Hearing Assessment of Neonates at Risk for Hearing Loss at a Hearing Health High Complexity Service: An Electrophysiological Assessment

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Abstract

Introduction Hearing is the main sensory access in the first years of life. Therefore, early detection and intervention of hearing impairment must begin before the first year of age.
Objective To analyze the results of the electrophysiological hearing assessment of children at risk for hearing loss as part of the newborn hearing screening (NHS).
Methods This is a cross-sectional study held at a hearing health public service clinic located in Brazil, with 104 babies at risks factors for hearing loss referred by public hospitals. A questionnaire was applied to parents, and the auditory brainstem response (ABR) test was held, identifying those with alterations in the results. The outcome of the NHS was also analyzed regarding risk factor, gestational age and gender.
Results Among the 104 subjects, most of them were male (53.85%), and the main risk factor found was the admission to the neonatal intensive care unit (NICU) for a period longer than 5 days (50.93%). Eighty-five (81.73%) subjects were screened by NHS at the maternity and 40% of them failed the test. Through the ABR test, 6 (5.77%) infants evidenced sensorineural hearing loss, 4 of them being diagnosed at 4 months, and 2 at 6 months of age; all of them failed the NHS and had family history and admission at NICU for over 5 days as the most prevalent hearing risks; in addition, family members of all children perceived their hearing impairment.
Conclusion Advances could be observed regarding the age of the diagnosis after the implementation of the NHS held at the analyzed public service clinic.

Keywords
- hearing
- risk factors
- newborn screening
- early diagnosis
- hearing loss

Introduction

Hearing is considered the main sensory access at the beginning of human beings' lives, enabling them to pay attention, identify, locate sounds and integrate essential hearing experiences for the speech and language development. Hearing loss in the early stages of life may lead to emotional, cognitive and social disorders.[1]

The study assessed the level of cognitive, affective and social development in children with diagnosis of hearing loss. It was concluded that the most significant gaps occurred in activities of verbal and non-verbal language comprehension and expression, in addition to damages in relationship competencies of personal-social behavior.[2]

The reasons for infants' hearing loss are diverse, and may occur before, during or after birth; they can also be classified

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as genetic and non-genetic, congenital or acquired. According to the Joint Committee on Infant Hearing (JCIH),[3] the risk indicators related for hearing loss in infancy include: family members' perception of hearing impairment, genetic predisposition, family history of childhood sensorineural hearing loss, birth conditions, admission at an intensive care unit (ICU) for over 5 days, hyperbilirubinemia exceeding 30 mg/dl (requiring exchange transfusion) and persistent pulmonary hypertension requiring mechanical ventilation; drug administration factors have also been proposed as risk factors for ototoxicity, craniofacial anomalies, in-utero infections (cytomegalovirus, herpes simplex, toxoplasmosis, rubella, syphilis among others), infant infectious/viral diseases, birth traumas and need for chemotherapy.

Due to the negative impact of hearing impairment on child development, the World Health Organization recommends the newborn hearing screening (NHS).[4] The Brazilian Ministry of Health implemented the National Policy on Hearing Healthcare (PNASA, in the Portuguese acronym),[5] considering the guiding tenets of the Brazilian Unified Health System (SUS, in the Portuguese acronym): universality, integrality and equity. Thus, it is objectified to meet the demands of assessment, diagnosis and (re)habilitation of hearing-impaired people with actions in the primary, intermediate and high complexity healthcare services.[6]

The PNASA has planned the implementation of programs of NHS in municipalities. The objective of the NHS is the early detection of hearing loss in those individuals who are very likely to be affected, referring them to habilitation and rehabilitation.[7] The guidelines for the NHS suggest the use of different protocols for newborns with low-risk and high-risk for hearing loss.[8] Thus, all the neonates must undergo the NHS within 48 hours after birth. When there are two consecutive failures in the test (within 40 hours after birth and after 30 days from the first screening), the electrophysiological hearing test, auditory brainstem response (ABR), must be performed.

The ABR consists of recording the electrical activity traveling from the inner ear to the brain cortex in response to acoustic stimuli. The ABR responses can be classified according to several criteria, the most commonly used is the classification according to the latency of the response. The use of the ABR is recommended as the hearing assessment methodology for children. However, the gestational age in neonates and infants must be considered, as the influence of the maturity process in the central hearing system occurs in that population. That testing enables the identification of cochlear hearing loss and neural hearing disorders, such as the auditory neuropathy spectrum disorder(ANDS).[9]

In spite of national and international recommendations on how the NHS must be held, it is uncertain whether or not all services in Brazil are following the recommendations of the PNASA, once there are still obstacles and difficulties regarding the best health conditions and early diagnosis of hearing impairment, despite the advances in Brazilian public healthcare.[5] A study based on the National Health Survey from 2013, with household population inquiry (a total of interviews in 64,348 residences), as part of the Integrated System of Household Surveys, Brazilian Institute of Geography and Statistics (IBGE, in the Portuguese acronym), estimated that the access to the NHS covered 56% of the Brazilian population, with the highest reach index verified in Southern Brazil, where it covers 77.6% of the population.[10] In the United States and England, the NHS reached 99% of the neonates.[11]

According to the literature, audiological diagnosis is still held late in Brazil, as shown in a study that analyzed the diagnoses of hearing-impaired children from the region of Campinas (São Paulo, Brazil), with a total of 320 cases reviewed between 1996 and 2006. The mean age of deafness diagnosis in that group was 1 year and 9 months, the first visit to an otorhinolaryngologist or speech language pathologist was at 3 years and 6 months of age, and the adaptation of the hearing aid was at 7 years and 5 months[12] of age. Another study reviewed 313 records of a service of hearing rehabilitation in Jundiaí, in São Paulo, Brazil, between 1991 and 2011, and found the mean age of hearing loss diagnosis to be 3 years of age. However, among the children who failed in the NHS, a total of 53 babies, the mean age of the diagnosis was 9 months.[13]

The current study objectified to analyze the results of the electrophysiological hearing assessment of children at risk for hearing loss as part of the NHS.

Methods

This is a cross-sectional study, which analyzed 104 neonates at risk for hearing loss, assessed at a hearing health high complexity service in Southern Brazil within a period of 2 years (2013 to 2015). The subjects were identified and referred by the maternity hospitals where they were born either for failing the NHS or for presenting a risk indicator for hearing loss.

The inclusion criteria considered for this study were: risk for hearing loss at birth, according to the JCIH;[3] to be born at a public maternity hospital, and to have accessed the high complexity service on hearing health for the first diagnosis between February 2013 and December 2015. The parents/legal guardians for the babies were invited to participate in the research, and if they agreed, they would sign the free informed consent form. The form was signed before any procedures were performed. Any doubts about the study were clarified before signing the consent form. The study was authorized by the Ethics and Research Board under number 105.576.

Concerning the procedures, a questionnaire on profile and data of risk indicators for hearing loss, elaborated under the criteria recommended by the JCIH, was applied to parents/legal guardians.[3] The ABR testing was performed using the Integrity V500 equipment (Vivosonic Inc., Toronto, ON, Canada).

The children were naturally asleep or awake. The responses were detected by using electrodes located as follows: active electrode in the upper part of the forehead (Fz); reference electrodes on the right (M1) and left (M2) mastoids, ground on both sides of the forehead (Fpz). The auditory stimulation was performed by means of ER-3A earphone. The stimulation parameters were: click, rarefaction polarity, 27.2 clicks per second, pro-mediated from 1,500 to 2,000 clicks with response duplication. The band-pass filter used was at 0–3,000 Hz, with analysis window of 20 ms. According to the ABR assessment protocol, the test began at an 80-dB hearing level to verify the neurophysiological integrity of the auditory pathway, to analyze the absolute latencies of waves I, III and V, and interpeak values I–III, III–V, and I–V, waveform amplitudes I and V, and interaural difference I-V. When response absence occurred at 80 dB, the sound stimulus intensity was raised to 85 or 90 dB. To assess the minimum level of response, the stimulus intensity was gradually reduced to the lowest intensity in which wave V could be observed. The tests were classified as normal or altered. The presence and latencies of waves I, III and V, interpeaks I-III, III–V, and I–V within normality patterns at 80 dB for the chronological age, according to the equipment reference, and the electrophysiological threshold equal to or lower than 30 dB were indicators of the integrity of the auditory pathways.

The results from the NHS (considered the first phase of the NHS) and rescreening (second phase of the NHS, when failures occurred in the first phase) were also analyzed. They were performed by means of the transient otoacoustic emissions testing. Both tests were performed in the maternity hospitals, and the results were registered on the neonate's Child Health Handbook (Caderneta de Saúde da Criança, in Portuguese), kept by parents/legal guardians. The NHS test is performed in the municipality at 48 hours after birth, except in those situations which prevent such screening, such as: lengthy stay in ICU as well as technical hindrances (problems with equipment maintenance, among others).The results were classified as "pass," when transient otoacoustic emissions were recorded, or "refer," when otoacoustic emissions were not recorded from each ear.

The data were statistically analyzed considering the results regarding the NHS and rescreening with the following variables: risk factors, gender and gestational age at birth, which was classified as full-term birth (equal or longer than 38 weeks of gestational age), and preterm birth (equal or shorter than 37 weeks of gestational age). The chi-square statistical test was used in this analysis, with critical significance level of 5% ($p = 0.05$). For the analysis, when one of the ears failed the screen or rescreen, the baby was considered as having failed. The ABR test results were analyzed regarding the baby's age at the moment of the screening, correcting it in the case of premature babies (equal to or shorter than 37 weeks of gestational age). The values of absolute latencies of each wave and interpeak intervals in the neonates were compared with the normality pattern for each age range (in months), provided by the equipment.

Table 1 Demonstration of the risk criteria for hearing loss at birth, according to the Joint Committee on Infant Hearing (2007) in babies ($N = 104$)

Risk criteria for hearing loss	Absolute	Relative
	Frequency	%
Length of stay in NICU longer than 5 days	53	50.96
Use of ototoxic medication	38	36.54
Family history of hearing loss	25	24.04
Need of mechanical ventilation	20	19.23
Hearing loss-associated syndromes	9	8.65
Craniofacial and temporal bone anomalies	8	7.69
Family's perception for hearing loss	7	6.73
In-utero infection–syphilis	7	6.73
Postnatal infection by meningitis	6	5.77
In-utero infection—toxoplasmosis	2	1.92

Abbreviation: NICU, neonatal intensive care unit.

Table 2 Result of the newborn hearing screening and rescreening, performed at the maternity hospital, by gender and gestational age at birth ($n = 85$)

Profile	Newborn hearing screening		*P*
TEST ($n = 85$)	Pass	Refer	
Gender:			
Male	22 (25.9%)	24 (28.3%)	0.0128*
Female	29 (34.11%)	10 (11.7%)	
Total	51 (60%)	34 (40%)	
Gestational age at birth:			
Full term	35 (41.17%)	24 (28.3%)	0.8475
Preterm	16 (18.8%)	10 (11.7%)	
RESCREENING ($n = 34$)			
Gender:	**Pass**	**Refer**	
Female	5 (14.7%)	12 (35.3%)	0.7139
Male	6 (17.6%)	11 (32.3%)	
Total	11 (32.35%)	23 (67.64%)	
Gestational age at birth:			
Full term	6 (17.6%)	17 (50%)	0.2573
Preterm	5 (14.7%)	6 (17.6%)	

*Chi-square test, significance level = 0.05.

Results

Subsequently, the screened babies were profiled, totaling 104, 56 (53.85%) of whom were male and 48 (46.15%) female.

The risk criteria for hearing loss found, according to the JCIH,[3] are in ►**Table 1**.

The most recurring risk factors for hearing loss were the admission to an intensive care unit longer than 5 days, followed by the use of ototoxic medication (gentamicin and others).

►**Table 2** shows the results of the NHS and rescreening performed in the maternity hospitals, per gender and gestational age at birth. Nineteen babies) did not undergo the hearing screening due to occurrences at the birth place, such as damaged equipment, hospital discharge on the day and time when a speech-language pathologist was absent, and extended hospital stay.

Among the 85 babies who underwent the hearing screening in the maternity hospital, 34 (40%) failed, and most of them were full-term (28.3%) and male (28.3%). There was a significant gender difference. In the rescreening, it was observed that from the 34 analyzed babies, 23 (67.64%) ratified the failures in the responses of the transient otoacoustic emissions, and there were no significant differences between gender and gestational age at birth.

The ABR test was performed in 104 babies, and 6 (5.77%) babies (3 males and 3 females) had sensorineural hearing loss confirmed, with 4 of them having a conclusive diagnosis at 4 months of age, and 2 at 6 months of age; 2 were born prematurely. Family history of hearing impairment and hospital stay in the ICU longer than 5 days in 50% of the cases were prevalent.

►**Table 3** shows the profile of the six babies diagnosed with sensorineural hearing loss.

Regarding the ABR test analysis, among the 6 babies with sensorineural hearing loss, it was observed that 3 (50%) did not present waves at 90 dB, 2 presented waves I, III and V with expected absolute latencies and interpeaks for the age, with electrophysiological hearing thresholds at 90 dB, and 1 baby with the presence of waves I, III and V, expected absolute latencies and interpeaks for the age, electrophysiological thresholds at 60 dB in the right ear, and 70 dB in the left ear. All children were referred to the individual hearing aid testing.

Table 3 Profile of babies with diagnosis for sensorineural hearing loss ($n = 6$)

Profile	Absolute	Relative
	Frequency	%
Gestational age at birth:	2	33.33
Full term	4	66.66
Preterm	2	33.33
Age of diagnosis:		
4 months	4	66.66
6 months	2	33.33
Risk index for hearing impairment:		
Family's perception for hearing loss	6	100.0
Length of stay in NICU more than 5 days	3	50.00
Mechanical ventilation	1	16.66
Use of ototoxic medication	1	16.66
Gestational events: drug abuse	1	16.66
Postnatal infection: meningitis	1	16.66
Hearing loss in the family	3	50.00
Craniofacial anomalies	1	16.66
Hearing loss-associated syndrome	1	16.66
Failed the newborn hearing screening	6	100.0

Abbreviation: NICU, neonatal intensive care unit.

►**Table 4** shows the ABR results, featuring the absolute latencies of waves I, III and V, and their respective interpeak intervals, separated by age (in months) during the testing (correcting the age of the premature babies) for the babies featuring no sensorineural hearing loss.

Absolute latency means of waves I, III and V, and their interpeak intervals are within the normality patterns for the age. It was observed that 52 (53.06%) babies without any sensorineural hearing disorders were submitted to the ABR from 1 to 3 months of age.

Discussion

The implementation of the NHS in Brazil enabled faster diagnosis of hearing loss among neonates, thus speeding the process of rehabilitation and subsequent reduction in the impact of hearing impairment in those children's quality of life. In this study, we reviewed the audiological diagnosis of neonates at high risk for hearing loss referred by maternity hospitals to a high complexity service on hearing health from a Southern capital city in Brazil.

The most recurrent risk indicators for hearing loss in this study, according to the JCIH[3] (►**Table 1**), were admission to the ICU for a period longer than 5 days and subsequent interventions performed in such situations, as follows: mechanical ventilation and use of ototoxic medication. Other Brazilian studies also found the prevalence of the same risk factors for hearing loss, whether they studied neonates at risk or at no risk for hearing impairment. A study with 140 neonates from a hospital found that ICU stay, the use of ototoxic medication and mechanical ventilation were the main risk factors for hearing loss.[14] In São Paulo, Brazil, a study with premature neonates also found ICU stay as the main risk for hearing loss.[15] In addition, international studies, such as one conducted in India with 9,448 neonates submitted to the NHS, the main risk for hearing loss was ICU stay in 24.75%.[16]

It is common for neonates admitted to a neonatal intensive care unit (NICU) to be exposed to several risk factors for hearing loss the greatest part of time. Among the hearing risk factors related to NICU stay are: hyperbilirubinemia with blood transfusion, lung problems requiring mechanical ventilation, meningitis, use of ototoxic medication, among others.[17] In the current study, only children at risk for hearing impairment were analyzed, which may have contributed to the high percentage of admitted neonates to an ICU. The literature reports that prematurity can also be a risk factor for hearing disorders, due to the fact that premature neonates are exposed to the possibility of association with multiple risk factors, such as hospital admissions and other procedures.[18] However, prematurity alone does not represent a potential risk for hearing impairment.[19] In the population in this study, neonates with gestational age equal to or longer than 38 weeks prevailed.

In the current study, it was observed that a little more than half of the neonates were male, which was also corroborated by other Brazilian studies, such as the study from Belo Horizonte, Brazil, with 789 children, 51.8% of whom

Table 4 Result of means of the absolute latencies of waves I, III and V, and interpeak intervals by ear and age at the moment of the testing (corrected at birth), in babies without sensorineural hearing disorders (n = 98)

Age range (months)	Absolute latency right ear (RE)			Interpeak latency RE			Absolute latency left ear (LE)			Interpeak latency LE		
	Wave I	Wave III	Wave V	I-III	III-V	I-V	Wave I	Wave III	Wave V	I-III	III-V	I-V
1–3 months *n* = 52	1.63	4.10	6.10	2.52	2.08	4.50	1.72	4.18	6.19	2.45	2.08	4.44
4–6 months *n* = 30	1.61	4.04	6.12	2.48	2.02	4.45	1.85	4.33	6.29	2.46	1.99	4.42
7–9 months *n* = 12	1.69	3.94	5.99	2.56	1.95	4.31	1.60	3.94	5.92	2.39	1.94	4.32
10–12 months *n* = 4	1.55	3.95	5.92	2.40	1.97	4.37	1.54	3.89	5.81	2.35	1.92	4.27

were male;[20] from Maceió, Brazil, in which 51.4% of the 1,626 neonates were male,[21] and from Campinas, Brazil, in which 51,3% of the 5,106 screened neonates were male.[22] There were 40% failures in the NHS. Observing the gender difference, more failures occurred among male than female neonates (►**Table 2**). A study in Rio Grande do Sul, Brazil, pointed 15% of failures in the first screening of the NHS,[23] and in Campinas, Brazil, another study found 23.90% of failures in the first screening.[24] In Bahia, with 50.29% of male neonates, a study detected 19.91% of failures.[25] Regarding gender, a study observed a 12% failure rate in the NHS test, with 55.27% of male and 44.72% of female subjects.[22] In Ceará, Brazil, a study showed that among the 88 analyzed neonates, 39.77% failed the NHS. Of these neonates, 62.86% were male and 51.43% were full-term.[26] According to the literature,[27] there is 1.5 times greater chance for a male neonate to fail than a female neonate. The fact that male neonates feature a higher number of failures in the NHS could be explained by the fact that the amplitudes of the otoacoustic emissions are greater in females; therefore, they are more perceptible.[28]

Studies in other countries also observed varied rates of failures in the first NHS held by means of the otoacoustic emissions testing in the first days of life, such as the study performed in France, which found failures in the first screening in 1.26% of neonates;[29] in China, with 14.7% of failures;[30] in South Africa, with 9.5% of failures;[31] in Poland, with 55.27%;[32] in Iran, with 14.56% of failures,[33] and in Japan, with 3.9%.[34] However, such studies did not analyze the cases by gender.

The NHS, held after 48 hours of birth, may present false-positive results (failures) without necessarily evidencing hearing loss.[35] Such a situation is common because screening by means of otoacoustic emissions testing can be hindered by improper conditions of the outer or middle ear. In neonates, the presence of vernix in the outer ear meatus is common, that is why rescreening is necessary after 30 days. However, the best used technology for the NHS is the transient evoked otoacoustic emissions testing, in Brazil as well as in other countries, as it features low cost, objectivity and simplicity in the assessment.[36–38]

Regarding the rescreening held after 30 days, from the 34 babies who failed the first testing, all of them returned for the rescreening, indicating 100% adherence to the NHS program. A review of the literature on NHS in Brazil pointed that absences for rescreening of the NHS ranged between 5 and 50% in public hospitals, and 9 and 34% in private-mixed hospitals.[36] In other countries, such as Iran, the return for the rescreening rate was 70.60%,[33] and in India, 82.6% returned to be rescreened.[16] A study that analyzed absence for the rescreening of the NHS, held with 60 legal guardians, pointed forgetfulness (30%) and lack of information about the rescreening (20%) as justifications for the absences.[39] Adherence to all steps of the NHS can be achieved when all the hospital medical staff, nurses, social workers and language-speech pathologists are involved in the NHS.[40] In a study in Campinas, São Paulo, absence for the rescreening reached 41.4%, and the reasons were analyzed. They concluded that the rate of absence for the rescreening was 1.4 times greater in the cases of mothers who lived without a partner than in those who live with a partner; the higher the number of children, the lower is mothers' return (absence is 1.5 times higher); absence of mothers who underwent one to three prenatal medical visits is 3.1 times higher than those who went to four or more prenatal appointments. They pointed out that there are several hindering factors for rescreening of the NHS, such as the need to take all children to the screening site, often due to the lack of family or social support, mothers' misunderstanding on the need of rescreening due to lack of health professional guidance, and lack of knowledge on the technology specifically used for that testing, which interferes with their aptitude of recognizing their children's health needs.[41]

In the rescreening results, 23 children (67.64%) failed again, without any significant differences regarding gender or age. Different from a study with 316 babies who underwent the hearing rescreening, gender did not interfere with the results, but failures associated with premature birth occurred.[42] A study with 5,045 babies found that 760 (15%) of them failed the screening; among those, 377 (49.60%) returned for rescreening, and 24 failed again (6.36%), but only 2 of them had hearing impairment confirmed.[23] In South Africa, a study found failures in 3% of the children after the rescreening.[31]

According to the JCIH,[3] only 4% of absences are acceptable for the assessment of neonates who failed the screening and rescreening.

Regarding the results of the 104 children in the brainstem auditory evoked potential (BAEP) testing, 6 children (5.77%) were identified, 5 (4.80% or 48 per 1,000) of whom had sensorineural hearing loss equal to or greater than 80 dB, and 1 (0.96%) with hearing loss lower than 80 dB. Among those, 50% featured the following high-risk criteria: hearing impairment in the family and stay at an ICU for a period longer than 5 days. In Japan, a study with 19,199 neonates found that 128 (0.67%) failed rescreening, and 28 failed BAEP, but among those, only 7 (0.036%) were diagnosed with hearing loss (2 males and 5 females). The false-positive rate was 28%.[32] The current challenge of global NHS is to reduce the false-positive rate, which occurs, according to the literature, due to the use of the otoacoustic emissions testing, a fast and cost-effective method.[43]

The rate found in this study at the high complexity service on hearing loss for sensorineural hearing loss equal to or greater than 80 dB is in conformity with the literature. Studies in developing countries report percentages of hearing loss between 1 and 53%.[44] According to the literature, the prevalence of severe/profound congenital sensory neural hearing loss is between 0.5 and 5 per 1,000 newborns, higher in developing countries.[45] As for neonates in ICUs for longer than 5 days, the estimated hearing loss is from 2–15%.[17] Another study in Brazil also found high rates of hearing loss, that is, the one in Minas Gerais with 186 babies at high risk for hearing loss, all premature ones, which found 6.3% of hearing disorders, most of them having mothers diagnosed with HIV infection, alcohol and drug abuse during pregnancy.[46]

From the 6 cases identified with sensorineural hearing loss, most of them were diagnosed at 4 months of age, and 2 of them at 6 months of age. A study performed in California, USA, reported similar results. The authors reported mean age of hearing diagnosis at 3 months in children who were submitted to hearing screening. They concluded that children identified by the NHS had an advantage of 24 months for the hearing diagnosis, 19 months for the beginning of the interventions, and 23 months for the beginning of the hearing aid use in relation to the ones who were not included in the NHS.[47] A study performed in Turin, northwestern Italy, also reported anticipation in the mean age of diagnosis after the NHS implementation, from 20 months to 6 months.[48] In the United Kingdom, the mean age for the hearing diagnosis used to be 22 months, and it was reduced to 10 weeks after the implementation of the NHS program.[49] In Brazil, with the implementation of the PNASA,[5] there was a 473% increase, until 2011, in the number of the tests and otoacoustic emissions testing for screening, signaling an improvement in the detection and probable intervention in the neonates featuring hearing loss.[6]

Concerning the ABR analysis, it was possible to detect waves I, III and V, and analyze their latencies and interpeaks in six children. The parameters with expected results for the age were found, but the electrophysiological thresholds were altered. A study assessed 186 children at risk for hearing impairment from a NICU and found that hearing loss was detected by the BAEP in 5 of them (4%), who had cochlear disorder.[50] Another study using the BAEP in 72 neonates, all premature, found alterations in 32 of them, with absolute latencies of waves III and/or V, of interpeaks I-III and/or I-V, retrocochlear alterations, different from the current study.[15]

In this study, 47% of the children had no alterations in the ABR, and they were screened at 4 months of age and older. According to the JCIH,[3] rescreening should be held as late as 3 months of age. The guidelines of the Ministry of Health for the NHS reinforce those recommendations.[8] However, it is not required for the screening to be performed at the hospital where the child was born, but in hearing health high complexity services. A study about the NHS effectiveness identified a set of factors hindering the access to the NHS program, among them, the organization of the NHS program, the difficulty in the access to it, and restriction of the service hours.[41] In the current study, the failure to return for ABR rescreening by children over 4 months of age is probably due to the organization of the offer of hearing health high complexity services by the SUS, which hinders the easy and fast access to the diagnosis, as there are only three hearing health high complexity services in the municipality.

This study holds some limitations: it was performed with subjects from a single hearing health high complexity service, and had no children without hearing risks, which did not make the comparison of the used analysis variables possible. In addition, it is suggested that further studies may add the number of children born within the period, enabling the calculation of incidence rates of hearing loss.

Conclusion

Among 104 babies at risk for hearing loss born in maternity hospitals in Curitiba, Paraná, Brazil, and referred to the hearing health high complexity service, most were full-term males. The main risk criterion was stay at an ICU for a period longer than 5 days.

Not all babies were submitted to the NHS in the maternity hospital, pointing to the need of tougher compliance with that action. However, from the babies who failed the NHS, all of them were rescreened, although a high rate of failures still occurred (23–67.64%), whose causes need to be investigated for its consequent reduction, and among those, 6 babies had the diagnosis for sensorineural hearing loss confirmed by means of the electrophysiological hearing assessment, BAEP, with ages ranging between 4 and 6 months.

The PNASA has certainly brought about significant advances by means of a broader approach on hearing health. However, within the reality of the analyzed Unified National Health Service (SUS, in the Portuguese acronym) facility, these actions have not yet completely met the international standards for the NHS. There is still an important path to be trailed in order to warrant the population access to hearing health policies in this country.

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