

# SPEECH LANGUAGE PATHOLOGY DISORDERS IN CHILDREN WITH CONGENITAL HYPOTHYROIDISM: CRITIC REVIEW OF LITERATURE

## *Alterações fonoaudiológicas em crianças com hipotireoidismo congenito: revisão crítica da literatura*

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### ABSTRACT

Congenital Hypothyroidism (CH) is the most common congenital endocrine disorder in childhood which corresponds to a deficiency of thyroid hormones. This article aimed to do a literature review about the Speech Language Pathology disorders that might be associated to HC. The keywords used for searching the electronic databases PUBMED and MEDLINE were: congenital hypothyroidism OR hypothyroidism AND hearing OR voice OR language. It was included studies published up to July 2011. Two researchers did the analyses, independently, with further discussion and consensus about the inclusion. Out of the 324 studies found in the preliminary analysis, only 20 of them were included in the final sample after establishing the criteria for inclusion. We observed that a great number of articles on the children language development on CH, but controversial ones, when it comes to the results of the evaluations. In Audiology, there has been a reduction in the number of articles that describe hearing loss in children who had CH. Only two papers were found about the voice, which referred exclusively to crying abnormalities in babies affected by CH. Although some findings were proven relevant to the subject, the great variability of the research methodology does not allow us to have a clear conclusion on the probable speech language pathology disorders in children with congenital hypothyroidism.

**KEYWORDS:** Congenital Hypothyroidism; Speech, Language and Hearing Sciences; Child; Hearing; Voice; Language

### ■ INTRODUCTION

Congenital Hypothyroidism (CH) is the most common endocrine congenital disease in childhood and its incidence is one for each 3000 up to

4000 births. Characterized by the lack of thyroid hormones (TH), CH may be prematurely detected through newborn screening test (the neonatal heel prick). Thyroid gland is responsible to produce, to store, and to release the TH (thyroxine and triiodothyronine) in bloodstream. The TH acts in almost all the organism cells in enzymatic concentration and activity, in substrate metabolism, as vitamins and minerals, basal metabolism, and also stimulates the oxygen absorption<sup>1</sup>.

In fetus and newborn (NB) the TH are determinant to central nervous system (CNS) development. In case of improper or premature hormone restoration the growth and development sequels may be irreversible<sup>2</sup>.

Literature reports the presence of speech-language disturbances in CH children. Studies point out the language disorders associated to CNS<sup>3</sup>

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development disturbances, and hearing losses due to maturation dysfunction of inner ear structures and VIII cranial nerve myelination<sup>4</sup>. Regarding voice, the rough crying is the one of clinical symptoms common at birth<sup>5</sup>, which may occur up to 20% of cases<sup>6</sup>. However the scientific evidences are not clear yet, especially about the endurance of this symptom during first childhood in premature treated children.

It is believed that the speech-language disturbances related to language, hearing and voice must be investigated mainly due to the advance in newborn screening tests systems and follow-up. It is possible that diagnose and premature treatment may be related to decreasing negative consequences to children.

The purpose of the present study was to review the literature regarding possible speech-language disturbances related to congenital hypothyroidism and, therefore, to answer the following question: *"Is there scientific evidence about the presence of speech-language disturbances in children with congenital hypothyroidism?"*

## ■ METHODS

The papers search was done in PUBMED and MEDLINE electronic database during 2011 July. The used keywords to search were: hypothyroidism OR congenital hypothyroidism AND voice OR hearing OR language. The crossing among all keywords combination was made.

The papers search process was done by two of the researchers of the present research, individual and independently, to posterior comparing and defining the final sample inclusion. To all data collection steps, the results of each researcher were compared and, at the end of each step, a meeting to consensus and clearing possible conflicts/inconsistencies regarding the found papers was made.

The inclusion criteria were: papers related to voice (phonation and resonance), language and hearing in children with congenital hypothyroidism (primary); with evidence level 1 (systematic review), 2 (controlled random studies), or 3 (nonrandomized studies), according to the proposed classification

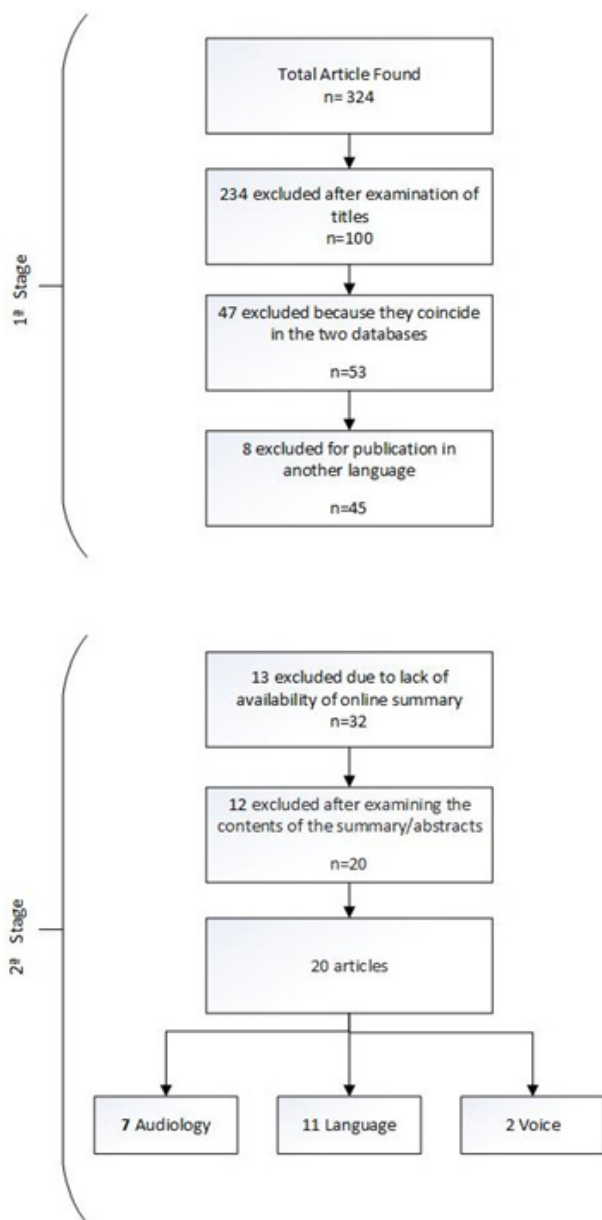
in previous study<sup>7</sup>; published up to 2011 July. The exclusion criteria were: papers which theme were not direct related to the speech-language aspects; written in other languages than English or Portuguese; which themes were acquired or transitional hypothyroidism; in which the congenital hypothyroidism were associated to others diseases/comorbidity; which abstracts were not able to be accessed in included database (PUBMED and MEDLINE) or CAPES periodic homepage; about adults exclusively; and using animal model.

At first, 324 papers about speech-language pathology and the diverse types of thyroid disturbances were located. Through title analysis, 100 were selected having direct relation to this review theme. 47 papers were excluded since they were coincident at both databases. Finally, eight papers were excluded since they were published in other languages than English or Portuguese, and therefore, the abstract and the complete text were not available in either the two languages. Thus, 45 papers remained to the next review step.

At second step, it was verified the abstracts existence. 13 papers were excluded since they did not have the abstract available at the website of the included databases (PUBMED and MEDLINE) and/or at CAPES periodic homepage and, therefore, the content of the paper could not be evaluated. Thereby 32 papers remained, 20 of them were accessed through CAPES periodic homepage, 11 were requested to national libraries, and one to an international library. Through reading the abstracts and full papers there was the exclusion of 12 papers due to not being compatible to the study theme. Therefore, the final number of papers included in the sample was 20 (Figure 1).

It was made a descriptive analysis about the content of the included papers in this review. It was sought to observe agreement and disagreement points among them, besides to identify whether there were enough scientific evidence to draw the speech-language pathology profile of CH children.

It was collected data regarding research purpose, age range, presence of control group, and main obtained results. From that, compiling data and critic analysis were made.



**Figure 1 – Flowchart about data collection**

## ■ LITERATURE REVIEW

The following results were distributed according to Speech-language pathology researched fields. It was located seven papers in Audiology, 11 in Language, and two in Voice (Figure 2)

Regarding Audiology, excepting one literature review paper<sup>8</sup>, which was made the option to include in the sample due its precursor character in investigating hearing losses due to congenital hypothyroidism, the others papers (n=6)<sup>9-14</sup> are transversal studies. Most of them<sup>10-13</sup> were carried out in the

nineties. From the total papers which reported the possibility of hearing loss in CH children<sup>9,12,13</sup>, only one of them had more methodological strength, having control group and a considerable number of children (n=75)<sup>13</sup>. The other papers, as the ones with newborns<sup>10,14</sup> as with children<sup>11</sup>, did not prove the relation between congenital hypothyroidism and hearing loss.

The papers located were about peripheral auditory evaluation. It was not located specific papers about the hearing processing investigation, defined as mechanisms and process of auditory nervous system, which promotes speech decoding and comprehension, especially in unfavorable situations, as the background noise presence or competitive speech<sup>15</sup>. It is considered of major importance to carry out new researches that investigate this aspect. It is believed that the results of these researches may contribute to clearing other complaint types commonly reported by the CH children, in language and learning (school, attention, memory and others difficulties).

Besides, the hearing loss incidence in CH children is questionable, since none reviewed paper had epidemiologic character. The only paper<sup>9</sup> suggesting hearing deviations percentage (10% or a tenth) to this population have a big variability regarding the beginning of treatment of the participants (14 days to seven years and three months), which could possible question and generate bias of the obtained results.

The results showed from the three Speech-language Pathology fields investigated, language was the one with higher number of published papers<sup>16-26</sup>. This allows the arguing about this topic in CH children to be more clear and consistent, but do not exclude the importance of other communication aspects. It is worthy to note that the totality of found papers corresponds to oral language deviations, with only two paper having information about writing language, literacy process, and scholar development in CH children.

Besides, about language yet, it was observed the predominance of cognitive process focus, with complementary information about the deviations in this area. Therefore, QI information, memory, attention skill and general neuropsychological development overlapped specific language data, with the contribution of these aspects regarding the language disturbance not clear.

About the content of the language files papers, there are still controversies about the relation between its development and CH presence. Some papers report proper development when CH children are compared to control children<sup>16,21,25</sup>. On the other hand, other studies point out phonologic deficits and

Authors/Year	Purpose	Sample	Main Results
Meyerhoff WL; 1976 <sup>7</sup>	To review in literature possible relations between hearing losses and thyroid disturbances from the following types: not genetic but congenital, not genetic but acquired, congenital, and genetic with late symptoms.	47 researches published in periodic (n=43) and books (n=3) from 1896 to 1974 were compiled.	The relation between hearing losses and thyroid disturbances are coincident and there is not a connection between them.
Debruyne F; 1983 <sup>8</sup>	To investigate the incidence, type and severity of hearing loss in CH children.	SG: 45 children with CH aging from 1 up to 13 years. CG: none.	20% (n=9) of children had some kind of hearing loss (four with mild degree and five needing hearing loss device adaptation).
François M et al.; 1993 <sup>9</sup>	To evaluate the newborn with CH hearing before and after the hormone treatment.	SG: 11 newborns with CH; CG: 9 newborns without the disease.	Up to 25 days of life the children with CH without treatment had normal hearing capability. It was concluded that the cochlea development and auditory-brain function is unresponsive to fetal hypothyroidism, and the thyroid hormone level during fetal life was enough to normal development of children.
François M et al.; 1994 <sup>10</sup>	To verify whether CH is related to hearing losses, and to relate the hearing data to the variables: beginning of treatment age, thyroxin level at the beginning of treatment, and CH cause.	SG: 42 subjects with CH, aging from 12 months up to 21 years; CG: 42 subject without hearing loss risk.	CH is not necessarily associated to hearing losses in high frequencies when children having the disease were compared to health ones. Besides, the hearing loss occurrence is independent of CH causes or the age of treatment beginning.
Bellman SC; 1996 <sup>11</sup>	To verify the prevalence of auditory-vestibular disturbances in 32 children with CH prematurely treated (longitudinal study).	SG: 38 children with CH, from 10 up to 12 years, followed since their birth; CG: none.	It may occur slight disturbance of hearing and vestibular function in CH children, even when prematurely treated.
Rovet J et al.; 1996 <sup>12</sup>	To determine incidence and type of CH children hearing loss; to relate the hearing loss and premature treatment to thyroid disease; and to report the functional significance of the hearing loss to posterior oral and writing language capabilities.	SG: 75 CH children, aging from 10 up to 12 years, followed after newborn screening, with specific neurologic assessment; CG: CH children classmates.	Fifteen (20%) of children had some hearing problem. Nine of them had unilateral hearing loss in high frequencies, five had conductive loss, and one had combined loss. The authors suggested CH children must have hearing screening.
Parazzini M et al.; 2002 <sup>13</sup>	To analyze the hormone deficiency effects on peripheral hearing system, at the first month of life in CH children.	SG: 29 CH newborns; CG: 42 healthy newborns.	There is not influence of CH in hearing capability up to the 30 <sup>th</sup> day of life
Fuggle PW et al.; 1991 <sup>14</sup>	To evaluate CH children prematurely treated intelligence, motor skills, and behavior.	SG: 57 CH children aging up to five years old; CG: 51 children without the disease, paired in sex, age, and socio-economic level to CG.	There are not differences in intelligence, vocabulary, comprehension and verbal IQ assessment between the SG and CG. However, CH children had the worst motor skills levels.
Rovet JF et al.; 1992 <sup>15</sup>	To evaluate the neurologic development of CH children and relate it to etiology and treatment interference variables.	SG: 108 CH children aging among 1 and 5 years; CG: 71 brothers without the disease.	Although the CH children development improves according to the newborn diagnose and treatment, it still may be risks for deficits due to thyroid hormone deficiency in uterus and the beginning of life. Children with thyroid agenesis had more risks to neurologic development.
Kooistra L et al.; 1994 <sup>16</sup>	To evaluate the cognitive and motor development of prematurely treated CH children, and to relate to the variables regarding etiology, thyroxin blood concentration at newborn screening and the beginning of treatment age.	SG: 72 CH children, aging among 7 and 9 years, prematurely treated; CG: healthy children.	Children with lower thyroxin level at newborn screening particularly the ones with thyroid agenesis had lower intelligence scores up to 9 years. To children with severe CH there was relation between the beginning of treatment age and cognitive and motor evaluation. Regarding language, there was no difference between CH children and control group. However, children with thyroid agenesis had the worst scores in oral fluency when compared to CG children due to other etiologies and control group.



Authors/Year	Purpose	Sample	Main Results
Simons WF et al.;1997 <sup>17</sup>	To describe the reading, mathematics, motor skills and behavior progress in a CH children group.	SG: 59 CH children, with 10 years old, in which 31 had severe CH and 28 less severe in newborn screening; CG: 59 classmates without the disease.	Severe CH children at the newborn screening had more deviations in mathematics, motor skills and behavior than moderate CH and normal control. Regarding reading there was no difference between groups.
Bargagna S et al.;1997 <sup>18</sup>	To longitudinally compare the neuropsychological development of twins, one with CH prematurely treated and the other without the disease, and also to compare them to a healthy children group.	SG: twins, one with CH and the other without the disease. CG: 34 healthy children, from 3 months up to 8 years old.	The twins language development were slight retarded comparing to control; At four years the CH twin had phonologic disturbance and poor expressive language comparing to her sister, but at 8 years this matter was normalized; CH twin was not different to control regarding school skills.
Rovet JF.; 1999 <sup>19</sup>	To longitudinally investigate the neuropsychological function in CH children	SG: 100 prematurely treated CH children that were assessed by intelligence tests (phase 1), psycho-educational assessment (phase 2), and neuropsychological complete examination (phase 3 – teenage); CG: brothers and classmates.	The CH children premature attendance is related to normal intellectual function levels.
Bargagna S et al.;1999 <sup>20</sup>	To evaluate the scholar development of CH children prematurely treated, and to compare them to normal control.	SG: 19 CH children aging from 5 to 10 years, attending nursery or elementary school; CG: 298 healthy children, paired in age and scholar level.	In nursery the CH children had the worst development in coping symbols and figures, sentences repetition, and spontaneous writing. Regarding spontaneous writing, the CH children had lower scores only in recognizing orthographic mistakes. QI, language and social condition levels were worst in CH children.
Bargagna S et al.;2000 <sup>21</sup>	To identify which neuropsychological functions would be more affected in prematurely treated CH children, comparing them to healthy control.	SG: 24 prematurely treated Ch children, evaluated at 3.5 and 7 years old; CG: 25 healthy children, paired in age and sex.	At 7 years, the cognitive development of CH children was similar to CG. At 3 years, 29% of CH children had phonologic disturbance and 21% expressive language disturbance. At 5 years, 37.5% of them had phonologic disturbance and 12.5% in expressive language. At 7 years, 12.5% of CH children still had phonologic disturbance. Severe CH children had more language disturbance.
Alvarez M et al.;2004 <sup>22</sup>	To identify the fetus, newborn, and treatment influence at the beginning of language development in CH children.	SG: 26 CH children, from 3 up to 18 months; CG: none.	The better language development was related to lower biochemical perturbation (T4 values) before the treatment beginning. The language development seems to be independent from the fetus hypothyroidism duration.
Gejão MG et al.;2008 <sup>23</sup>	To draw the development profile of prematurely treated children focusing on communicative skills.	SG: 32 Ch children, from 2 up to 36 months; CG: none.	Majority of children had proper motor, cognitive, language, social and self-care skills development. Among deviated children, more deficits were observed in language skills (expressive and cognitive skills).
Gejão MG et al.;2009 <sup>24</sup>	To describe the communicative and psycholinguistics skills of phenylketonuria (PKU) and CH children.	SG: 68 children, as 43 with CH (from 1 up to 60 months) and 25 with PKU (from 1 up to 120 months). CG: none.	CH and PKU children had risk to development skills (motor, cognitive, linguistic, adaptive, and social). Socio-linguistics disturbances were observed mainly after preschool age. CH patients had more cognitive and language deficits.
Michelsson et al.;1976 <sup>25</sup>	To investigate possible deviation in CH newborn cry through acoustic spectrographic analysis.	SG: 4 CH children aging from 10 days up to 4 months; CG: 75 children without the disease, at the same age range.	CH newborns had lower mean, minimum and maximum fundamental frequency values. F0 variations also occurred more in SG.

Authors/Year	Purpose	Sample	Main Results
Boero D et al.;2000 <sup>26</sup>	To evaluate the acoustic parameters of CH newborn cry at the diagnose moment and after 30 days of the medical hormone treatment.	SG: 12 CH newborns; CG: 16 newborns without the disease and healthy.	At first evaluation, the CH children had cries in lower volume and lower number of vibratos during emissions. Mean initial FO, mean, minimum, maximum and final were also lower in SG. At second evaluation, even with some change in parameters, there was no change in time parameter, fundamental frequency and frequency peak. The authors concluded to be abnormalities in CH newborn cry and part of them do not modify after a month treatment with thyroid hormone.

Subtitles: SG= study group; CG = control group

**Figure 2 – Contents of localized papers about speech-language disturbances related to congenital hypothyroidism**

significant delay in language development<sup>17-20,22-24,26</sup>. Lower inconsistencies were observed when the language deviations were related to CH etiology and “severity of the disease at diagnose (newborn screening)” variables. All the papers that purposed to evaluate such relation concluded that thyroid agenesis and more deviated hormone levels at diagnose (more severe) contributes to a higher risk to deviation in language development<sup>17-19;23,24</sup>.

There was a big methodological variability in Language papers, probably due to the differences and particularities regarding main evaluation focus (some papers includes the language evaluation as complementary to neuropsychological development evaluation), or the academic graduation and research line of the author(s). Besides, does not seem to have a relation between the paper publication period and obtained results, once the most recent ones had variability about the findings of CH children language development<sup>22-26</sup>.

About the relation between congenital hypothyroidism and possible vocal deviation in children, there still is a big gap of knowledge to be fulfilled. That is because, even the literature pointing out rough cry as one of the main clinic symptoms of CH children at birth (usually evaluated under the physician perspective), only two papers made objective analysis about the subject<sup>27,28</sup>. The two papers have similar conclusions and make clear there is a considerable level of CH newborns having voice deviations. One of them<sup>28</sup> points out that even after a month treatment and the hormone levels within normal patterns, part of the children still had vocal disturbances. However, there was not obtained papers that pointed out any evidence about the maintenance of these deviations throughout first childhood. It is worthy to mention that one of the above mentioned researches<sup>28</sup> is from the medical

field and it was carried out trying to relate vocal characteristics to neurologic and breathing development of the children<sup>28</sup>. But it was made the option to select the paper to this review due to acoustic analysis inclusion and the shortage of papers with strong data about the topic.

It was not located other studies of voice assessment in CH children, in any other age range than newborns. So, it is important to carry out other researches that clear this aspect, once there is still not clear whether there is the maintenance of a possible dysphonia throughout childhood information.

Currently, with the advance of newborn screening programs, the CH newborns receive treatment and medical attendance since the first weeks of life. The hormone reposition and following will be permanent which may promote the normal or very close to normality growth and development. However, the real implications of prematurely treated CH, mainly in teenage and adulthood, are still unknown<sup>29</sup>. Therefore, longitudinal studies, which will follow the hearing, language and voice development, are fundamental in order to better understand the cases progress and their hypothyroidism possible consequences with aging. It is worthy to highlight that newborn screening became a law in Brazil in 1990 and 2001, through GM/MS ordinance n° 822, and it was held in all national territory and, therefore, there are already a big number of teenagers and adults followed since their birth, systematically, in specialized centre<sup>30</sup>.

## ■ CONCLUSION

The big method variability of the reviewed papers does not allow a clear conclusion about possible speech-language disturbances in children having

congenital hypothyroidism, mainly in Audiology and Voice fields. Some papers, really old, report the subject in a previous moment to newborn screening tests implantation which certainly contributed to the bigger number of descriptions in the children of these researches. Although it seems to have a tendency to “normalization” or decreasing the number of speech-language disturbances as the screening tests implantation happens, there is a lack of evidence regarding the subject.

It is important that new researches in language to be performed by speech-language pathologists in order to be possible to prior and analyze the most important aspects of the field, adding the speech-language pathology perspective so the findings may be easily applied in human communication disorders clinic. The audiology researches have been prioritized only audiometric thresholds and, therefore, researches about sound perception should be carried out. In voice, the production is pretty scarce and, even coinciding about deviations

in voice of CH newborns they do not allow to make inference about possible dysphonia maintenance in childhood and teenage.

Speech-language pathologist action in congenital hypothyroidism children is still poorly discussed and deserves attention. Therefore, the insertion of this professional in inter-disciplinary teams that follows CH children should be considered, and also in the development of researches that produce stronger evidence regarding the importance of its action to this population.

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#### RESUMO

O Hipotireoidismo Congênito (HC) é a doença endócrina congênita mais comum na infância e corresponde à deficiência de hormônios tireoidianos. Este artigo teve o objetivo de realizar uma revisão crítica da literatura, a respeito das possíveis alterações fonoaudiológicas relacionadas ao HC. Os descritores utilizados para a busca nas bases de dados eletrônicas PUBMED e MEDLINE foram: *hypothyroidism* OR *congenital hypothyroidism* AND *voice* OR *hearing* OR *language*. Foram incluídos estudos publicados até julho de 2011. As análises foram realizadas independentemente por dois dos pesquisadores, com posterior discussão e consenso sobre a inclusão. Dos 324 estudos localizados na análise inicial, apenas 20 compuseram a amostra final após o estabelecimento dos critérios de inclusão. Observou-se que há um número considerável de artigos sobre a linguagem de crianças com HC, embora com controvérsias no que se refere aos resultados das avaliações. Quanto à Audiologia, nos últimos anos houve uma redução no número de artigos que descrevem alterações auditivas em crianças com HC. Na área de Voz, foram localizados apenas dois artigos, que se referiram exclusivamente às anormalidades observadas no choro de bebês com HC. Embora com algumas constatações relevantes a respeito do assunto, a grande variabilidade metodológica das pesquisas não permite que se tenha uma conclusão clara sobre as possíveis alterações fonoaudiológicas em crianças portadoras de hipotireoidismo congênito na atualidade.

**DESCRITORES:** Hipotireoidismo Congênito; Fonoaudiologia; Criança; Audição; Voz; Linguagem

## ■ REFERENCES

1. Fisher D A. Disorders of the thyroid in the newborn and infant. In: Sperling M A. *Pediatric Endocrinology*. 3<sup>a</sup>.ed. Philadelphia: W.B. Saunders; 2008. p. 198-226.
2. American Academy of Pediatrics/American Thyroid Association. Lawson Wilkins Pediatric Endocrine Society. Update of newborn screening and therapy for congenital hypothyroidism. *Pediatrics*. 2006;117(6):2290-303.
3. Lazarus JH. Congenital hypothyroidism. *Arch Dis Child*. 2005;90:112-3.
4. Working Group on Neonatal Screening of the European Society for Pediatric Endocrinology. Revised guidelines for neonatal screening programs for congenital hypothyroidism. *Horm Res. Basel*. 1999;52:49-52.
5. Maciel LMZ, Kimura ET, Nogueira CR, Mazeto GM, Magalhães PKR, Nascimento ML *et al*. Hipotireoidismo congênito: recomendações do Departamento de Tireoide da Sociedade Brasileira de Endocrinologia e Metabologia. *Arq Bras Endocrinol Metab*. 2013;57(3):188-92.
6. Pezzuti IL, Lima PP, Dias VMA. Hipotireoidismo congênito: perfil clínico dos recém-nascidos identificados pelo Programa de Triagem Neonatal de Minas Gerais. *J Pediatr*. 2009;85(1):72-9.
7. Cox RM. Waiting for evidence-based practice for you hearing aid fittings? It's here. *The Hearing Journal*. 2004;57(8):10-7.
8. Meyerhoff WL. The thyroid and audition. *Laryngoscope*. 1976;86(4):483-9.
9. Debruyne F, Vanderschueren-Lodeweyckx M, Bastijns P. Hearing in congenital hypothyroidism. *Audiology*. 1983;22(4):404-9.
10. François M, Bonfils P, Leger J, Avan P, Czernichow P, Narcy P. Audiological assessment of eleven congenital hypothyroid infants before and after treatment. *Acta Otolaryngol*. 1993;113(1):39-42.
11. François M, Bonfils P, Leger J, Czernichow P, Narcy P. Role of congenital hypothyroidism in hearing loss in children. *J Pediatr*. 1994;124(3):444-6.
12. Bellman SC, Davies A, Fuggle PW, Grant, DB, Smith I. Mild impairment of neuro-otological function in early treated congenital hypothyroidism. *Arch Dis Child*. 1996;74(3):215-8.
13. Rovet J, Walker W, Bliss B, Buchanan L, Ehrlich R. Long-term sequelae of hearing impairment in congenital hypothyroidism. *J Pediatr*. 1996;128(6):776-83.
14. Parazzini M, Ravazzani P, Medagliani S, Weber G, Fornara C, Tognola G *et al*. Click-evoked otoacoustic emissions recorded from untreated congenital hypothyroid newborns. *Hear Res*. 2002;166(1-2):136-42.
15. ASHA: American Speech and Hearing Association [Internet].(Central) auditory processing disorders, 1997-2008. Available at <http://www.asha.org/members/deskref-journals/deskref/default>. 2005.
16. Fuggle PW, Grant DB, Smith I, Murphy G. Intelligence, motor skills and behavior at 5 years in early-treated congenital hypothyroidism. *Eur J Pediatr*. 1991;150(8):570-4.
17. Rovet JF, Ehrlich RM, Sorbara DL. Neurodevelopment in infants and preschool children with congenital hypothyroidism: etiological and treatment factors affecting outcome. *J Pediatr Psychology*. 1992;17(2):187-213.
18. Kooistra L, Laane C, Vulsma T, Schellekens JM, Van Der Meere JJ, Kalverboer AF. Motor and cognitive development in children with congenital hypothyroidism: a long-term evaluation of the effects of neonatal treatment. *J Pediatr*. 1994;124(6):903-9.
19. Simons WF, Fuggle PW, Grant DB, Smith I. Educational progress, behavior, and motor skills at 10 years in early treated congenital hypothyroidism. *Arch Disease in Childhood*. 1997;77:219-22.
20. Bargagna S, Chiovato L, Dinetti D, Montanelli L, Giachetti C, Romalini E, Marcheschi M, Pinchera A. Neuropsychological development in a child with early-treated congenital hypothyroidism as compared with her unaffected identical twin. *Eur J Endocrinol*. 1997;136(1):100-4.
21. Rovet JF. Long-term neuropsychological sequelae of early-treated congenital hypothyroidism: effects in adolescence. *Acta Pediatr Suppl*. 1999 88(432):88-95.
22. Bargagna S, Dinetti D, Pinchera A, Marcheschi M, Montanelli L, Presciuttini S *et al*. School attainments in children with congenital hypothyroidism detected by neonatal screening and treated early in life. *Eur J Endocrinol*. 1999;140(5):407-13.
23. Bargagna S, Canepa G, Costagli C, Dinetti D, Marcheschi M, Millepiedi S *et al*. Neuropsychological Follow-up in Early-Treated Congenital Hypothyroidism: a problem-oriented approach. *Thyroid*. 2000;10(3):243-9.
24. Alvarez M, Carvajal F, Renón A, Pérez C, Olivares A, Rodríguez G *et al*. Deferential effect of fetal, neonatal and treatment variable on neurodevelopment in infants with congenital hypothyroidism. *Horm Res*. 2004;61:17-20.
25. Gejão MG, Lamônica DAC. Habilidades do desenvolvimento em crianças com hipotireoidismo congênito: enfoque na comunicação. *Pró-Fono R Atual Cient*. 2008;20(1):25-30.
26. Gejão MG, Ferreira, AT, Silva GC, Anastácio-Pessan, Lamônica D. Communicative and psycholinguistic abilities in children with



phenylketonuria and congenital hypothyroidism. *J Appl Oral Sci.* 2009;17(sp. Issue):69-75.

27. Michelsson K, Sirvio P. Cry analysis in congenital hypothyroidism. *Folia Phoniatica.* 1976;28(1):40-7.

28. Boero D, Weber G, Vigone MC, Lenti C. Crying abnormalities in Congenital Hypothyroidism: Preliminary Spectrographic Study. *J Child Neurology.* 2000;15(9):603-8.

29. Klein RZ, Mitchell ML. Hypothyroidism in infants and children In: Braverman, LE, Utiger RD. *The Thyroid: a fundamental and clinical text.* 8 ed. Philadelphia: Ed. Lippincott Williams e Wilkins, 2000. P. 973-88.

30. Brasil. Ministério da Saúde. Portaria GM/MS n. 822/GM, de 6 de junho de 2001. Disponível em: [HTTP://dtr2001.saude.gov.br/sas/sas02/sasjun02.htm](http://dtr2001.saude.gov.br/sas/sas02/sasjun02.htm). Acesso em 05 out. 2012.

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