NEWBORN HEARING SCREENING: CHARACTERIZATION OF DEMAND/TERRITORY AND HEARING TESTS

Triagem auditiva neonatal: caracterização da demanda/território e exames auditivos

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ABSTRACT

Purpose: to characterize the demand, territory and hearing tests performed on a Newborn Hearing Screening Program. **Methods:** retrospective study of a sample of 2334 records of newborns screened, involving the analysis of data on Newborn Hearing Screening, Newborns of information and demographic variables. **Results:** 88% were screened newborns, and of these 16% had Risk Indicator for Hearing Impairment and 84% did not. It was observed that the indicator was the most prevalent family history, and that the chances of passing the test are lower in the presence of indicator and when the newborn's weight less than 1,500 g. The index-pass test failure was 78% and 22% passes failure. On the test result, the greater number of failures unilateral and retest failure 4% being a membership of more than 70%. **Conclusion:** study like this allows the active pursuit of newborn risk group for hearing impairment in their respective territories, with greater possibility of tracking and thus reach the primary goal of hearing screening is that the diagnosis of deafness until the third month life, in addition to designing a Neonatal hearing Screening Program effective in their steps: screening, diagnostic audiology, indication, selection and fitting of hearing aids and re (ha) bilitation hearing.

KEYWORDS: Neonatal Screening; Otoacoustic Emissions, Spontaneous; Hearing Loss

INTRODUCTION

A program for detection of early deafness should begin with NHS (Neonatal Hearing Screening), followed necessarily by diagnosis and rehabilitation, contemplating the four necessary stages for the program to be effective: hearing tracking and/or screening; audiologic diagnosis; indication, selection and adaptation of hearing aids and hearing re(ha) bilitation[1].

The Universal NHS (UNHS) is the hearing tracking whereby all newborn babies should have access to hearing screening, preferably before being dismissed from hospital as an ideal goal, allowing the infants who fail the tests to receive adequate medical and audiologic evaluation to confirm hearing alterations before they are three months old [2-4].

In a conference carried out in 1993, the *National Institute of Health* recommended screening through Evoked Otoacoustic Emissions (EOAE), in all newborns due to being a very efficient, objective, non-invasive and low cost method, which makes the evaluation of a large number of children viable [5,6].

In 2007, the JCIH[3] made a new recommendation, and suggested that quality indicators be used to evaluate UNHS programs. Suggesting that the fail rate of UNHS before being dismissed from hospital should not surpass 4%; where as when it comes to the diagnosis, suggesting that 90% of the newborns sent for diagnosis be evaluated prior to completing three months and the identification of hearing loss of 35dB minimum in the best ear; after diagnosis, it was recommended that 95% of the children with

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confirmed hearing loss begin using sound amplification, within one month.

In Brazil, in 2010 the *Comitê Multiprofissional em Saúde Auditiva (COMUSA)*[4], after analyzing the literature referring to identification, diagnosis and early intervention in newborn and infants with hearing impairment, also recommends steps towards a program of neonatal hearing health[3]. In this same year, in Brazil, Federal Law Nº 12.303/2010 of the 2nd August 2010, was sanctioned by the President of the Republic Luiz Inácio Lula da Silva making Evoked Otoacoustic Emissions tests obligatory and free in Neonatal Hearing Screening for all babies born in hospitals and maternities [7].

Within this context the following study has as its objective to characterize the demand, territory and hearing tests carried out in a Program for Neonatal Hearing Screening.

METHODS

The data began to be collected after it was approved by the Research Ethics Committee of the *Pontifícia Universidade Católica de Campinas*, under protocol number 0400/1.

The study was carried out by the Residents in Speech Therapy of the Hospital e Maternidade Celso Pierro (HMCP), responsible for carrying out the screening through Transient Evoked Otoacoustic Emissions (TEOAE) of the Sistema Único de Saúde (SUS – Public Health Care System) patients.

The sample consisted of 2334 medical records of newborns screened by the NHS Program of the HMCP, attended between February 2010 and February 2011, of both genders, born preterm and term, coming from Hospital Wards (HW) and Neonatal Intensive Care Units (Neonatal ICU), with and without Risk Indicators for Hearing Impairment (RIHI).

At present, the HMCP is a philanthropic teaching hospital belonging to PUC-Campinas, which attends SUS and private healthcare patients, whose main users are inhabitants of the Northwestern and Southwestern regions of Campinas.

The first stage of the study consists of collecting data from the medical records of newborns, whose data examined was: what are the Risk Indicators for Hearing Impairment (RIHI) that the Newborn presents; if they passed or failed the screening test; the rate of attendance in the case of failures (retest); mothers age bracket; Newborn gender; weight at birth; newborn's gestational age and the Health Reference Centers (Basic health units) that they belonged to.

To have a clearer view of the information, the mother's age was subdivided into 10-year brackets, the gender between female and male. The weight according to the definition of Newborn with low weight and Newborn with Very Low Weight[8]; and lastly the gestational age according to the International Illnesses classification[9].

The second stage was to analyze the data obtained comparing the rates of screening carried out with the number of live births of the *Sistema Único de Saúde*, the percentage of Newborns screened with or without RIHI, as well as the results of the tests, the rate of attendance for retesting and the rate of newborns referred for diagnosis.

The study's third stage was to analyze the quality indicators of the NHS Program services, beginning with the number of test carried out.

The test carried out for NHS was the Transient Evoked Otoacoustic Emissions (TEOAE) carried out using OTOPORT equipment - Otodynamics, with frequencies from 1000 to 4000 Hz, with intensity of 70 dB. The result was registered considering the responses of the TEOAE in relation to signal/noise, having as a criteria: Present – responses in three consecutive frequencies or more; and Absent – responses in zero, one or two frequencies.

The screening was carried out close to hospital discharge, both for the Newborns in Hospital Wards, as well as those in Neonatal ICU.

All orientation to parents with regards to return visits and the test results were annexed to the newborn's vaccination card and on the patient's medical record. With retesting carried out as an outpatient at the PUC – Campinas Speech Therapy Clinic.

For cases where the newborn passed without RIHI, the newborn's mother was orientated with regards to the development of the child's hearing and language and consequentially the speech therapy approval.

For cases where the newborn Passed or Failed with RIHI, apart from orientation about the development and the need for a re-test in cases of failure, the mothers of the Newborn were orientated about the bi-annual return for hearing monitoring up until the age of three. And for the cases where there was a Fail without RIHI they were booked to come back for retesting within 30 days.

For cases of fail in retesting, the Newborn coming from Hospital Wards were evaluated by the ENT specialists within one week and after intervention and discharge were booked for a second retesting.

With regards to the Risk Indicators for Hearing Impairment used as a reference for the service, they were those described in current literature [3,4,10,11].

This protocol of speech therapy and ENT appointments, which includes a second retest after the evaluation of the ENT Specialist, had as its aim

to reduce the rate of false-positives, taking into consideration that some factors of outer and middle ear can be solved through medical intervention before being referred to brainstem auditory evoked potential testing.

Lastly, the data collected from the medical records was analyzed quantitatively expressed in numerical values and percentages, using the statistical chi-square tests with a confidence interval of 5% and a statistical proportion test with a 5% significance level.

RESULTS

Of the 2640 live newborns (hereinafter NB) at the HMCP in the city of Campinas - SP, 2334 (88%) passed through the SUS Neaonatal Hearing Screening.

Of the NB who were screened, 379 (16%) presented RIHI and 1955 (84%) did not present RIHI.

The rate of pass/fail of the 1st test carried out on the NB with or without RIHI was observed. From the total number of NB with or without RIHI, 1832 (78%) passed and 502 (22%) failed the screening. Table 1 presents the results of the test.

The data from Table 1 was analyzed using statistical chi-square tests with a confidence interval of 5%. The test evaluates the relation between the two variables. With the p-value = 0,06, it isn't possible to affirm that there is a difference between the group that "Passed" and the group that "Failed" when it comes to the presence or not of a risk indicator. The Odds Ratio (OR) shows that the chances of passing with RIHI are smaller than the chances of passing without RIHI (chance of passing with RIHI is 283/96 = 2,94 and the chance of passing without RIHI is 1549/406 = 3,81).

Table 1 – Results of the first test on the newborn with and without a risk indicator for hearing impairment

	Passed		Failed		p-value	OR
	N	%	N	%		
With RIHI	283	75%	96	25%	0,06	0,77
Without RIHI	1549	79%	406	21%		

**Odds-Ratio* – Is the odds ratio of an event occurring in a group and the odds of it occurring in another group.
The data in Table 1 was analyzed using statistical Chi-Square test with a confidence interval of 5%.

The pass-fail percentages of the NB with and without RIHI were: 1549 (66%) passed the screening without RIHI; 283 (12%) passed with RIHI; 406 (17%) failed without RIHI; 96 (4%) failed with RIHI.

The rate of newborns referred for diagnosis was 89 (4%), including the NB that remained in the Neonatal ICU and those who failed the second retest.

Of the total number of NB who failed the screening, 79,88% do not present RIHI and 18,92% do present RIHI.

Of the NB with RIHI 61,05% failed in only one ear, 36,84% failed with both ears and 2,11% did not conclude the test. On the retest of the NB with RIHI, 4,21% failed in only one ear, 10,53% failed in both ears and 26,32% did not return for the second test. 58,95% of the NB with RIHI passed the retest.

Of the NB without RIHI, 55,36% failed in only one ear, 39,90% failed in both ears and 4,74% did not conclude the test.

For the retest of the NB without RIHI, 5,49% failed in only one ear, 5,24% failed in both ears and 24,94% did not show up. 66,58% of the NB without RIHI passed the retest.

The proportion test did not indicate any statistically significant differences between the proportions of tests and retests with NB with or without RIHI.

Table 2 – Information on the test results of newborns who failed the screening

Screening Results	N	%	P-value
Total NB who failed	502	100.00%	
Total NB who failed without RIHI	401	79.88%	
Total NB who failed with RIHI	95	18.92%	
1st Test – Unilateral fail without RIHI	222	55.36%	0,37
1st Test – Unilateral fail with RIHI	58	61.05%	
1st Test – Bilateral fail without RIHI	160	39.90%	0,66
1st Test – Bilateral fail with RIHI	35	36.84%	
1st Test – Not concluded without RIHI	19	4.74%	0,38
1st Test - Not concluded with RIHI	2	2.11%	
Retest - Unilateral fail without RIHI	22	5.49%	0,8
Retest - Unilateral fail with RIHI	4	4.21%	
Retest - Bilateral fail without RIHI	21	5.24%	0,09
Retest - Bilateral fail with RIHI	10	10.53%	
Retest - Not concluded without RIHI	1	0.25%	1
Retest - Not concluded with RIHI	0	0.00%	
Retest – Did not show up without RIHI	100	24.94%	0,88
Retest - Did not show up with RIHI	25	26.32%	
Retest – Passed without RIHI	267	66.58%	0,19

The proportion test did not indicate any statistically significant difference between the proportions of tests and retests with NB with or without RIHI.

Tables 3 and 4 present the number of NB per risk indicator for hearing impairment. It can be noted that family history is the most frequent indicator in NB, both in those who passed and those who failed the test. Using a statistical proportion test with a 5% significance level no statistically significant difference was found between the proportions of each incidence in both groups (pass/fail).

Table 3 – Risk indicators for hearing impairment in newborns who passed the screening

Risk indicators in NB who passed the screening		
Family history	115	41%
Permanence in Neonatal ICU	72	25%
Prematureness	61	22%
Apgar	48	17%
Ototoxic medication	43	15%
Weight < 1500 g	8	3%
Ventilation	4	1.4%
Consanguinity amongst parents	3	1.1%
Intrauterine infections	3	1.1%
Acute Perinatal Anoxia	2	0.7%
SGA	2	0.7%
Craniofacial Anomalies	1	0.4%

Using the statistical proportions test with a significance interval of 5% no statistically significant difference between the proportions of each incidence in both groups (passed/failed) was noticed.

Table 4 - Risk indicators for hearing impairment in newborns who failed the screening

Risk indicators in NB who failed the screening		
Family history	38	40%
Apgar	21	22%
Permanence in Neonatal ICU	18	19%
Prematureness	11	11%
Ototoxic medication	6	6%
Consanguinity amongst parents	6	6%
Weight < than 1500 g	3	3%
Intrauterine infections	3	3%
Acute Perinatal Anoxia	2	2%
Craniofacial Anomalies	2	2%
Syndromes associated with HI	2	2%
SGA	1	1%

Using the statistical proportions test with a significance interval of 5% no statistically significant difference between the proportions of each incidence in both groups (passed/failed) was noticed.

Table 5 presents the demographical variables and their association with the test result (pass/fail). Considering a confidence interval of 5%, it is not possible to notice any statistically significant association between the demographical variables and the test results.

Nearly all the Odds-ratio (OR) gave values close to 1, meaning that the chance of passing at each of the variables was the same. Only the odds-ratio of the weight variable called attention: The chance of passing the test with a weight between 1500g and 2500g is 1.7 times higher than the chance of passing with a weight lower than 1500g. And the chance of passing with a weight greater than 2500g is 1.3 times greater than the chance of passing with a weight smaller than 1500g.

Table 6 shows in percentages the subdivision of the regional Districts of the city of Campinas from where the NB who failed the test and will need to be retested and those who presented RIHI and will need biannual hearing monitoring came from.

Table 5 – Demographic variables and association with the test result

Variables	Passed		Failed		p value	OR
Mother's age						
From 10 to 20 years	475	76.5%	146	23.5%	0.16	1.00
From 21 to 30 years	925	79.9%	232	20.1%		0.82
From 31 to 40 years	347	81.6%	78	18.4%		0.73
From 41 to 50 years	24	75.0%	8	25.0%		1.08
Gender						
Female	918	79.2%	241	20.8%	0.56	1.06
Male	873	78.2%	244	21.8%		
Weight at birth						
< 1500g	15	83.3%	3	16.7%	0.28	1.00
Between 1500g and 2500g	134	74.4%	46	25.6%		1.72
> 2500g	1629	79.4%	423	20.6%		1.30
Gestational age						
< 37 weeks	144	81.4%	33	18.6%	0.85	1.00
37 to 42 weeks	1617	80.0%	403	20.0%		1.09
> 42 weeks	2	100.0%	0	0.0%		

**Odds-Ratio* – Is the odds ratio of an event occurring in a group and the odds of it occurring in another group.

Table 6 – Subdivision of Campinas city districts versus newborns who failed the screening and newborn with risk indicators for hearing impairment

District	Failed	With RIHI
North West	44,00%	38,00%
South	2,00%	0,80%
South West	16,00%	9,00%
North	0,40%	1,30%

RIHI: Risk Indicator for Hearing Impairment.

DISCUSSION

In this study, the percentage of newborns screened in relation to the number born was 88%. Other research pointed to values varying between 61,2% [10]; 94%, 96%, 52% [12]; 68%, 88%, 80% [13]; 95,2% [14]; 62,17% [15].

In relation to the RIHI, it was noted that the incidence in NB without RIHI was of 84% and of 16% in those with an indicator. Studies have shown samples with more than 10% of newborns with RIHI, confirming this evidence when it came to the presence of the indicator in the following studies: 12% [12]; 29% [14]; and 6%, 12% and 14% [15].

In 2009, a study about the prevalence of risk indicators for deafness developed at the same institution (HMCP), pointed to a higher incidence of NBs with some RIHI that year in relation to 2010, with a rate of 25% in 2009 and 16% in 2010 [16].

Amongst the most prevalent risk indicators present in the pass/fail groups, the following appeared in the greatest number: Family history and complications coming from the neonatal ICU. Other authors have also reached the same conclusion[15-19]. Another study also relates this indicator with a population of low risk NB[8].

When it comes to the chances of passing/failing in newborns with RIHI, it was noted that the chances of passing with RIHI are lower than the chances of passing without RIHI[10].

Still in relation to risk indicators, it was also analyzed whether there was a pass/fail relation with the mother's age, weight, gestational age and the gender of the NB.

The weight variable called attention: it was statistically shown that the chances of passing the test with a weight between 1.500g and 2.500g is 1.7 times greater than the chances of passing with a weight smaller than 1500g. And the chances of passing with a weight greater than 2.500g is 1.3 times bigger than the chances of passing with a weight smaller than 1.500g.

In 2007, researchers concluded that the chance of a newborn with a weight at birth smaller than 1.500g having a hearing loss is approximately 5.5 times higher than for those born weighing more than 1.500g; also observing that low weight at birth was associated with hearing loss[20].

Prematurness and low weight at birth are generally concurrent, making it hard to separate the factor associated to one or another. Being that newborn when born with a low weight, lower than 1.500g, present various factors which may lead to brain damage or hearing loss[21,22].

With regards to the screening results, it was seen that 1832 (78%) passed the screening and 502 (22%) failed. This data representing higher rates than in the previous study from the same institution, with a 58% pass rate[16].

Also, the failure rates observed are high in relation to the recommendations of the *Joint Committee on Infant Hearing,* which suggests that this rate should not surpass 4% before being discharged from hospital[3].

Other studies reveal a pass/fail rate of 73,3% Pass and 26,7% Fail [14]. 90,50% Pass and 9,50% Fail[10].

It can be seen that a large number of the studies related to NHS were developed in University Hospitals, as is the case with this study. Together with this, with each new year, new Residents, teachers and students take on the responsibility of carrying out the Neonatal Hearing Screening, where time is needed to acquire experience in carrying out the tests.

This experience is an important indicator in relation to the factors that can interfere in the results received from the EOAE, such as the state of consciousness of the newborn, the displacement of the probe through the external ear canal, placement of the probe, localization and noise [23].

A study about the specificity and the rate of false-positives of NHS protocols, observed that an increase in the experience of the professional

involved led to a fall in the rate of referrals and false-positives [19].

When it comes to the results of the screening, amongst the NB who failed the screening with and without RIHI, unilateral failure was observed in 61,05% (with indicator) and 55,36% (without indicator); bilateral failure in 36,84% (with indicator) 39,90% (without indicator).

In the retest the following was found: unilateral failure in 4,21% (with indicator) and 5,49% (without indicator); bilateral failure in 10,53% (with indicator) and 5,24% (without indicator); 26,32% (with indicator) and 24,94% (without indicator) did not show up for the retest; and 58,95% (with indicator) and 66,58% (without indicator) passed the retest.

The following authors also described similar results in unilateral failure in the first test, with percentages that vary of: 67,3% [10]; 62,6% [14]; 61,5% [24].

In retests other studies present the following failure percentages: 6,6% [14]; 23,81% to 39,91% [6,24].

In relation to the adhesion of the studied population to the retest it was observed that approximately 73,68% (with indicator) and 75,06% (without indicator) showed up for the retest. This data is close to what other studies show: 68,2% [14] and 73,1% [6].

The number of newborns referred to diagnosis was 89 (4%), including the NB who remained in the Neonatal ICU and those who failed the second retest.

To evaluate the effectiveness of the NHS Program of the HMCP, the verification of the quality indicators was carried out, which were: rate of screening carried out superior to 95% amongst live newborns, trying to reach a rate of 100% amongst live newborns; screening carried out during the newborn's first month and with a rate of newborns referred to diagnosis inferior to 4%[3].

The percentage analyzed in this study was of 88% of NB screened. This data can be related to the fact that the Hospital makes available a number of live births from a total of NB coming from private healthcare plans together with the number the live births from the *Sistema Único de Saúde*.

The screening's high reach index can be justified by the fact that the test must be carried out up to 48 hours, or prior, to hospital discharge, being that screening during admission is prioritized, be it via the SUS or through a private healthcare plan. The availability of staff and their weekend shifts can also contribute to this goal[14]. It can also be understood that carrying out the tests throughout all week without interruptions, also consists of a decisive factor in the effectiveness of the UNHS Programs [16].

The rate of newborn referred to diagnosis was 89 (4%), reaching the recommendations for verification of quality indicators.

To achieve success in the implementation of NHS Programs prevention actions are also recommended, as well as the territorialization of demand.

For this, in this study we carried out the mapping of the newborns that passed and failed the screening and those who will need biannual hearing monitoring.

Although other regions do use the Hospital services, the regions of the Northwest and Southwest district of Campinas concentrate the greatest number of newborns who pass through the NHS.

CONCLUSION

A study like this one allows for the active search of newborns from the risk group for hearing impairment in their respective territories, with a higher possibility of accompaniment of the NBs and in this manner, reaching the primary goal of hearing screening that is the diagnosis of deafness by the newborn's third month of life, developing an effective NHS Program in two stages: screening, hearing diagnosis, indication, selection and adaptation of hearing aids and hearing re(ha)bilitation.

RESUMO

Objetivo: caracterizar a demanda, território e exames auditivos realizados em um Programa de Triagem Auditiva Neonatal. **Métodos:** estudo retrospectivo de uma amostra de 2334 prontuários de recém-nascidos triados, envolvendo a análise de dados referentes à Triagem Auditiva Neonatal, informações dos Recém-nascidos e variáveis demográficas. **Resultados**: foram triados 88% dos recém-nascidos, e destes 16% apresentavam Indicador de Risco para Deficiência Auditiva e 84% não apresentavam. Observou-se que o indicador mais prevalente foi o histórico familiar, e que as chances de passar no teste são menores quando na presença de indicador e quando o recém-nascido apresentava peso inferior a 1.500g. O índice de passa-falha no teste foi de 78% passa e 22% falha. No resultado do teste, maior número de falhas unilaterais, e no reteste falha de 4% sendo a adesão de mais de 70%. **Conclusão**: estudo como este possibilita a busca ativa dos recém-nascidos do grupo de risco para deficiência auditiva em seus respectivos territórios, havendo maior possibilidade de seguimento e assim, chegar ao objetivo primordial da triagem auditiva que é o diagnostico da surdez até o terceiro mês de vida, além de projetar um Programa de Triagem Auditiva Neonatal efetivo em suas etapas: triagem, diagnóstico audiológico, indicação, seleção e adaptação de aparelhos auditivos e re(ha)bilitação auditiva.

DECRITORES: Triagem Neonatal; Emissões Otoacústicas Evocadas; Perda Auditiva

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