in this study reflects a self-selected group of AVT graduates and the results reported are subjective. This method of sampling may cause the results to be biased as well as limiting the generalizability of the results. The inclusion criteria were restricted to participants that had been enrolled in therapy for a minimum of three years and to participants that were at least 18 years of age The outcome measures included:

degree of mainstreaming, telephone communication, societal integration/involvement in community activities, work history/attendance at post-secondary institutions not specifically designated for persons with hearing loss, and perceptions of current participation in the "hearing", "deaf", or both worlds. The authors of this article concluded that the majority of the people who responded were "integrated into regular learning and living environments".

In a follow-up study, Goldberg and Flexer (2001) updated the outcomes of AVT that were researched in their 1993 study. Questionnaires were again used to collect self-reports and self-perceptions of current level functioning from AVT graduates. The authors reported that they made adjustments to the survey they used in response to new technology and to problematic wording identified during their 1993 investigation. A total of 114 survey forms were returned with only 20% of the participants identified as participants of the previous study. Although the authors made a better attempt to contact all of the known AVT centers and certified AVT therapists, the results are once again based on subjective data reported by a self-selected sample of AVT graduates. The inclusion criteria and the outcome measures used in this study did not change from the 1993 study. The authors arrived at the same conclusion with this investigation as they did during their 1993 study.

In a study reported by Rhoades (2001) and Rhoades & Chisholm (2000), the global language growth rates of children who received intensive AVT were examined. A total of 40 children were included in the study all of whom received treatment from the same facility for 1-4 years, were between the ages of 50-120 months and had moderate to profound hearing losses. The inclusion criteria were limited to a minimum participation of one year in therapy and the participant had to have at least a bilateral moderate hearing impairment. The sample used in this study is a convenience sample which limits the generalizability of the results to the population of hearing impaired children whose primary intervention consisted of AVT as a whole. Three language development measures with normative data on children without hearing loss were used: the *Sequenced Inventory of Communication Development* (SICD) (Henrick, Pranther, & Tobin, 1984), *the Preschool Language Scale – 3* (PLS-3) (Zimmerman, Steiner, & Pond, 1992), and *the Oral-Written Language Scale* (OWLS) (Carrow-Woolfolk, 1995). All of these measures have documented psychometric properties and are all commonly used to assess children's language abilities. Data was collected at the initiation of therapy and at annual intervals thereafter. The assessments provided the researches with data on the child's expressive and receptive language age equivalency scores which were used comparatively regardless of the measurement tool used. These scores were then analyzed as a function of the amount of time a child was in therapy. The authors made no comment on the potential limitations of their results due to the measurement tools not being uniform in their administration, response type and difficulty level that may affect the accuracy of the comparison of the equivalency scores. Results of this study indicated a significant improvement in equivalent language ages as a function of each year in therapy. With a subset of the data (i.e. data from only those students who 'graduated' from the program), the authors concluded that "these children attained linguistic competency at levels commensurate with their normally hearing peers" (Rhoades 2001 and Rhoades & Chisholm 2000).

Roberts & Rickards (1994a/b) created a 26-item self-report questionnaire which was completed by graduates of an Australian integrated auditory/oral preschool. The authors reported the results in two parts: Part I (1994a) reported on the information obtained regarding amplification usage, communication practices, and speech intelligibility while Part II (1994b) reported on academic achievement, utilization of support services, and friendship patterns. This study describes the results of a specific program/center which limits the generalizability of the results to any other AVT programs. The results are again subjective and reported by a self-selected sample. The inclusion criteria required the participants to be at least 7 years of age, enrolled in the specific program they were researching, and have no additional disabilities. This study was the only one reviewed that conducted a pilot study of the questionnaire for suitability purposes. Specific reference to confounding variables was made by the authors in this study when they were analyzing their results. The authors clearly state: "In the analysis of the data, the relationships between degree of hearing loss and educational setting and the students' amplification usage, communication practices, speech intelligibility, academic achievement, utilization of support services, and friendship patterns were examined separately. Interpretation of these bivariate relationships, however, necessitates caution, since it is unlikely that the functioning of the hearing-impaired child can be attributed to any one background variable, or that these variables do not interact with one another to influence the hearing-impaired child's functioning" (Roberts & Rickards 1994a/b). Despite the recognition of this limitation to their study, these authors proceeded to report the results of their survey using only the results of these bivariate relationships. The results reported in Part I revealed that the majority of students stated that they used their hearing aids consistently, speech was their major mode of communication, they were less reliant on supplementary modes of communication than their deaf peers and that they perceived themselves to be better listeners than speakers. The results of Part II revealed 83% of these children perceived their academic achievement as average to above average as compared to class peers, use of support services was reported by nearly all of the graduates, and nearly two-thirds of the children reported that most of their friends had normal hearing. The authors carefully state that "these findings may, in part, reflect the auditory/oral preschool educational experience they received" (Roberts & Rickards, 1994a/b).

Robertson & Flexer (1993) investigated the reading development of children with hearing impairment who developed speech and language through the auditory verbal method. They used questionnaires and asked parents to submit standardized test scores of reading development for their children. The sample used for this study was self-

selected and the data reported in the questionnaires is subjective; both of these issues may have caused biased results. Due to the fact that the standardized test scores reported contained both percentile scores and grade level equivalent scores, the authors assigned the 50th percentile to each score reported in grade level terms as a conservative estimate of a percentile score (i.e. if the grade equivalent score was above grade level the score was estimated at the 50th percentile in the absence of a percentile score). Considering that this is a conservative method of assigning a percentile score, the results of this measurement tool can be more confidently interpreted. The authors used this data for purposes of computing a mean and defining a median. The results of this article revealed that "thirty of the thirty seven children investigated scored at the 50th percentile or higher on reading tests normed on hearing children".

Wray, Flexer, & Vaccaro (1997), investigated the classroom performance of children who are deaf or hard of hearing and who learned spoken language though the auditory-verbal approach. A total of 19 children were included in this study all of whom attended the same preschool AVT program at the University of Akron. Use of participants from the same center limits the generalizability of these results. This study included a teacher questionnaire and information obtained by the *Screening Instrument for Targeting Educational Risk* (SIFTER) (Anderson, 1989). The SIFTER has a total of 15 questions rated on a Likert Scale and assesses the teacher's perceptions of student performance in the areas of academics, attention, communication, class participation and school behaviour. Although the SIFTER allows for a rating of a "marginal pass", the authors of this study counted any "marginal pass" score as a fail. This may allow for greater confidence in the measurement tool due to the conservative approach taken with the interpretation of the subject's scores. The authors also conducted telephone interviews with the subject's parents and sent a non-standardized questionnaire to the teachers to corroborate the results. The results of this article stated "that even students with severe to profound hearing losses can be placed in mainstream classrooms with extremely positive results if they receive early auditory-verbal intervention" (Wray et al., 1997).

Conclusions and Recommendations

Consideration of the effectiveness of any therapy approach suggests that the "gold standard" of randomized control trial study designs be put aside as a result of the fact that it is unethical to withhold therapy from anyone if it may be beneficial to them. Parents ultimately decide what intervention approach is best for their child and it is unlikely that a control group of subjects not participating in any type of therapy could be found (although it is noted that this may not be completely impossible as some parents may voluntarily chose not to enroll in therapy due to the cost or due to distance from a therapist). The limitation of studies without a control group of subjects is that it is impossible to definitively attribute the results to the therapy intervention directly (i.e. no direct causal relationship can be determined).

Although some of the studies reviewed specified inclusion criteria, the lack of control for confounding variables was a major shortcoming in all of the studies. Understandably, when considering the effectiveness of AVT, there are an abundance of variables that make this an enormous task. Some of these variables include (but are not limited to) the age of the child when they were amplified, the age of the child upon initiation of therapy, the amount of direct therapy provided by certified AVT therapists, the setting the child is placed in when not in therapy, the amount of one-on-one time outside of the therapy setting the caregiver devotes to AVT, the type of amplification used, the characteristics of the therapist, and the severity of the hearing loss. To illustrate the importance of just one of these variables, the reviewer refers back to the guiding principles of AVT that state AVT specifically emphasized the use of residual hearing to acquire language. Logical reasoning would conclude that the children with more residual hearing would receive greater benefits from AVT. Unfortunately, none of the studies reviewed sufficiently controlled for this variable. The majority of the articles collected the demographic data of the participants (i.e. age of identification, etiology of hearing loss, age of amplification, age of child, etc.) and although this information was reported it was not controlled for. Minimally, the degree of hearing loss the children have, the amount of time enrolled in AVT, as well as the type of amplification through which the children are using their residual hearing should be controlled for. Control of these variables (among others) may allow future researchers to begin identifying the demographics of the children who receive the greatest benefit from AVT (i.e. identification of predictive variables).

Additional considerations of the study designs include the potential bias of the subjective responses collected through survey/questionnaire data collection methods (especially problematic in the studies that did not corroborate the responses with follow-up data) and the inability to generalize the results to other settings (which reflects poor external validity). As well, none of the studies were designed to compare the effectiveness of AVT with other types of therapy for hearing impaired children (such as Cued Speech or Total Communication). As a professional responsible for the recommendations of intervention for children with hearing impairments, the ability to provide evidence of your recommendations through experimental research is extremely important. Future research that addresses the comparison of the effectiveness of AVT to the effectiveness of other types of therapy employed with children with hearing impairments is recommended.

This review did not restrict the outcome measures that were used in any of the studies that were included. As such, each of the studies had very different outcome measures and could not be used comparatively to evaluate the research question.Future research needs to address what the definition of "effectiveness" in relation to AVT is and propose specific outcome measures to address this definition. Once created, these outcome measures should be proposed to the research community as a whole so that each study can be designed to allow for comparison of the data

and to allow researchers to add conclusions to previous research.

Based on the literature reviewed here, it appears that a recommendation for the effectiveness of AVT with children with hearing impairments is warranted. Although there is little quantifiable data to refer to, the information gained through the survey studies is important and cannot be disregarded. Additionally, the reviewer was unable to locate any research that opposed AVT as an effective therapy approach. In conclusion, further research on this topic, which improves on the methodological and statistical weaknesses of past studies, may provide clinicians with greater confidence in this proposal.

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Critical Review: Effectiveness of bilateral and unilateral botox injections for the treatment of adductor spasmodic dysphonia

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This critical review examines the effectiveness of unilateral and bilateral botox injections for the treatment of adductor spasmodic dysphonia. Study designs include: pre-test post-test controlled designs, randomized controlled trial, quasi-experimental design, meta-analysis, and retrospective analysis. Overall, the research supports the use of bilateral and unilateral botox injections as treatment for adductor spasmodic dysphonia. Evidence is inconclusive regarding whether one type of injection is preferred over the other as both are effective.

Introduction

Spasmodic dysphonia (SD) is a focal dystonia, particularly affecting the laryngeal musculature (**B**ielamowicz et al., 2002). It is a laryngeal motor control disorder that is specific and action-induced; it is present during speech, but not during singing or other laryngeal actions. SD affects both men and women, but women are most often affected, with the average age of onset around 40 years of age. There are different types of SD: adductor SD, abductor SD, and mixed SD, which has characteristics of both abductor SD and adductor SD. Adductor SD is the most common form of SD. It is characterized by a strained-strangled voice, harsh voice, effortful phonation, pitch breaks, with irregular voice spasms, which are due to hyperadduction of the vocal folds (Adams, 2005).

The treatment for adductor spasmodic dysphonia (ADSD) has varied over the years. Treatment has included recurrent laryngeal nerve section, psychotherapy, speech therapy, and drug therapy. All have had some success to varying degrees. Most of the literature has demonstrated that the most effective treatment for SD is the injection of botulinum toxin (botox) into the thyroarytenoid muscle in the neck (Adams, 2005). Botox can be injected either unilaterally (the right or left thyroarytenoid muscle) or bilaterally (into both thyroarytenoid muscles). Botox works by causing partial paralysis of the muscles, thereby reducing or eliminating the dystonic contractions. Botox prevents the release of acetylcholine from the presynaptic terminal on the neuromuscular junction. Botox takes approximately two to four days to cause the nerve block. It is a temporary solution; its effects can last three to six months, so repeated injections are necessary. Studies have demonstrated that the side effects of botox are vocal breathiness and swallowing problems (mild aspiration) (Maloney et al., 1994). These side effects do not last the whole duration of treatment; they can last an average of one to 14 days. Studies have suggested that bilateral injections may be associated with longer lasting side effects.

Objectives

The primary objective of this paper is to critically evaluate the existing literature regarding the effectiveness of botox injections as treatment for ADSD. The secondary objective is to propose evidence-based practice recommendations regarding the use of botox for ADSD.

Methods

Search Strategy

Computerized databases, including PubMed, CINAHL, Cochrane Library, and Medline-OVID were searched using the following search strategy:

> (spasmodic dysphonia) AND (treatment) OR (adductor spasmodic dyshonia) AND (botox injections) OR (unilateral versus bilateral botox injections) AND (spasmodic dysphonia).

The search was limited to articles written in English.

Selection Criteria

Studies selected for inclusion in this critical review paper were required to investigate the impact of bilateral and unilateral BT injections on ADSD. No limits were set on the demographics of research participants or outcome measures.

Data Collection

Results of the literature search yielded the following types of articles congruent with the aforementioned selection criteria: pre-test post-test controlled designs

(3), randomized controlled trials (2), quasi-experimental design (1), meta-analysis (1), and retrospective analysis (3).

Results

Pre-test post-test controlled designs

Adams et al. (1993) used acoustic and perceptual measures to compare the effects of unilateral versus bilateral BT injections in the treatment of ADSD (Adams et al, 1993). This study had 26 patients who received either unilateral or bilateral BT injections, under EMG guidance, into the thyroarytenoid (TA) muscle in the neck; 15 patients received unilateral injections and 11 patients received bilateral BT injections. The patients were audio recorded three times: pre injection, two weeks post injection, and six weeks post injection. The recorded data included repetition of a sentence ("Buy Bobby a poppy") and sustained prolongation of the vowel /ah/. Acoustic measures of the patients voice were assessed and included maximum phonation time (MPT), average fundamental frequency, jitter, shimmer, and total number of voice breaks per second (voice break factor). Four SLPs were randomly assigned to listen to the recordings; they did not know which subject had unilateral or bilateral injections. They rated the patients in terms of severity of vocal spasms and degree of vocal breathiness (perceptual measures) using an open ended rating system called magnitude of estimation Patients did rate their own voices or the effects of treatment.

To assess the data, the authors used Mann-Whitney U nonparametric testing ($p < 0.05$) and Wilcoxon Signed Ranks test ($p < 0.05$), which are commonly used for statistical analysis. The authors claim that unilateral injections provide superior and longer lasting benefits than bilateral injections based on maximum phonation time (increased at 6 weeks for unilateral), vocal jitter (reduction toward normal jitter values), and the number of voice breaks per second (maintain a reduced number at 6 week assessment. The authors did acknowledge that the failure to observe significant differences between the groups on perceptual measures may relate to the lack of sensitivity and specificity of these measures in voice production (Adams et al. 1993).

The study by Langeveld et al. (1998) compared the efficacy and side effects of unilateral versus bilateral injections of BT in patients with ADSD. This was a prospective study with 27 patients (20 women and 7 men). The subjects were given equal doses of both unilateral and bilateral injections of BT (5 units for unilateral and 2.5 in each TA for bilateral under EMG guidance). This is good that the patients served as their own control and equal doses were used to help reduce confounding variables, but the authors and patients were not blind, which can lead to expectations regarding benefit of treatment. The patients were assessed prior to treatment and after treatment, however, only intelligibility of speech and fluency were assessed by the patients using a self-rating scale (0-100% scale). Side effects were also assessed using a similar self-rating scale. The data was analyzed using McNemar X2 test. The authors stated that 85% of the patients experienced benefits after both procedures with the dosage of 5 units and over half of the subjects (61%) preferred bilateral injections. Aspiration was rated as statistically significant after bilateral injections.

Whurr et al. (1993) looked at the use of BT in the treatment of ADSD. The purpose of this study was to assess, treat, and evaluate treatment of patients with SD using BT. There were 31 subjects in this study and only bilateral injections of BT (3-3.75 units under EMG guidance) were analyzed. Information about the patients was provided in a chart (age, sex, mean duration of symptoms, previous treatment history, etc.). The patients were given different doses (3 or 3.75 units) and an explanation for this was not given. The patients were assessed two times; one pre-injection and one post-injection assessment based on an audio and video recording of a connected speech sample. The patients were asked to keep a voice diary regarding voice improvement and side effects after treatment. A speech analysis, using Visipitch, was also obtained, but only fundamental frequency of the voice sample was analyzed. Only 22 of the subjects acoustic analysis was accepted (explanations for why the other 9 voice samples were rejected was not provided). The results were analyzed and compared using a Wilcoxon Signed-Rank Test. The authors reported that 96% of the subjects reported improvement in their voice at the follow-up visit and vocal benefits were also observed (reduction in the number of pitch and voice breaks, increase volume, and increase in ease of voice production) (Whurr et al, 1993). Side effects were reported by a quarter of the subjects and were transient in nature (swallowing problems, weak cough, and slight pain at the site of injection.

Randomized Control Trials

Adams et al. (1995) compared the effects of unilateral and bilateral injections of BT in patients with ADSD using objective acoustic and perceptual measures of voice change. In this study, 50 patients were ADSD were randomly assigned to either treatment group (25 unilateral and 25 bilateral

injections) 15 control subjects were also included. The unilateral patients received 15 units of BT into the left TA muscle and the bilateral subjects received 2.5 units of BT in each TA muscle (all by EMG guidance). Voice recordings of each patient were taken pre-injection, 2 weeks post injection, and 6 weeks post injection (patients sustained vowel /a/ and did this three times, and the second prolongation was used for analysis). Acoustic measures (MPT, shimmer, jitter, average fundamental frequency, standard deviation of fundamental frequency, signal to noise ratio, and voice break factor) and perceptual measures (voice performance) were assessed. Fours SLPs performed the perceptual judgements and they were blind to the type of injection.

Non-parametric Wilcoxon and Mann-Whitney U tests were used to evaluate patients and control subjects' data. The Dunn-Bonferroni procedure was used to correct for multiple comparisons ($p< 0.05$). The results show that both methods provide equivalent degrees of improvement, but bilateral injections are associated with a larger period of breathiness. This study replicated an earlier study by Adams et al in 1993 and incorporated many changes to help improve the strength of the research design.

The study by Troung et al. (1991) was a double-blind controlled study of BT in patients with ADSD. There were 13 patients in this study who all underwent rigorous assessment by an independent SLP, otolarynologist, and neurologist. This study only looked at EMG guided bilateral injections of BT (5 units into each TA muscle), but patients were randomly assigned to either BT injections or saline solution injections. Acoustic measures were obtained from each subject's sustained prolongation of the vowel /a/ and patients self-evaluation of voice 4 days after treatment. Mann-Whitney U tests was used to test for nonparametric data. The authors claim that BT is effective, and side effects were noted in 3 patients (breathiness and mild bleeding). This study did not compare unilateral and bilateral injections.

Quasi-experimental Design

Bielamowicz et al. (2002) looked at unilateral versus bilateral injections of BT in patients with ADSD. The purpose of the study was to determine which injection type would result in a preferable effect/side effect profile. The authors stated that the ideal injection should have an effect lasting 3 months or more and side effects should last 2 weeks or less. There were 45 subjects included in this study, which is fairly good sample size. The patients were not randomly assigned to the treatment group; 16 received unilateral injections and 33 received bilateral injections (under EMG guidance). Only subjects who were previously treated at the authors' treatment facility were included in the study. It looks like the authors may have selected for only responsive patients in their study. Information about the subjects' disorder severity was not provided. There was no attempt to control injection type or dosage by disorder severity. Patients were allowed to alter their dosage depending on their treatment response. Information regarding treatment schedule and how many times the patients were assessed were not provided. Each patient was given a different dosage depending on their needs. It is not known whether or not the patients were overmedicated or undermedicated. It is not known how the authors determined "benefit". Acoustic or perceptual measures would have been beneficial in this study so objective measures of benefit could be assessed.

The data provided in this study is limited. Chi-square analysis was used for statistical analysis ($p < 0.05$). This type of analysis is weaker when compared to parametric testing, which may have been more appropriate for this study. The authors claim that unilateral injections are more frequently associated with optimal effect and side effects. Information regarding how the treatment benefited each subject was not provided; it would have been useful to see how beneficial the treatment was in each subject (i.e. increase in maximum phonation time, decrease in vocal spasms, subject self report, etc).

Meta-analysis

A meta-analysis done by Bousten et al. (2002) reviewed BT efficacy data in ADSD to determine whether and to what extent BT treatment is supported by the data. With regards to the comparison between unilateral injections and bilateral injections, 9 studies were assessed. The authors claim that these studies have limited power to detect differences (dosage for either method are most often not controlled, which can affect generalizabilty). They claim that the data suggests that neither method has a distinct advantage over the other. Looking at all of the studies regarding the use of BT a number of statistical tests were performed including univariate t-tests, Bonferonni adjusted alpha level, MANOVA, and Tukey's HSD test. This article claims that the methodological issues limit the conclusions regarding the efficacy of BT treatment in ADSD (e.g. many studies are not blind, so a Rosenthal effect may have influenced the results, small sample sizes, measurement error, etc.) (Bousten et al., 2002).

Retrospective Analysis

The study by Maloney and Morrison (1994) compared the effectives of unilateral versus bilateral BT injections for the treatment of ADSD. The study did a retrospective chart review along with a prospective telephone interviews. They looked at the charts of 24 patients, 10 male and 14 female. Information on treatment schedule was given and all were initially given bilateral injections under EMG guidance (2-2.5 units) and when patents returned for repeat injections they could choose between unilateral or bilateral injections. Patients were given a diary to rate their vocal performance, acoustic measures were not performed. The non-parametric Wilcoxon Test was used for the statistical analysis. Results indicated that bilateral injections provided greater duration of benefit and greater duration of side effects (breathiness and swallowing difficulties), but if the side effects were severe unilateral injections can be used. The data was analyzed for gender differences. It was found that men experienced longer duration of benefit after bilateral injections than women.

The study by Blitzer et al. (1998) was a retrospective analysis of 901 patients with SD over 12 years (747 patients had ADSD). The purpose of this study was to analyze the effectiveness of BT injections for the treatment of SD. All of the patients went through a detailed assessment (neruologic examination, acoustic and aerodynamic measures). Patients were also observed during a connected speech sample. The patients also rated themselves pre-injection, every day for 2 weeks, and then weekly until their next injections. A doctor and SLP independently rated the patients' voice as well. The patients started out with 2.5 units of BT unilaterally injected under EMG guidance in one vocal fold and stated this had no effect, so larger doses were administered and bilaterally. No statistical information was provided in this study, and the authors did not compare unilateral to bilateral injections.

Brin et al. (1998) examined 901 patients who were treated with bilateral injections of BT. The purpose of this study was to determine if BT injections are an effective treatment for SD. This study looked at patients with ADSD and abductor SD. This study did not compare unilateral to bilateral injections of BT. The patients went through a detailed assessment (neurologic, otolaryngologic, SLP assessment, and fiberoptic laryngoscopy). Patients began with 3.75 units of bilateral injections under EMG guidance; the dosage was then altered depending on the patients' response to treatment. Statistical information was not provided; results were based on patients self-report. The authors claim the patients benefited from BT injections, but how "benefit' was measured was not reported. The effectiveness of BT treatment is ADSD was confirmed by the results, but a lot of information was not provided (patient summary, severity of SD, acoustic and perceptual measures, etc.). This study did not compare unilateral and bilateral injections.

Conclusions

In conclusion, all ten of the studies examined provided support for the effectiveness of unilateral and bilateral injections in the treatment of ADSD. The side effects of bilateral injections (breathiness and mild aspiration) may last for a longer duration, but still provides equal benefits when compared to unilateral injections. There is inconclusive evidence to support one type of injection over another. Ultimately, the onus is on the patient to the type of injection he or she prefers. Some of the methodologies used by some of the authors were more stringent than others, but all of the articles can be used to guide further research and provide weight to support the use of BT for the treatment of ADSD.

Recommendations

The evidence suggests that unilateral and bilateral injections are an effective treatment for ADSD, but it is recommended that more research be conducted to confirm and clarify the research that has already by completed. Researchers working in this area are encouraged to:

1. Research the long-term effects of BT. Follow-up studies (5 years) with subjects could be done to see what, and if any, long-term side effects are caused by BT injections.
2. Research the effectiveness of unilateral and bilateral BT injections on patients with the same disorder severity. Few studies have been done that looked at subjects' severity of ADSD. How the patient presents his or her symptoms may play a role in BT effectiveness.
3. Continue to research the effectiveness of unilateral and bilateral BT injections in the same individual, but conduct a study where the subject is blind to the type of injection used. For example, unilateral injections are done first, then for the second round of treatment, bilateral injections are performed.

4. Continue to include objective measures (acoustic and perceptual), but also include subject self report/self-rating. Objective measures are important in order to determine the change in the laryngeal musculature, but ultimately the patient has be decide whether or not the treatment is effective and beneficial for his or her everyday functioning.

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Critical Review:
Effectiveness of therapy approaches for Developmental Apraxia of Speech

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This critical review examines the effectiveness of therapy approaches for children with developmental apraxia of speech (DAS). Research supports the use of augmentative or alternative communication (AAC) principles in facilitating language and communication development, while behavioural approaches for treatment of articulation were weakly supported. Overall, the evidence base for therapy in this area is limited and the studies reviewed exhibited a variety of methodological weaknesses. Recommendations for practicing clinicians, as well as for future research, are given.

Introduction

Strand (1995) defines developmental apraxia of speech (DAS) as a child who has "difficulty carrying out purposeful voluntary movement sequences for speech in the absence of paralysis of the speech musculature". Some typical characteristics of DAS include: multiple speech sound errors, difficulty with sequencing sounds, and groping behaviour while speaking. A variety of therapy approaches have been proposed to treat DAS, including rate control, melodic intonation therapy, and the use of AAC.

Objectives

When conducting intervention, it is necessary to use methods that are based on evidence. With so many therapies in the literature, the practicing clinician needs to know which therapies have truly been effective in the treatment of DAS. This paper considers the literature on therapy for DAS in order to determine what approaches have demonstrated effectiveness in treating the disorder.

Methods

Search Strategy

A search of the following computerized databases was completed: PsychInfo, CDSR, AMED, CINAHL, EMBASE, and Medline. The search terms included: apraxia OR dyspraxia OR motor speech AND childhood OR developmental OR children AND therapy OR treatment OR intervention AND speech.

Selection Criteria

Studies were chosen for inclusion in this critical review based on the following criteria: (a) they performed a study on treatment for DAS and (b) they came to conclusions and gave recommendations regarding the treatment of DAS.

Data Collection

Results of the literature search yielded eight articles that were identified for review based on the above search criteria. Seven of the studies employed a case study design. One study employed a quasi-experimental design.

Results

Three articles presented cases where augmentative and alternative communication (AAC) was used to maximize the child's language learning and functional communication in spite of their speech limitations. The first of three case studies describes a 6.5 year-old boy with DAS who was given a Macaw digital voice output device (Bornman, Alant, and Meiring, 2001). His mother was trained on how to use the device to promote higher language functioning, however she was blind to the exact purpose of the study. The results demonstrated that the mother's training was correlated with an increase in number of communication attempts and the appropriateness of the child's responses, however no statistical analysis was done on the results.

Culp (1989) describes a case study of Terri, an 8 year-old girl with DAS who attended a 3-day program with her mother, teacher, and speech-language pathologist (SLP) focussed on developing communication behaviours of all the participants. After 2 months of employing the PACT principles at home and at school, the results showed "some gains in child-mother communication interaction skills" (Culp, 1989). Gains included an improved message frequency ratio between Terri and her mother, a slight improvement in Terri's intelligibility, an increase in the variety of Terri's communicative functions, and improvements in the mother's

interaction behaviours. All the measures used to compile the results are based on the evaluator's subjective interpretation of interactions between Terri and her mother. The gains themselves are very small and no statistical analysis was done to determine if they were significant. The authors report informal observations from Terri's mother, who reports positive changes. It is difficult to quantify these changes considering the subjective nature of the report: "… Terri seemed to be spontaneously communicating more and with a variety of partners in different situations" (Culp, 1989).

Cumley and Swanson (1999) describe three case studies in which AAC is used as a successful intervention for children with DAS at different ages (preschool, school, and junior-high aged). Each child "had received intensive motor speech intervention and supplemental sign language instruction" prior to the introduction of the multimodal AAC intervention approach. Each child's AAC system was personalized to suit their home and school needs. The authors give descriptions of the types of AAC intervention used, but fail to clearly outline their methods. It appears that they mostly relied on parent and teacher report in compiling their data. This subjective treatment of the results makes it difficult to analyze the validity of the findings.

The next three articles presented case studies in order to demonstrate the effectiveness of the proposed therapy. Rosenthal (1994) describes Rate Control and how it could impact the organization and sequencing difficulties children with DAS face. He then presented 3 case studies to display the successful use of Rate Control. Multiple approaches were used in conjunction with Rate Control, so it is impossible to determine if Rate Control is the approach that caused the effects. Further, the results that could be clearly attributed to Rate Control were achieved after a long period of intervention with no evidence of carry over to natural communication situations.

Watson and Leahy (1995) followed Edward, a boy with DAS, from 3-1 to 7-1. Intense group programs and biweekly 1:1 therapy sessions over 2 years employed a multimodal approach using sign and oral motor movement with an emphasis on "meaningful activities". Slow gains were made in MLU, phonetic inventory, and expressive and receptive language scores, but it is unclear when, how, and by whom the measures were taken. Subjective judgements of intelligibility were given throughout the case. The authors describe the case as successful, yet the gains seen required 2 years of continuous therapy, and progress was so slow that maturation may have yielded the same results. The authors do not give compelling reasoning to convince the reader that Edward's gains were due to the intervention. Further, Edward's mother was trained as an SLP at the undergraduate level, so success may have been due to additional procedures.

Powell (2000) proposes increasing stimulability early in treatment to facilitate generalization of treatment targets. In general, the therapy timeline and methods are unclear. It is not explicitly stated how many different therapists were used over the 15 month period or if stimulability was employed over the entire 15 months or only for 3 months during therapy with the author. Powell's subject demonstrated increases in his phonetic inventory, but since the gains were made over 15 months, it is difficult to conclude that the results were due to the stimulability aspect of the intervention as opposed to maturation.

In summary, although the theories behind these approaches may be appropriate, none of these case studies give results that demonstrate the effectiveness of the approach proposed. The methods of treatment and evaluation are not systematically described so that the reader is left wondering about exactly how therapy was implemented and how progress was tracked. Although all studies claim that improvement occurred due to their approach, the reasons for therapeutic success are unclear and the authors fail to use statistical analysis of their data so objective interpretation of the results is limited.

In the 7th study, Strand and Debertine (2000) present a multiple baseline (across behaviours) design examining the impact of integral stimulation on the production of experimental and control stimuli. The integral stimulation procedure is not described in the article so that the study is difficult to interpret. The design included 1 subject who received intensive therapy, but the authors fail to state how many weeks the subject received therapy. They report mastery of the experimental stimuli while the control stimuli showed mild improvement, but the results require the reader to interpret various graphs containing data that is unclear. Thus, this study provides very limited evidence of the effectiveness of integral stimulation as an approach to the treatment of DAS.

In the 8th study, Krauss and Galloway (1982) used a repeated measures design to compare the use of Melodic Intonation Therapy (MIT) with "traditional therapy" vs. "traditional therapy" alone, however, they fail to define "traditional therapy". Two subjects, who were their own controls, received a 2-month period of traditional therapy followed by a 2-

month period of the same therapy including MIT, where MIT constituted 20% of the session. They used the Wilcoxon matched-pairs signed-ranks test to examine the difference between baseline, pre- and post- MIT scores, but it appears they used the results of multiple subtests as data, not individual subjects in which case the results may not be as powerful as they appear. However, a cursory look at the results reveals a pattern of improvement across the subjects similar to the pattern seen in adults, so that an effect of therapy may exist.

Discussion

The authors of the 3 AAC studies give extensive descriptions of their subjects and their DAS diagnostic criteria. Since AAC intervention is by nature individualized, the results demonstrate how the underlying principles can work, despite the case study design. The principles can be generalized even if the specific approach cannot be. As well, the authors approach DAS in a wholistic manner. AAC is presented as a means to develop language and facilitate communication in conjunction with other approaches. Further, they concentrate on intervention with the child as well as with communication partners and the physical environment. In this way, the articles present intervention that follows the World Health Organization (WHO) model since it considers body structure and function, activity, participation, and contextual and environmental factors (WHO, 2001). Despite methodological weaknesses, the results of these 3 studies demonstrate that the principles of AAC can be used to treat the language and communication component of DAS.

In general, the literature regarding effective behavioural approaches to treatment of DAS is weak, for several reasons. First, case study designs lack generalizability since the case does not represent the population. Secondly, the authors appear to use convenience or purposive sampling, as in Edward's case where his mother is trained in speech-language therapy. Further, it is not clear if they chose a case because it was successful, or if they wanted to demonstrate effectiveness so they chose a case at random. A retrospective look at a case can create a biased perception of the results, while choosing a case at random to apply a theory indicates better validity. Third, many of the studies shared the same methodological weaknesses. Often authors failed to adequately describe their subjects, including the diagnostic criteria used to determine that the subjects had DAS. There was no evidence of blinding in most studies, so much so that the authors were often the therapists, suggesting potential bias. Details of the methodology were often limited, making replication of the findings difficult. The general lack of statistical analysis and the subjective treatment of the results are fundamental weaknesses in all of the studies. For several of the studies, the methodological weaknesses are such that the studies cannot be considered as evidence for effective therapy approaches to the treatment of DAS. In general, these studies provide very limited evidence for effective therapy in DAS.

Recommendations for Future Research

As demonstrated in this review, the evidence base for effective therapy for DAS is weak. There are a number of obstacles preventing quality research from being conducted. First of all, the field lacks an agreed-upon definition for DAS. Many of the articles did not include sufficient diagnostic criteria to explain why subjects were included. This failing is likely in part due to the fact that there is no agreed-upon definition of DAS. This critical review used Strand's (1995) definition of DAS, but in fact the definition is not clear-cut. Although many researchers consider DAS to be a motoric disorder, some researchers argue that there is a linguistic or phonological aspect to the problem (Paul, 2001). In an effort to develop evidence-based guidelines, a group of researchers reviewed the literature on Apraxia of Speech (AOS) in adults (Helm-Estabrooks, Frattali, Bayles, Beeson, Kennedy, Wambaugh, and Yorkston, 2003). In considering a definition for AOS, they focused on characteristics such as "slow speech rate" and "speech sound distortions" as diagnostically significant, while maintaining that "articulatory groping" and "anticipatory sound errors" were not appropriate to differentially diagnose (Helm-Estabrooks et.al, 2003). Paul (2001) summarizes these issues, stating that some authors think that DAS is not a "clinically definable entity", others see it as a subtype of developmental coordination disorder, and others see it simply as a severe persistent speech sound disorder. When characteristics of the disorder are not clearly defined, it becomes difficult to sample subjects for research and give accurate diagnostic criteria.

Secondly, the studies reviewed in this paper generally contained many methodological problems that weakened the strength of the findings. It is recommended that future researchers include enough detail for the reader to understand the exact nature of the intervention, who was giving the therapy, and how the results were obtained. Regardless of whether the field agrees on a definition of DAS,

researchers need to give detailed descriptions of subjects so that the reader has a clear picture of the subject's speech characteristics. Case history information should also be given regarding who assessed the subjects, when they were assessed, history of therapy, and types of therapy given. Further, the method of subject selection should be detailed. Many of the studies reviewed in this paper failed to state how they selected their subject, leading the reader to wonder if authors employed purposive sampling in their case studies. This type of sampling method will decrease the generalizability of the findings.

For the purpose of research, it is important that details are given regarding how intervention was given and how results were obtained. This is important for two reasons: (1) to allow for replication of the findings and (2) to improve the validity of the findings. It is difficult to gain understanding of an approach if one cannot be sure that a study is reliable or valid. Further, case study results alone may give weak evidence, but if successful case studies can be followed by similar studies using multiple subjects, then the field can move forward. Similarly, when studies have weak results, follow-up studies looking at long-term results may help to demonstrate whether or not the initial findings were 'true'. This will help other researchers to know if a particular therapy is worth pursuing and will help clinicians to have more confidence in the approach.

Recommendations for Clinical Practice

In spite of the lack of quality research, children with DAS need to receive treatment. This presents a dilemma for the practicing clinician who wants to use methods that are based on evidence. Based on this critical review, the following recommendations for the practicing clinician are suggested. First, the use of augmentative or alternative communication (AAC) has demonstrated effectiveness and thus could be used in cases of DAS, especially moderate-severe cases where children's communication abilities may not develop normally due to their articulation difficulties. The principles of AAC can be used as a means to facilitate development of both language and communication in the presence of imprecise articulation. The exact nature of the AAC approach would have to be tailored to the individual, but the articles reviewed here could be used as a guide. AAC does not target the articulation difficulties that these children face however, so in most cases, it will not be the sole means of intervention.

Secondly, children with DAS need treatment targeting their articulation difficulties. The behavioural approaches reviewed here are at best weakly supported by the evidence, so no single approach should be used as the sole intervention. As many of the authors suggest, a multimodal approach should be used, which may include rate control, melodic intonation therapy, principles of motor learning, sign, etc. The clinician will need to tailor therapy to the client's strengths and responsiveness. Further, since these approaches have only weak support in the literature, intervention will require clinicians to be especially observant and systematic in their therapy sessions. Clinicians need to make careful observations and detailed notes regarding the client's gains (however minimal they may seem). If the child responds well to a particular approach, perhaps more emphasis should be put on that approach. The clinician can then note if alterations in the emphasis of certain approaches was correlated with improvements in functioning.

In addition, clinicians need to be systematic in how they choose stimuli, evaluate progress, and implement therapy. If the clinician does not conduct therapy systematically, it will be difficult to determine why the child is making gains or to alter isolated components of the intervention strategy when the child is not responding well. A systematic approach will make it easier for the clinician to make accurate observations and follow through with appropriate changes to the intervention strategies employed.

Finally, more research is needed to determine what therapy approaches are effective in the treatment of DAS. The above recommendations offer a temporary solution until more rigorous research can be completed to provide clinicians with a therapy approach that has demonstrated effectiveness.

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Critical Review:
The Effect of a Chin Tuck Posture on Swallow Function

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This critical appraisal discusses the effect of a chin tuck posture on swallow function. The studies include a case report, a nonrandomized group comparison design, and repeated measures design with a single group of subjects. At this time there is supported evidence concerning some predicted effects of the chin tuck, however it is of great importance to analyze each patients specific dysfunction before deciding if the therapeutic posture is likely to be effective.

Introduction

Dysphagia is a disorder affecting the lives of up to 22% of people over the age of 55 (Hind et al., 2001). Dysphagia can be defined as difficulty moving food and liquid from the mouth and into the stomach (Logemann, 1998). There are many consequences of the disorder including increased morbidity and mortality related to pneumonia, dehydration, malnutrition, and obstruction of the airway (Hind et al., 2001).

Postural adjustments are common management techniques provided by Speech-Language Pathologists to those with dysphagia in an attempt to enhance safe bolus transport from the oral cavity into the esophagus. Thus decreasing the incidence of penetration into the larynx, aspiration into the trachea, and the risk of dehydration and malnutrition (Lewin et al., 2001). Therefore, postural techniques allow a person to obtain nutrition by mouth safely, even when swallowing function is compromised (Welch et al., 1993).

One such postural technique is the chin tuck. The chin tuck is performed by tilting the head forward with the chin brought as close to the chest as possible. This maneuver is often used when there is a potential for premature spillage into the pharynx arising from lack of retro-oral seal and delayed triggering of the pharyngeal stage of the swallow (Welch et al., 1993). Although postural adjustments such as the chin tuck are often used in clinical practice, relatively little is know about their effectiveness in reducing aspiration and making swallowing safe for oral nutritional intake (Bulow et al., 2001). Postural adjustments also affect swallowing anatomy inconsistently across patients (Shanahan et al., 1993). Speech-Language Pathologists are presented with these questions of inconsistency and the effects of the chin tuck on swallow function on a daily basis.

Information in the recent dysphagia literature surrounding the chin tuck is not abundant, particularly when the amount of information available is compared to the widespread recommendation of the postural adjustment in therapy (Shanahan et al., 1993). Clinician interpretations as to how the chin tuck is thought to be increasing swallow safety are confirmed in one study, yet found to be inconsistent in additional research (Welch et al., 1993). These challenges in the literature make it difficult for clinicians to focus on sound research to support and develop "best practice" standards for dysphagia management. For these reasons, and given the prevalence of recommendation of the chin tuck across numerous professionals, this posture adjustment is a crucial research topic.

Objectives

The objective of this review is to critically examine the literature surrounding the effect of a chin tuck posture on swallow function. Recommendations concerning the clinical use of the chin tuck within Speech-Language Pathology and proposals for future research will also be presented.

Methods

Search Strategy

Computerized databases were searched, including EMB Reviews, AMED, CINAHL, and EMBASE. Keywords used included (chin tuck) OR (effortful swallow) OR (supraglottic swallow) AND (dysphagia) AND (pharyngeal dysfunction). Additional articles were found via reference lists from computer searched articles.

Selection Criteria
The studies selected for inclusion in this critical review were required to examine the effect of the chin tuck posture on swallow function of individuals with or without dysphagia. No restrictions were set concerning outcome measures, measurement tools, or study design.

Data Collection
Results of the literature search yielded the following study types: one case report, one nonrandomized group comparison design, and four repeated measures designs with a single group of subjects.

Results

In their study Welch, Logemann, Rademaker, and Kahrilas (1993) used a repeated measures design in which postural effects of the chin tuck were compared to an upright neutral head position in individuals with dysphagia complaints. Pharyngeal angles and distances were measured from still frames representative of the two static head postures from lateral radiographic views. The study demonstrated that the angle between the mandible and the posterior pharyngeal wall decreased, the angle between the posterior surface of the epiglottis and the anterior wall of the trachea increased, the distance from the epiglottis to pharyngeal wall decreased, and the width of the laryngeal inlet decreased ($p < .05$). The distance from the most posterior surface of the arytenoids cartilage to the posterior pharyngeal wall decreased in males and remained unchanged in women, and correlated negatively with age ($r = .41$) (as age increased the distance decreased).

Shanahan, Logemann, Rademaker, Pauloski, and Kahrilas employed a nonrandomized group comparison design in which the effects of the chin tuck were examined in individuals with dysphagia (1993). The chin tuck was evaluated with respect to changes in pharyngeal angles and distances measured from two video prints taken from videofluroscopic data at the end of a swallow, when structures returned to rest. All subjects indicate the angle formed by the mandible and posterior pharyngeal wall decreased, the angle formed by the posterior surface of the epiglottis and the anterior wall of the laryngeal vestibule increased, and the epiglotic distance to the posterior pharyngeal wall increased. Diameter of the airway entrance was not reduced significantly. ($p < .05$)The group who continued to aspirate despite the chin tuck were significantly younger, group 2 (continued to aspirate) had a significantly larger increase in epiglottic angle than group 1, and group 2 had a significantly higher incidence of aspiration of material from the pyriform sinus.

Bulow, Olsson, and Ekberg (1999) used a repeated measures design where the chin tuck position was evaluated in comparison to a typical (chin up) control swallow in healthy subjects. Changes in bolus passage, intraluminal pressures, and movement of anatomical structures were measured using simultaneous videofluroscopic imaging and videomanometry registration mixed and displayed together. The authors reported that the chin tuck posture decreased maximal distance of the laryngohyoid preswallow and during swallow, decreased the distance of the hyoid-mandible preswallow, and reduced pharyngeal peak contraction pressure and pharyngeal contraction duration ($p < .05$).

In 2001, Bulow et al. used a repeated measures design in which the chin tuck position was evaluated in comparison to a typical (chin up) control swallow in dysphagia patients. Changes in bolus passage, intraluminal pressures, and movement of anatomical structures were measured using simultaneous videofluroscopic imaging and videomanometry registration mixed and displayed together. Results indicate the chin tuck did not reduce the number of misdirected swallows, but reduced the depth of penetration into the larynx and trachea, reduced maximal distance between the thyroid and hyoid during swallow, and reduced the distance between the hyoid and the mandible preswallow ($p < .05$).

The final study conducted by Bulow et al. (2002) was a repeated measures design in which the chin tuck position was evaluated in comparison to a typical (chin up) control swallow in patients with dysphagia in relation to intrabolus pressure. Intrabolus pressure, defined as the hydrodynamic pressure within a bolus was measured using simultaneous videofluroscopy imaging and videmanometry registration mixed and displayed together. Results indicate the chin tuck did not alter peak intra bolus pressure or the duration of this pressure when measured at the level of the inferior pharyngeal constrictor. There was a tendency to higher intrabolus pressure but it was not statistically significant ($p < .05$).

Lewin, Hebert, Putnam and DuBrow conducted a case report in 2001 in which the chin tuck was evaluated in the management of aspiration. A standard barium swallow including videofluroscopic examination of the oropharyngeal tract was used to evaluate the presence or elimination of aspiration.

The study indicated the chin tuck alleviated all episodes of aspiration in 17 of the 21 aspirators (81%).

Discussion

Appraisal of the Results

The research evidence available to determine the effect of the chin tuck in swallow dysfunction is on a continuum from sound research supported with statistically significance evidence to research with few confound controls. Thus, it is important for clinicians to perform a through examination of the methodological procedures before adopting research conclusions into clinical practice.

Study Design

The majority of the studies followed a repeated measures design with a single group of subjects (Bulow et al., 1999, 2001, 2002, Welch et al., 1993). This study design has inherently more control for possible subject confounds that could arise from between group comparisons, as only a single group of subjects is studied. A nonrandomized group comparison design is appropriate for the comparison of two subject groups to determine if subjects for whom the chin tuck was successful are different from those who continue to aspirate when using the chin tuck. However non-randomized group designs can create biased results, as participants are not arbitrarily assigned to a subject group. Case reports (Lewin et al., 2001) have a reduced level of control for confounding variables compared to the previous study designs, producing results of a subjective nature, with less evidentiary support

Methodology

The most common measurement tool used in the research was simultaneous videofluoroscopic imaging and videomanometry registration mixed and displayed on a monitor together. (Bulow et al., 1999, 2001, 2002). A standard barium swallow was also used (Lewin et al. 2001) Videofluoroscopy is a suitable measurement tool as it is clinically common and measurements are made in real-time, during the completion of a swallow. Manometry is a standard measurement tool used to determine pressures such as pharyngeal contraction pressure, however the effects of a manometry catheter on swallow function is not known. Welch et al. used still frames representative of the two static head postures from lateral radiographic views (1993). However the measurements were not taken during completion of an actual swallow, therefore results may not generalize to swallow function. Shanahan et al. corrected this flaw by attaining measurements during completion of a swallow (1993).

Four of the six studies used pharyngeal angles and distances as outcome measures. These outcome measures were described in depth to allow for replication. While these types of measure are valid indicators of the effect of the chin tuck, their relation to swallow function has not been determined.

Methods of data collection can also affect the results of a study. The study with the most rigor concerning data collection was by Welch et al, in which all measures were performed twice by two investigators (1993). Accordingly, this was the only study with high inter/intra rater reliability (95% and 97%). In all studies the investigators could not blind raters as the raters were the study authors. Unconscious expectations of the authors/raters may have biased the results.

The three studies by Bulow and colleagues did not provide any information concerning subject recruitment or selection. Without this information one must be cautious as to the representativness of the sample, and hidden bias such as subject selection bias. The remaining three studies used convenience sampling with reasonable exclusion criteria to account for some of the factors that may have confounded results.

Subject-specific characteristics, such as etiology and severity of dysphagia, were not controlled for in the majority of studies. This could have a substantial effect on results as outcome measures may be altered depending on the severity (mild, moderate, severe) and type (oral, pharyngeal, both) of dysphagia. Age and sex are critical variables that should be controlled in dysphagia research. With age the larynx lowers in the neck, affecting outcome measures of pharyngeal dimensions and angles. Similarly sex can affect these measures since, on average, males have a larger larynx. Welch et al. were the only authors that adequately controlled for the effects of age and sex (1993).

Recommendations

After careful examination of the evidence and the methodological procedures used to determine study results some general effects of the chin tuck can be expected by clinicians.

As the chin tuck creates a reduction in the distance between the larynx and the hyoid, and the hyoid and the mandible, it can be assumed that these decreased

dimensions indicate a shortening of the pharynx (Bulow et al., 1999, 2001). Thus, clinicians can expect that the chin tuck will affect the route necessary for laryngeal elevation and airway closure, as it is shortened.

During the chin tuck, the angle between the mandible and posterior pharyngeal wall decreases, and the angle between the posterior surface of the epiglottis and anterior wall of the trachea increased (Welch et al., 1993, Shanahan et al., 1993). Therefore, an effect of the chin tuck is a posterior shift of anterior pharyngeal structures.

The chin tuck posture creates a reduction in pharyngeal peak contraction pressure and a reduction in contraction duration (Bulow et al. 1999). A reduction in pharyngeal peak contraction exacerbates swallowing difficulties in patients with weak pharyngeal constrictor muscles. Consequently, it is recommended that clinicians use caution when using the chin tuck with these patients.

The chin tuck was not found to affect the number of misdirected swallows, but did create a reduction in the depth of penetration in to the larynx and trachea (Bulow et al., 2001). This result should be interpreted with caution as it only pertains to thin liquid bolus. Further, research indicates there is an important relationship between bolus location and the postures effectiveness in elimination of aspiration. When the source of aspiration is the pyriform sinus the chin tuck is not effective in eliminating aspiration (Shanahan et al., 1993). Thus, it is suggested that clinicians consider that boluses entering/pooling in the pyriform sinus during the pharyngeal swallow decreases the chances that the posture will eliminate aspiration.

With regards to age, younger individuals show a greater increase in epiglottic angle compared to their older counter parts. This greater increase in epiglottic angles is thought to be related to continued aspiration despite use of the chin tuck (Shanahan et al., 1993). Thus the lowering of the larynx with age may make the chin tuck more effective for older individuals.

Given the presence of methodological flaws in some of the existing literature, further research is recommended. Future research should address the following issues.

a. Larger randomized studies to increase rigor in collecting evidence in research, and increase levels of experimental control.
b. Employ data collection procedures to minimize prospective sources of bias.
c. Further control for subject-specific characteristics such as etiology and severity of dysphagia.
d. Specific attention should be given to age and sex controls. Comparison of older and younger age groups is necessary to determine how age affects posture use. Subject groups of exclusively males and females and comparison studies are necessary as sex was found to be another confounding variable in the research.
e. Conduct measurements tools during actual swallows with a dynamic pharynx if results are to generalize to swallow function.
f. Use a greater variety of bolus viscosities. If results are to generalize to the clinical setting thick, puree, pudding and solid consistencies need to be included in research along with thin liquids.

Conclusion

While some general clinical recommendations concerning the effects of the chin tuck can be made assumptions about patient-specific effects of the chin tuck should not be made without radiographic evidence. Rather, predicted effects of the chin tuck should be used to determine patients who are more or less likely to benefit from the effects of the posture based on individual characteristics (location of bolus at aspiration, age, viscosity of bolus, any anatomical abnormalities, weak pharyngeal constrictor muscles). It is of great importance to analyze each patient's specific dysfunction before deciding which therapeutic strategies will be most efficient.

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