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Does newborn hearing screening anticipate the diagnosis and the intervention in children with hearing loss?

A triagem auditiva neonatal antecipa o diagnóstico e a intervenção em crianças com perda auditiva?

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ABSTRACT

Purpose: To identify the age at diagnosis, intervention and amplification, pre and post Newborn Hearing Screening (NHS) implantation into a hearing health service and to compare with the indicators proposed by Joint Committee on Infant Hearing. **Methods:** Three hundred and thirteen files of children enrolled in the auditory rehabilitation sector were analyzed, verifying if the newborn hearing screening and its results were performed, suspicion and age at the diagnosis, intervention and amplification and if they reach the recommended indicators: 3 months for diagnosis and 6 months for intervention. **Results:** Children identified by the NHS were diagnosed and started the intervention sooner than those who did not perform newborn hearing screening. Considering the institutional demand pre and post NHS implementation, there was a reduction of intervention and amplification ages, post newborn hearing screening implementation. Regardless the NHS outcome (pass/fail), screened children had advantage when compared to the non-screened ones, once, among those screened, the diagnosis, intervention and amplification were anticipated. Less than a half of the children who failed NHS completed the diagnosis and began the intervention in the recommended period. **Conclusion:** NHS anticipates the diagnosis and the intervention in children with hearing loss; however, some factors such as family non-adherence and the diagnosis slowed the process, making it impossible for the recommended indicators to be reached in most of the children.

Keywords: Hearing loss; Early diagnosis; Child; Child health; Hearing

RESUMO

Objetivo: Identificar a idade de diagnóstico, intervenção e amplificação pré e pós-implantação da Triagem Auditiva Neonatal (TAN) em um serviço de saúde auditiva e comparar aos indicadores propostos pelo Comitê Conjunto para Audição Infantil. **Métodos:** Trezentos e treze prontuários de crianças atendidas no setor de reabilitação auditiva foram analisados, verificando se foi realizada a triagem auditiva e seu resultado, suspeita e idade de diagnóstico, intervenção e amplificação e se estas últimas atendiam aos indicadores preconizados: três meses para diagnóstico e seis meses para intervenção. **Resultados:** Crianças identificadas pela TAN foram diagnosticadas e iniciaram a intervenção mais cedo do que as que não realizaram. Considerando-se a demanda institucional pré e pós a implantação da TAN, observou-se redução da idade de intervenção e amplificação após a implantação. Independentemente do resultado obtido na TAN (passa/falha), as crianças que passaram pela triagem apresentaram vantagem, quando comparadas às não triadas, uma vez que, dentre as triadas, antecipou-se o diagnóstico, a intervenção e a amplificação. Menos da metade das crianças que falharam na TAN concluíram o diagnóstico e iniciaram a intervenção no tempo preconizado. **Conclusão:** A TAN antecipou o diagnóstico e a intervenção em crianças com perda auditiva. Contudo, fatores como a não adesão da família e as peculiaridades do diagnóstico retardaram os processos, impedindo que os indicadores preconizados fossem alcançados, na maior parte das crianças.

Descritores: Perda auditiva; Diagnóstico precoce; Criança; Saúde da criança; Audição

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INTRODUCTION

The first year of life is considered critical to the acquisition of speeach and language, because it is in this period that the apex of the central hearing system maturation process occurs, existing, therefore, bigger plasticity of the auditory pathway[1]. Studies make clear that children with hearing loss who received adequate sound stimulation in this period, had speech and language development similar to hearing children[2].

Therefore, it's fundamental to strengthen all the iniciatives able to anticipate the diagnosis and the hearing intervention, decreasing the time of sensory privation. In this sense, the implantation of Newborn Hearing Screening (NHS) programs has been adopted as a strategy throughout the world. In Brazil, such programs started to be implanted since 1998 and have been enhanced through the years[3]. The Project of Law number 3842/97[4], which made mandatory the performance of NHS in a universal way in Brazil, was sanctioned on August 2nd, 2010, so that its implantation in the country is still recent and gradual.

The NHS is, however, only the first step of a hearing health program, having to be followed by the process of diagnosis and intervention[5,6]. Authors[2] showed that children with hearing loss, diagnosed by their 6 months of age and that, right after, started the intervention process, receiving adequate amplification, showed an expressive and receptive language performance as it was expected, when evaluated at their 26 months. The children diagnosed after their 6 months of age, with an intervention interval consequently bigger, showed a 12 to 14 months delay in the expressive and receptive language, when compared to the hearing ones.

The Joint Committee on Infant Hearing (JCIH)[5] preconizes that the NHS must be performed by the first month of life and the identified children must undergo audiologic evaluation, at most, by the third month of life and, in case of sensorineural hearing loss confirmation or permanent conductive, the intervention must start by the sixth month of life. National recommendations as the ones from the Multiprofessional Comittee on Hearing Health (MCHH)[6] and the Attention Guidelines for Newborn Hearing Screening[7], from Ministry of Health, reinforce these recommendations.

It is relevant the number of studies that report that the age in which the hearing loss diagnosis is concluded occurs substantially after six months of age[8,9]. Studies made in developed countries show the hearing loss diagnosis average age from 2 years and 6 months to 3 years, in the absence of NHS programs[10]. In developing countries, the situation is even more critical, ranging between 2 and 7 years of age[11].

Studies carried out in countries in which the implantation of NHS has already been consolidated refer that the diagnosis and intervention age has been decreasing, being most of the cases identified before 6 months of age[12-14]. A research which characterized a service of high complexity in hearing health in the capital of São Paulo pointed the diagnosis average age smaller among children who were referred because they failed at NHS, when compared to other procedences[15].

Documenting the NHS role in anticipating the diagnosis ages and hearing intervention in our country strengthens the implantation iniciatives. For this, studies which aim the identification of these ages, and compare them to the preconized ones, can lead better practices in hearing health. The objective of this study was to identify the hearing loss diagnosis average age, the intervention and amplification, in a cohort of infants with hearing loss, enrolled in an institution specialized in assisting deafness, in two moments: before and after the implantation of NHS in the same assisting institution and, moreover, compare the results to the quality indicators proposed by JCIH[5].

METHODS

The current study had the approval by the Research Ethics Committee of the *Faculdade de Medicina de Jundiaí*, under the protocol number 436/10. It is a retrospective study of data collection registered in prontuaries of children enrolled in an institution specialized in assisting deafness, between December, 1991 and December, 2011. The inclusion criteria were all the available prontuaries of children with permanent hearing loss, who underwent assistance at the institution's Hearing Rehabilitation sector, within the studied period. It was considered an exclusion criterion the occurence of any lacking data in the prontuaries, among those required in the collection, being therefore, discarded the prontuaries which didn't present enough information to the study.

Information about gender, laterality, and the degree of hearing loss were collected; NHS and the outcome (pass/fail) were carried out; suspicion of hearing loss; the infant's age when the diagnosis was made; the age at which the intervention started and, also, the amplification age, that is, the age at which the child received the Hearing Amplification Device (HAD).

The diagnosis age (months) was calculated based on the date the type and degree of hearing loss were defined. The intervention age (months) was based on the date in which after the identification of loss, the patient had the first assistance in the service of the institution's Hearing Rehabilitation, for starting the HAD screening process and the therapy. The amplification age (months) was calculated based on the date the patient got his first HAD, via SUS (Brazil's Public Health System). The times between the diagnosis and the intervention,and the intervention and amplification were calculated through the simple mathematic difference among the average ages obtained and also were expressed in months. These times reflect the waiting period between the end of a process and the beginning of the other.

Based on the last audiometry available in the prontuary, the hearing losses were classified according to the laterality (unilateral or bilateral), and to the degree, in normal (up to 25 dB), mild (26-40 dB), moderate (41-70dB), severe (71-90dB) or profound (>91dB)[16], considering the tritone average of 500,

1000, and 2000 Hz of the best ear. For comparison purposes and, considering the impact of the loss gravity in the subjects' every day life activities, the hearing losses were grouped in: 1-normal, mild, and moderate degrees, and 2- severe and profound degrees.

Aiming to characterize the beginning of the NHS implantation in the institution, the prontuaries were divided in two groups. In the first (G1), were included the children who concluded the hearing diagnosis between December, 1991 and the end of November, 2001. The second group (G2) represented the subjects who concluded the diagnosis of deafness between December, 2001, when the institution started the NHS program, evaluating those born in the Public Health System (In Brazil, SUS) in the city's university hospital, and December, 2011 (Figure 1).

The protocol used by the institution, for the performance of NHS, was the Transient Evoked Otoacoustic Emissions (TEOAE), and the research of the cochleopalpebral reflex in all newborn infants, regardless the presence of Risk Indicators for Hearing Loss (RIHL). Since October, 2010, the protocol has been modified for the accomplishment of the Automated Auditory Brainstem Response (AABR) in neonates with RIHL and also as a second stage in the evaluation of neonates wihout RIHL, but failed in the register of TEOAE.

It is important to emphasize that several children who came for a diagnosis, via fail at NHS, were not screened through the service offered by the institution, but through other services existing in the region. The children who came for diagnosis for other reasons, not the fail at NHS, were named as coming from other procedences, not the NHS.

The data were tabulated and submitted to statistic analysis. The descriptive measurements of average and standard deviation were analyzed, and the ANOVA analysis was made, to test the differences between the studied groups and variables. The significance level was set at 0.05 (5%), with intervals of 95% of statistical confidence.

RESULTS

Three hundred and thirteen (313) prontuaries were evaluated, being 189 from male subjects and 124 from female. Fifty-three (53) subjects were identified through NHS (failed) and 260 came for other procedences diagnosis. From the latter, the most (74.3%), the suspicion of hearing loss happened in the family (n=193), mobilizing the search for the diagnosis. The suspicion occurred at school in 10.8% (n=27); the pediatrician suspected 6.9% (n=18); 3.1% presented various reasons (n=8) and, in 5.4% (n=14), there was no suspicion. In the cases with no suspicion, 2 subjects presented unilateral loss, and 12 presented mild to moderate dregree hearing losses.

The distribution of the variables diagnosis age, intervention age, amplification age, time between diagnosis and intervention and time between the intervention and amplification, for the subjects who were identified through NHS (failed) or brought from other procedences, are presented on Table 1.

The values of p obtained show there was a difference for all the studied variables, between the children who were identified through NHS and those directed to other procedences diagnosis. The hearing loss diagnosis age, the intervention age, and the amplification age were smaller in children whose procedence was the fail at NHS. In those children, there was an advantage of 40.7 months in the diagnosis, 40.8 months in the intervention, and 54.9 months in the amplification, when compared to those brought from other procedences.

The G1, consisting of children diagnosed before the beginning of the NHS program, was composed by 163 subjects. The G2 was composed by 150 children diagnosed after the implantation of the program, existing, therefore, in this group,

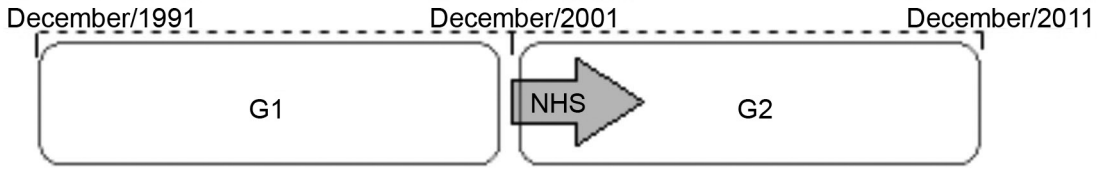


Figure 1. Distribution of groups regarding the studied period

Table 1. Average age and time for the subjects identified through NHS and brought from other procedences

Studied variables (months)	Total (n=313)	Failed at NHS (n=53)	Other procedences (n=260)	p-value
Diagnosis age	46.3 (± 35.3)	9.7 (± 10.3)	50.4 (± 34.7)	<0.001*
Intervention age	51.6 (± 39.3)	13.7 (± 13.8)	59.5 (± 38.9)	<0.001*
Amplification age	63.2 (± 45.7)	17.7 (± 14.7)	72.6 (± 46.9)	<0.001*
Time between the diagnosis and intervention	8.7 (± 27.3)	3.7 (± 6.7)	10.1 (± 21.9)	0.039*
Time between intervention and amplification	11.9 (± 23.3)	4.3 (± 4.7)	13.6 (± 28.5)	0.028*

* Significant values (p<0.05) - ANOVA

Note: NHS = newborn hearing screening ; Total = failed at NHS + other procedences

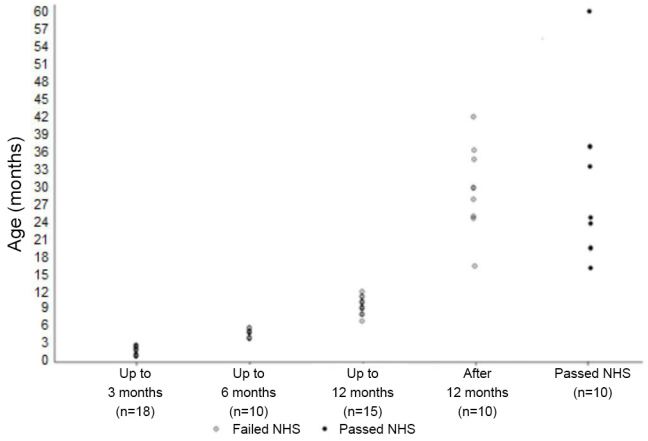
children who performed NHS (regardless the pass/fail outcome) and children who didn't. To evaluate if there was difference between the groups, the test ANOVA was carried out (Table 2).

The G2 showed average values smaller than the G1, for all the studied variables, except for the diagnosis age, suggesting that the beginning of NHS program and its recurrent demand contributed for the anticipation of the intervention and amplification ages, and the time reduction between the diagnosis and the intervention, and the intervention and amplification in the institution. Considering only G2, period in which the institution kept receiving, for diagnosis, children from the most varied procedences and also started to receive the children identified through NHS, the children of this group, who were identified through NHS (failed) (n=53), the ones who performed the NHS and had a positive outcome (passed) (n=10) and the children who didn't perform NHS (n=87) were compared to the studied variables (ANOVA) (Table 3).

In the group G2, the children who were identified through NHS (failed) showed smaller ages for diagnosis, intervention, and amplification than those who didn't perform the NHS (p3 values). Regarding the comparison between the children who failed with those who passed the NHS and were subsequently diagnosed with hearing loss (p1 values), although in absolute numbers there is difference between the ages, statistically this data showed no significance. The children who performed NHS and were diagnosed, subsequentily, with hearing loss showed smaller ages for diagnosis, intervention, and amplification than those who didn't perform the NHS (p2 values). In this group, the time elapsed between the diagnosis and the intervention, and the intervention and amplification was regardless the fact of the children having or not performed NHS and its outcome.

The 53 children identified through NHS (failed) were distributed in terms of diagnosis conclusion age in pré-established periods of time: up to 3 months, up to 6 months, up to 12 months, and after 12 months, and children who performed the NHS and had a satisfactory outcome, showing subsequent hearing loss (n=10) (Figure 2).

Only 34% of the children who failed the NHS (n=18) concluded the diagnosis on the time recommended by JCIH[5] (3 months). Those started the intervention before 6 months of age, also as recommended by the committee[6]. 18.9%(n=10)



Note: NHS = newborn hearing screening

Figure 2. Diagram of age dispersion in the diagnosis of children who performed NHS (n=63)

Table 2. Age and time for subjects of G1 and G2

Studied variables (months)	G1 (n=163)	G2 (n=150)	p-value
Diagnosis age	45.4 (± 33)	41.2 (± 37.6)	0.306
Intervention age	57.6 (± 39.8)	45.5 (± 38.9)	<0.001*
Amplification age	75.8 (± 51.5)	50.6 (± 40.0)	<0.001*
Time between the diagnosis and intervention	13.1 (± 25.5)	4.7 (± 11.3)	<0.001*
Time between the intervention and amplification	18.5 (± 34.2)	5.5 (± 11.2)	<0.001*

* Significant values (p<0.05) - ANOVA

Note: G1 = children diagnosed before the beginning of newborn hearing screening program; G2 = children diagnosed after the implantation of newborn hearing screening program

Table 3. Average age and time for the subjects of the group G2 related to NHS

Studied variables (months)	Performed NHS (n=63)		Didn't perform NHS (n=87)	P1 value[a]	P2 value[b]	P3 value[c]
	Passed (n=10)	Failed (n=53)				
Diagnosis age	26.3 (± 14.6)	9.7 (± 10.3)	61.3 (± 36.0)	0.284	0.003*	<0.001*
Intervention age	27.6 (± 13.9)	13.7 (± 13.8)	65.7 (± 37.3)	0.449	0.002*	<0.001*
Amplification age	32.3 (± 14.4)	17.7 (± 14.7)	71.1 (± 38.2)	0.443	0.003*	<0.001*
Time between diagnosis and intervention	1.4 (± 2.0)	3.7 (± 6.7)	5.7 (± 13.7)	0.856	0.559	0.570
Time between intervention and amplification	4.6 (± 5.0)	4.3 (± 4.7)	6.3 (± 13.9)	0.997	0.914	0.608

* Significant values (p<0.05) - ANOVA

Note: NHS = newborn hearing screening; a = P1 passed x failed; b = P2 passed x didn't perform; c = P3 failed x didn't perform NHS

concluded diagnosis by 6 months, given that, from these, only 2 started the intervention by 6 months, and 28.3% (n=15) concluded diagnosis by their 12 months. The diagnosis was concluded by 1 year of age in 81.2% of the cases (n=43). Even being identified through NHS, in 18.8% of the studied children (n=10), the diagnosis was concluded after 1 year of age, as the children who performed NHS and showed subsequent hearing loss (n=10). These individual cases and the children who concluded the diagnosis after 6 months will be reviewed in the discussion.

Out of the total children studied, 22 showed unilateral hearing loss and 291, bilateral. Regarding the degree of the best ear hearing loss, 29 children were classified as normal degree, 33 children with hearing loss in mild degree, 81 with moderate degree, 49 with severe degree, and 121 children with hearing loss in a profound degree.

Regarding the laterality and the hearing loss degree, the diagnosis was late for unilateral loss and for normal/mild/moderate degrees and always for the children from other procedences, not the NHS (Tables 4 and 5).

DISCUSSION

About the suspicion of hearing loss, the outcomes observed agree with the other studies[17,18], demonstrating that, in children sent to other procedences hearing diagnosis not the fail at NHS, the initial suspicion of hearing loss occurs more frequently within the family or at school, mobilizing the search for diagnosis. What calls attention and also meets the observed in other studies[18,19] is that, although big part of these children has a pediatrician support, a few were the cases in which this professional looks at hearing aspects (7.2%). In the cases which there was no suspicion of hearing loss (n=14), all the subjects had losses categorized as normal/mild/moderate degrees, what justifies the absence of the suspicion, seen that the hearing loss can remain undetectable to the parents/teachers for a prolonged period of time[20,21].

The children diagnosed through NHS started the intervention and received amplification in ages substantially lower than the children who didn't perform NHS (Table 1). A study carried out in California[14], USA, reported similar outcomes. The authors observed the average diagnosis age of 3 months in screened children and 27 months in non-screened ones. The children identified through NHS showed an advantage of 24 months for the diagnosis, 19 months for the beginning of intervention, and 23 months for the beginning of amplification, related to the non-screened children, periods of time much lower than the ones found in this study (40 months in diagnosis, 45 months in intervention, and 54 months in amplification).

A study carried out in the region of Turin, Northwestern Italy[22], also reported anticipation in the average diagnosis age, from 20 to 6 months, after the implantation of NHS. In a study in United Kingdom[13], the average age for hearing diagnosis, which before was 22 months, decreased to 10 weeks, after the implantation of the NHS program. The diagnosis age, which was 12-24 months, decreased to 3-6 months, after the implantation of the NHS programs, as another study carried out in the United States[12]. The same was observed for the intervention/amplification age, which has fallen from 13-16 to 5-7 months.

The diagnosis, intervention, and amplification ages reported in the Brazilian studies are elevated and previous to the implantation of NHS. A study carried out in Bauru, in the interior of São Paulo state, shows an average diagnosis age of 20 months[23]. A study in the region of Campinas[18] described the average of 51 months for the diagnosis conclusion, and 89 months for the beginning of intervention. A recent study carried

Table 4. Average age and diagnosis for unilateral and bilateral hearing losses for children who failed the NHS and brought from other procedences

Diagnosis age in hearing losses (months)	n	Average (± standard deviation)	p-value
Unilateral in children who failed NHS	7	4.9 (± 3.3)	<0.001*
Unilateral in children brought from other procedences	15	75.3 (± 38.8)	<0.001*
Bilateral in children who failed NHS	46	10.5 (± 10.8)	<0.001*
Bilateral in children brought from other procedences	245	48.5 (± 33.7)	

* Significant values (p<0.05) - ANOVA
Note: NHS = newborn hearing screening

Table 5. Average diagnosis age for bilateral hearing losses for children who failed NHS and brought from other procedences

Diagnosis age in bilateral hearing losses (months)	n	Average (± standard deviation)	p-value
Normal/mild/moderate degrees in children who failed NHS	32	9.2 (± 9.0)	<0.001*
Normal/mild/moderate degrees in children brought from other procedences	111	66.0 (33.9)	<0.001*
Severe/profound degree who failed NHS	21	10.4 (11.9)	<0.001*
Severe/profound degrees in children brought from other procedences	149	39.1 (30.7)	

* Significant values (p<0.05) - ANOVA
Note: NHS = newborn hearing screening

out in the city of São Paulo[21], refers to the average diagnosis age of 5, and the intervention, of 6. These ages are considered late and are similar, and even later than the observed in this study, for the children who didn't perform NHS (Table 1), and confirmed the average showed by developing countries (2 to 7 years)[11]. It is important to mention that, in our country, although the law which made compulsory the performance of NHS in a universal way is from 1997, its sanction occurred only in 2010 and the implantation of the NHS programs is being done gradually. A few Brazilian studies report the diagnosis age of children identified through NHS.

The diagnosis age of children enrolled in hearing health service in the city of São Paulo[15], whose procedence was the fail at NHS, varied between 9 and 11.6 months, age similar to the one observed in this study (9.7 months). These ages are still considered late, when compared to the ages recommended by JCIH[5] (3 months), and to the ages reported by other countries, such as Italy (6.8 months)[22], United Kingdom (10 weeks)[13], and United States (3 to 6 months)[12].

In the comparison between the children diagnosed in the institution, before (G1) and after the implantation of NHS (G2) (Table 2), it is observed that the beginning of the NHS program and its current demand contributed to the reduction of the intervention, amplification ages, and also the time reduction elapsed between these processes, in the institution.

Analyzing separately the G2 (Table 3) (children who concluded the deafness diagnosis between December, 2001 and December, 2011, period in which the institution started receiving the children identified through NHS, but kept receiving referrals from other procedences), it was also observed the diagnosis, intervention, and amplification ages reduction in children who failed the NHS, when compared to those who didn't perform (Table 3, P3 value). However, the diagnosis, intervention, and amplification ages in children who performed NHS and were diagnosed, subsequently, with hearing loss, were not different from the ages presented by children who failed the NHS (Table 3, P1 value).

The children who performed the NHS and were diagnosed, subsequently, with hearing loss, presented such ages significantly smaller than those who didn't perform the NHS (P2 values). Thus, it is remarkable that children who performed NHS, regardless the outcome (pass/fail), had advantage, when compared to those who didn't. A study carried out in California[14] also reported similar fact, arguing that, probably, the orientation received by the parents about the importance of being aware of the child's hearing develpment, together with the explanatory leaflet about the hearing development delivered after the NHS, can be responsible for this finding.

Especially in G2, the time elapsed between the diagnosis and the intervention, and the intervention and amplification was regardless the fact of the children having or not performed NHS and the outcome of NHS (pass/fail) (Table 3). It is believed that the institution's intention in concluding the diagnosis, and the intervention in the times preconized by JCIH[5], as well as the restructuring of the attendance flow to achieve this objective, with the arrival of NHS, are the elements responsible for the general reduction of the time elapsed between these processes, once such differences were significant in other analysis (Tables 1 and 2).

The use of reference values, aiming to evaluate the hearing health services capacity in achieving established goals, was valid and could contribute to decrease the diagnosis and intervention ages.

A study carried out in California[14] didn't observe any difference in the times elapsed between these processes, when compared to children who performed NHS and those who didn't. The authors reported an average time between the diagnosis and the beginning of intervention of 1.38 to 4.12 months, periods inferior to the ones observed on this study (4.7 months between the diagnosis and the intervention, and 5.5 months between the intervention and amplification) and the ones reported by other study[24], from 6 to 10 months between the diagnosis and the intervention.

Several factors intervene directly in the time elapsed between one process and another. In this service of hearing health, it is believed that, although there is commitment to minimize the bureaucracy, the patient referral from one sector to another, the difficulties in conciliating the schedulings to the number of vacancies, added to the eventual absences by the patients part, are the main responsible for increasing the time between the diagnosis and the intervention. The same way, the delay in the confection of the molds, the absences in the HADs screening process, the difficulties of rescheduling and the wait for the concession of the HADs are the responsible for elevating the time between the intervention and the amplification.

It is also important to consider that, in the child population, especially the infants identified through NHS, the amplification screening process is complex and demands more time than in older children or adults. Although in the hearing health service in question the patients who wait for the concession of hearing aid generally make use of devices lent by the institution, we chose to consider as amplification age the date in which HADs were delivered via SUS, once several times the lent HADs are not necessarily the most indicated for the case. This option, itself, can have increased considerably the time between the beginning of intervention and the amplification, in this study, once other studies tend to consider the time with the lent hearing amplification devices.

An interesting observation is that children from G1, diagnosed before December, 2001 and that, therefore, didn't perform NHS (Table 2), showed an average diagnosis age inferior to the children of G2, diagnosed after the beginning of the NHS program (Table 3), but who also weren't screened (45 and 61 months, respectively). This finding shows that without NHS, there was no improvement in the hearing loss identification age, in the studied period.

A study carried out in California[14] also reported the absence of improvement in the hearing loss diagnosis age, when compared the average diagnosis age of children born in the state between 1996 and 2004, who weren't screened with the average diagnosis age showed by a study carried out in 1991. Thus, the observation above and all the other differences found when comparing the diagnosis and intervention ages of children who were or not screened, answer the question which entitles this study: After all, does NHS anticipate the diagnosis and intervention in children with hearing loss? Yes, the findings are unquestionable in giving NHS this role.

On the other hand, when we compare the diagnosis and intervention ages of children who performed NHS within the periods of time recommended by JCIH[5] (Figure 2), it's asked if only NHS would be enough for the recommended times to be reached. In this study, the average diagnosis and intervention ages observed in children who failed NHS (9 and 13 months respectively) are out of the recommended indicators. Only 34% of the children who failed the NHS (n=18) concluded the diagnosis and started the rehabilitation in the time recommended by JCIH[5] (3 and 6 months respectively). This number grows to 52.9% (n=28), if we consider the diagnosis conclusion up to 6 months of age. Of the children who concluded the diagnosis up to 6 months, only 2 started the rehabilitation before this age, making clear that the delay in the diagnosis reverberates directly in the intervention age. Studies carried out in countries like Italy and United States report diagnosis age of 6.8 months[22] and between 3 to 6 months[12], respectively, so that,the first years after the implantation of NHS, the diagnosis still happened after the recommended time.

When we investigated the reasons why there was a delay in the conclusion of the diagnosis in the cases concluded after 6 months (n=25), we can highlight the non-adherence to the schedule appointments, several times the service abandonment and the return after months (n=12) and the evaluator's difficulty to conclude the diagnosis in this population, which demands specific procedures, such as the register of Brainstem Auditory Evoked Potential (BAEP) with stimuli of specific frequency, and by bone conduction (n=11). Two children who failed NHS and the mothers abandoned the service, not returning to conclude the retest deserve attention in G2. One of the children returned to the service with 2 years and 4 months of age and the other with 3 years and 5 months, both with severe/profound degrees hearing losses, with hearing complaints and speech and language delay. We shall reinforce that the institution makes contact by phone twice in a row, calling the absents for a retest and, in case they don't return, they are sent to Social Service and the municipality's Guardianship Council is notified. Even so, the number of absences is elevated, confirming the literature, which points out high indexes of non-adherence to the retest and reports that the intervention of the social assistent is no effective, most of the times[25].

The literature has evidenced high evasion rates of families in the different phases of NHS[25-27], pointing out, as predominant reasons, the desinterest and the difficulty in conciliating the scheduling with the family routine[28]. It is believed that, in the current study, one of the adherence difficulties has been the locomotion to the hearing health service in question, once the service attends a region which encompasses 24 municipalities. In reflection about the adherence of families to the speech therapy, authors[29] emphasize that facilitating the adherence in the low-income population is not an easy task, establishing a challenge that demands constant attention. Some authors[28] believe it is necessary to develop education in health strategies which provide conditions for the families to understand their important role in the hearing health program. The performance of the family health strategy program teams, when adequately able about child hearing health, can help in the community's awareness about the importance of all the stages of the identification process and the hearing disability treatment, and in the rescue of the absent patients to the reference services.

Curiously, all the cases of delay in the diagnosis conclusion, which derived from the difficulty of the evaluator in concluding, were about mild/moderate degrees hearing losses, in which there are answers in the registers of BAEP in intensities close to the levels considered normal. This, added to the non-realization of the register in specific frequencies and through bone access, as it is recommended for the evaluation in this population[5], or even for the evaluator's inexperience took to the delay in the process, because several registers of BAEP are done repeatedly, with the intention of defining the type and degree of the hearing loss. Contrary to the mild/moderate degrees hearing losses, in the cases of severe/profound degrees the BAEP is, generally, absent, or present only in the register in strong intensities, facilitating the diagnosis conclusion.

The outcomes that made clear the laterality and the hearing loss degree influenced in the age and diagnosis (Tables 4 and 5) are observed. Unilateral hearing losses and in normal/mild/moderate degrees are diagnosed later than the bilateral and/or severe to profound degree. In a general way, the justification for these findings is that, besides the difficulty of diagnosis conclusion, already discussed, the children with severe or profound hearing losses frequently show more commitment related to the development of speech and language, being the auditory changes noticed earlier than the changes of mild/moderate/severe degrees and/or unilateral, which can remain undetectable for more time[20,21].

Related to the children who passed NHS and presented hearing losses (n=10), we observed one case whose procedure used at NHS was the TEOAE and the child was, subsequently, diagnosed with the auditory neuropathy spectrum. This way, the adopted procedure for NHS was not enough to identify the auditory changes. However, the child didn't show RIHL which justified the evaluation through AABR. The other nine cases of hearing loss late diagnosis with satisfactory outcome at NHS were screened in a hospital different from the one in which the

institution has the NHS service. Although in all prontuaries there was a copy of the NHS outcome, those just informed the satisfactory outcome (pass) and the procedure used (TEOAE), without showing the exam register or the device used. Thus, it was not possible to raise any hypothesis about the NHS outcome, specifically. However, it is known that it's possible for children with mild/moderate degrees hearing losses to obtain satisfactory outcome at NHS, once both procedures (TEOAE and AABR) have low sensibility for lower degrees of hearing loss[30]. As seven out of the nine children showed severe/profound degrees hearing losses, it was searched, moreover, to verify their etiologies. This way, it was not possible to discard the possibility of progressive losses in most of the cases, once two of the cases had history of infection by cytomegalovirus and three cases, history of hospitalization in the ICU and the use of ototoxic medications. In only two cases the etiology remained unknown. The other two cases which presented mild/moderate degrees of hearing loss also had history of hospitalization in ICU and use of ototoxic medications.

Such data make clear that the NHS, itself, is not enough for the recommended indicators to be reached. Even if NHS and the referral have been performed, even so, for several reasons, the diagnosis was postponed, delaying the intervention. The NHS, the diagnosis and the intervention must form a continuous and inseparable process, for the expected outcome in children with permanent hearing losses to be reached. This way, although there are pre-established quality indicators and even if the hearing health services strive to reach them, we believe it is necessary strict inspection by the government, for these indicators to be reached in the public health system, justifying all the investiment in hearing health. The regulamentation of NHS law, still non-existent, could contribute significantly in this aspect.

CONCLUSION

Regardless the obtained outcome (passed/failed), the NHS anticipated the diagnosis, intervention and amplification in the studied children. However, factors such as the family non-adherence to the NHS retest, diagnosis and intervention and, even, the peculiarities of the neonates and infants hearing diagnosis delayed the processes, hindering the preconized indicators to be reached, in most part of the children.

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