Sistema de freqüência modulada no transtorno do processamento auditivo: prática baseada em evidências?*******

Frequency modulation (FM) system in auditory processing disorder: an evidence-based practice?

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Abstract
Background: use of frequency modulation (FM) system in auditory processing disorder. Aim: to verify the existence of scientific evidence confirming the effectiveness of personal FM systems in the treatment of central auditory processing disorders (APD). For this purpose a systematic review of the literature was made, using data found in electronic databases (Medline, Lilacs and Cochrane library) as well as on the internet. The articles retrieved were analyzed according to the CONSORT statement and then classified by their evidence level. Conclusion: the search resulted in 1,589 references out of which only 19 met the inclusion criteria. All of the analyzed articles were classified as having low level of evidence (expert opinion or case studies). Strong scientific evidence supporting the use of personal FM systems for APD intervention was not found. Since such device is frequently recommended for the treatment of APD, it becomes essential to carry out studies with high scientific evidence that could safely guide clinical decision making on this subject.
Key Words: Central Auditory Diseases; Hearing Aids; Rehabilitation; Audiology.

Resumo
Tema: uso do sistema de frequência modulada (FM) no transtorno do processamento auditivo. Objetivo: verificar a existência de evidência científica que comprove a efetividade do sistema FM para tratamento do transtorno do processamento auditivo (TPA) por meio de revisão sistemática da literatura pertinente encontrada em bases de dados eletrônicas (Medline, Lilacs e registro de ensaios clínicos da biblioteca Cochrane) e buscadores da internet, sendo os artigos recuperados analisados com base na declaração CONSORT e classificados quanto ao nível de evidência. Conclusão: a busca resultou em 1589 referências, das quais somente 19 enquadraram-se nos critérios de inclusão. Todos os artigos analisados foram classificados com baixo nível de evidência (opinião de especialista ou estudo de casos). Não foi encontrada forte evidência científica que comprove a efetividade do uso do sistema FM na intervenção de indivíduos com TPA. Uma vez que este equipamento é freqüentemente recomendado para a intervenção nos casos do TPA, se torna imprescindível a realização de estudos com alta evidência científica que possam guiar seguramente as tomadas de decisões clínicas a este respeito.
Palavras-Chave: Doenças Auditivas Centrais; Auxiliares de Audição; Reabilitação; Audiologia.

Introduction

Individuals with auditory processing disorder (APD) present one or more of the following behavioral characteristics: difficulty to understand auditory information (language) in competitively noisy or reverberant environment; inconsistent or inappropriate responses in speech, frequent requests for repetition of spoken message, difficult attention, easy distraction, difficulty to follow complex verbal orders, difficulty to localize the sound, difficulty to learn songs and rhythms, as well as reading and learning problems. The APD often causes higher impact to children, to whom such characteristics may interfere in their social, reading, speaking, language, comprehension, attention, and communication skills. Thus, it may cause anxiety, low self-esteem, and below-the-expected academic performance (1,2).

Children spend much of their time at school, and in 45% of this time, they are concerned with activities in which teachers' and classmates' speeches dominate. So it is easy to conclude that the clear perception of the message, and the capability to process it auditively, is essential for learning process at school (3).

The spoken message is highly redundant. In the daily context of communication, listeners, without any malfunction of their peripheral or central auditory pathways, do not need all the acoustic clues from a message to understand it. On the other hand, understanding the message is more difficult for individuals with hearing impairment, if the reduction of such clues occur.

The elimination of redundant information of the speech, occasioned by the presence of the noise, reverberation, and the distance among the speakers, has a severe effect in the perception of the speech, mainly in hearing handicapped, such as: children with language and speech impairment, auditory processing disorder or learning difficulties. Until the end of day, the student will have spent enormous energy to cope with the adverse acoustic situations, which may lead him or her to exhaustion, and consequently, low performance at school and little utilization of their training/learning. For this reason, the additional loss of information in speech should be avoided to the maximum. It is important to stand out that auditory, attention, and memory skills/ abilities become similar to the one of an adult, at age around 12 years old.(3)

The frequency modulation (FM) system consists of two elements: a microphone/transmitter and a receiver. The microphone/transmitter, utilized by the speaker, catches the sounds, encodes them in electric signs and then converts them in signs of frequency modulation. This FM sign is decoded by the receiver, utilized by the listener, and is once again transformed in acoustic energy. The FM transmission provides a simple solution to reduce the distance between speaker and listener and, consequently, diminish the masked effects of the noise and the reflection to the sign of speech (4).

By this action, the FM system can be considered as one more alternative among the differentiated material and resources of support utilized by disabled students needing special education, aiming at their educational integration/full inclusion (5).

The FM personal system can also be appropriate for infants without peripheral hearing loss, but who present difficulties of learning associated to deficit of attention (4) and with central auditory processing disorder (6, 7). For that population, a favorable signal-to-noise ratio seems to facilitate the attention for the task and improve the time of answer, therefore when the teacher's speech becomes clearer, infants present a longer time of focus and concentration in prominent sonorous stimulus, while ignore competitive stimulus.

Currently, a lot has been discussed about practice based in evidence - defined as clear and pondered use of the best existing scientific evidences in the decision about the care of patients, integrating the experience with the best clinical evidences obtained in systematic research. In this context, priority is given to results from specially planned original clinical researches and with specific and rigorous methodological support, which really measure the success of treatments in actual conditions. Books and opinions of specialists have smaller importance (8,9). Therefore, the concern and achievement of studies with scientific evidence, which can safely guide the clinical decision-making regarding this subject, become indispensable, once in Speech Pathology and Audiology it is common that the available scientific facts do not present a strong level of evidence followed by the success observed in the clinical practice (10).

Faced with indications for the use of the FM personal system in individuals with ADP, the present study had the objective to carry out a systematic revision of the literature, in order to verify the existence of scientific evidences that maintain that clinical practice.

For the development of this study, searches of the pertinent literature were carried out in electronic databases:

. Centro Latino-Americano e do Caribe de Informação em Ciências da Saúde - Bireme (www.bireme.br): Lilacs database (literature in sciences of the health published in the Latin America and Caribbean, from 1982) e Medline (international literature of the medical and biomedical area, compiled since 1966).
. Pubmed (www.pubmed.com): a service of National Library of Medicine and National Institute of Health, including citations of Medline and others newspapers of the area of "sciences of the life", compiled since 1948.
. Eletronic Reference Library (www.portal dapesquisa.com.br): access to more of 30 databases among them the bases ERIC (education) and PsycInfo (psychology, education, psychiatry, social sciences).
. Web of Science (www.thomsonisi.com): databases in the fields of Sciences, Social Sciences, Arts and Humanities. Biblioteca Cochrane (http:// cochrane.bvsalud.org): access to the Cochrane databases of systematic revisions, record of attempts controlled by Cochrane Collaboration, evaluation of technologies in health, among others.

TABLE 1. List of words and subject describers utilized in databases and search tools.

Search Number	Crossed words and describers
1	auditory AND processing AND personal AND FM
2	auditory AND processing AND FM AND technolog*
3	auditory AND processing AND FM AND system*
4	auditory AND processing AND frequency modula*
5	auditory diseases, central AND personal AND FM
6	auditory diseases, central AND FM AND technolog*
7	auditory diseases, central AND FM AND system*
8	auditory diseases, central AND frequency modula*

* Broken words according to each database

Search engines as Google Academico also were utilized (www.scholar.google.com) and manual searches from the bibliographical references of the articles found in the bases above described and recuperated.

Descriptors extracted of the Medical Subject Headings (MeSH) and their respective (DeCS) were utilized and keywords utilized in the databases were crossed as described in Table 1.

The search was limited to one year, so the results embody every articles in each database, since the beginning of April, 2008. There was no restriction regarding the language in which the articles were published.

Criteria for literature inclusion

The following was utilized as criteria of inclusion:

. randomized controlled clinical attempts,which could evidence the use of FM system in treatment of ADPs
. studies which contained in their titles, intervention forms to ADPs , and which mentioned the use of FM personal system in any part of the text, and
. studies with individuals presenting normal peripheral hearing acuity.

Analysis of results

Despite the strategy of search utilized (table 1) the research in the library Cochrane revealed absence of systematic revisions or clinical attempts recorded in this theme. In the remaining databases the search resulted in 1589 citations (table 2). The repeated citations and those that did not fit the criteria of recuperation were excluded from the analysis of the summaries. Only 20 of these citations fit in the criteria of enclosure.

TABLE 2. List of studies found in each database, according to each search number.

Search Number	LILACS (Bireme)		MEDLINE (Bireme)		Pubmed		ERIC (ERL)		MEDLINE (ERL)		PsychoInfo (ERL)		Web of Science		Google Scholar	
	E	I	E	I	E	I	E	I		E	I	E	I	E	I	E
1	-	-	1	1	-	-	-	-	1	-	-	1	1	-	-	-
2	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
3	-	-	30	1	22	-	-	-	3	-	-	30	1	22	-	-
4	1	-	243	7	-	-	-	-	4	1	-	243	7	-	-	-
5	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-

no study found, * does not utilize search per subject describer, ** no search was held with such words, E studies found I studies included in the analyses

Three independent revisers evaluated the recovered articles, classifying them according to the levels of evidence (9) described in Table 3. The utilization of the recommendations CONSORT (Consolidated Standards of Reporting Trials) (11) was chosen for the characterization of the Randomized Controlled Clinical Trials. The analyses of each reviser, then, were compared. Meetings of consensus resolved/decided disagreement between the facts, when necessary.

TABLE 3. Description of six levels of evidence of a study.

Level of Evidence	Description
1	Systematic reviews and meta-analysis. Randomized Controlled Clinical Trials
2	Randomized Controlled Clinical Trials
3	Not randomized studies of intervention
4	Descriptive studies, transversal (cross-sectional) studies, coort studies, case-control studies).
5	Case studies
6	Specialists' opinions

Search: Cox RM. Evidence-based practice in provision of amplification. J Am Acad Audiol. 2005; 16(7):`419-38.

TABLE 4. Description of works analyzed according to the names of the authors, title, year, design and level of evidence.

author	title	year	Design	level of evidence
ASHA (24)	(Central) Auditory processing disorders	2005b	Specialists' opinions	6
Baran JA (16)	Managing Auditory Processing Disorders in Adolescents and Adults	2002	Specialists' opinions	6
Beck DL; Bellis TJ (18)	(Central) auditory processing disorders: Overview and amplification issues	2007	Specialists' opinions	6
Bellis TJ (13)	Developing Deficit-Specific Intervention Plans for Individuals with Auditory Processing Disorders	2002	Specialists' opinions	6
Bellis TJ; Ferre JM (29)	Multidimensional Approach to the differential diagnosis of central auditory processing disorders in children	1999	Case studies	5
Cameron S; Dillon H (30)	The listening in spatialized noise-sentences test (LISN-S): test-retest reliability study	2007	Specialists' opinions	6
Ferre JM (17)	Managing Children's Central Auditory Processing Deficits in the Real World: What Teachers and Parents Want to Know	2002	Specialists' opinions	6
Flexer C (19)	The impact of classroom acoustics: listening, learning and literacy	2004	Specialists' opinions	6
Phonak (27)	Ear-level FM receiver stimulates auditory neural plasticity in children with APD	2006	Descriptive studies (control cases)	4
Friel-Patti (14)	Clinical decision-making in the assessment and intervention of central auditory processing disorders	1999	Specialists' opinions	6
Keith RW (23)	Clinical issues in central auditory processing disorders	1999	Specialists' opinions	6
Kreisman BM (26)	Frequency Modulation (FM) Systems for children with normal hearing	2002	Descriptive studies(coorte study)	4
Launer S (15)	Wireless solutions: the state of the art and future of FM technology for hearing impaired consumer	2004	Specialists' opinions	6
Rosenberger GG (20)	Classroom acoustics and personal FM technology in manegment of auditory processing disorder	2002	Specialists' opinions	6
Sharma M; Purdy SC (28)	A case study of an 11-Year-Old with auditory processing disorder	2007	Case study	5
Souza-Jacob, RT, Almeida MA e Bevilacqua MC (5)	Uso Alternativo do Sistema de Freqüência Modulada (FM): Crianças com Dificuldades de Aprendizagem e Déficit de Atenção	2002	Case studys	5
Weihing J (22)	FM systems as a treatment for CAPD	2005	Specialists' opinions	6
Whitelaw GM (25)	FM candidacy issues and the "alphabet soup"	2004	Specialists' opinions	6
Wertz D et al (21)	Auditory Processing Disorders: Management Approaches Past to Present	2002	Specialists' opinions	6
Young et al (12)	Preferred FM system listening levels of children with central auditory processing disorders.	1997	Descriptive studies(coort study)	4

The Randomized Controlled Clinical Trials are described as "gold-standard " in the evaluation of therapeutic issues in health, since by means of this kind of study, the probability to obtain tendentious facts (bias) in the research is reduced, thus, privileging the quality of information. For information of the authors, authors, title, year, level of evidence for the 20 works recovered, the reader is referred to Table 4. Considering the recommendations Consort, none of the works was classified as being Randomized Controlled Clinical Trial. It was verified that fourteen works (70%) were classified as "opinion of specialists", three (15%) as "case study", and three as descriptive studies (15%). Such drawings of study present low scientific evidence.

Conclusion

One of the main objectives of a systematic revision is to aggregate strong research evidences to guide the clinical practice. The inexistence of Randomized Controlled Clinical Trials to evaluate the effectiveness of the personal FM system in the intervention of individuals with central auditory processing disorders limits the considerations of the present work.

The performance of Randomized Controlled Clinical Trials is indeed complex and of elevated cost, causing other types of experimental studies to be used to substantiate health practices.

Although there was no exhaustive effort to recover the unindexed publications (e.g. annals of congresses), what calls attention is that not even these other types of studies were found in abundance and the indication of the system FM for central processing disorders seems almost totally to come from specialists' opinions (Table 4).

Although basic knowledge in books and from more experienced specialists are essential for clinical practice, these cannot be the only base for clinical decision-making (8, 9), mainly currently, when work offer is associated to rational use of resources, being these, public or private.

For infants with ADP, a technology, which provides audibility and clearness of the acoustic signal, such as the system FM (12-21), has been recommended, being this considered part of the rehabilitation process, not the only strategy for it (22). However, few scientific data which demonstrate the efficacy of the system FM as a rehabilitation strategy for ADPs have been published (23-29).

Although being possible that the system FM is an effective resource in ADPs' treatment, taking into account publications that have been analyzed, the present revision cannot confirm or exclude such possibility. Once this equipment is often indicated in clinical practices, the need to perform Randomized Controlled Clinical Trials, comparing the use of system FM to other forms of treatment, or even the absence of any kind of treatment, is justified - always and whenever the study design does not imply in infringing ethical principle. In case any evidence of effectiveness of the system FM upon other forms of intervention is found, it is convenient to compare the available types of FM (personal versus free range). Finally, it is important to consider the perspective of the user or his/her family/carers, as well.

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