PREVALENCE OF RISK INDICES FOR HEARING LOSS IN 'FAILURE' RESULTS OF NEWBORN HEARING SCREENING

Prevalência dos indicadores de risco para perda auditiva nos resultados 'falha' da triagem auditiva neonatal

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ABSTRACT

Purpose: to establish which risk indicator for hearing loss shows the highest prevalence of 'failure' in newborn hearing screening. **Methods:** using a retrospective analysis of medical records involving 702 infants undergoing neonatal hearing screening in the Audiology Clinic of the Federal University of Bahia in the period 2007-2011, the chi-square test for the hypothesis of no association was made between the risk indicators and 'failure' of the newborn hearing screening. **Results:** in relation to the infants studied, 352 (50.29%) were male and 348 patients (49.71%) were females, two had no references as to gender. Most babies were between one to three months of age and 45.40% of babies were born prematurely. It was found that infants showed the following risk indicators: 28.83% had hyperbilirubinemia; 22.54% had a history of congenital infection; 15.06% were born weighing less than 1,500 grams; 8.21% had Apgar scores of 0-4 in the 1st minute; 5.07% had Apgar scores 0-6 in the 5th minute; 9.09% received mechanical ventilation; 4.09% had syndromes associated with hearing loss and only 1 (0.84%) infant had bacterial meningitis. Among these infants, 92.45% had no family history of hearing impairment and 97.09% had no craniofacial malformation. **Conclusion:** there were associations between five risk indicators and 'failure' in neonatal hearing screening. Risk indicators showed the following descending order of prevalence: Apgar score 0-4 in the 1st minute; craniofacial malformations; syndrome associated with hearing loss; Apgar score 0-6 in the 5th minutes; mechanical ventilation.

KEYWORDS: Risk Index; Hearing Loss; Neonatal Screening.

INTRODUCTION

Hearing Loss is the most frequent congenital disability among those usually screened in preventive health programs[1]. Approximately one to three newborns (NB) in 1,000 present neonatal hearing loss. When babies come from Intensive Care Units (ICU), the presence of neonatal hearing loss increases to two to five in 100 NBs [2-12]. It is important to point out that an early diagnosis of hearing impairment in children is highly desirable, preferably in the first six months of life, since hearing impairments can lead, in the long term, to irreversible alterations in the process of acquisition of language and cognitive abilities[4,13-19].

Among newborns, 7 to 12% have at least one risk index for hearing impairment[4]. Since 1972, the *Joint Committee on Infant Hearing* (JCIH) has recommended the use of specific risk indices associated to hearing loss in newborns and children. These risk indices have been applied in the United States and in other countries with two purposes: to identify children with priority to undergo audiological evaluations and to identify children who must receive audiological monitoring, as well as medical monitoring after the neonatal screening. The aim of this is to identify children with possibilities of late onset of hearing loss and/or a progression of the already existing hearing loss since birth, so children would have adequate treatment[5].

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Conflict of interest: non-existent

In 2007, JCIH identified the problem of late onset of hearing loss and defined the risk indices that demand audiological monitoring during the first years of life[20,21]. They are: family history of congenital hearing impairment; congenital infection (TORCHS - toxoplasmosis, rubella, cytomegalovirus, herpes, syphilis); craniofacial malformation (ear auricle anomaly, external ear canal, nasal filter is missing, root of the hair is implanted low); weight at birth inferior to 1,500g, something to the effect of 3 pounds, 4 ounces; hyperbilirubinemia (serum levels indicating exchange transfusion); use of ototoxic drugs for more than five days (aminoglycosides or others, associated or not to loop diuretics); bacterial meningitis; Apgar scores from 0 to 4 at the 1st minute or 0 to 6 at the 5th minute; artificial respiration for a minimum period of five days; signs or syndromes associated to conductive or sensorineural hearing impairment[1,9,17,21,22].

Using a retrospective analysis of the infants who underwent neonatal hearing screenings, this study had as an objective to establish which risk index for hearing loss shows greater prevalence of 'failure' results in the Neonatal Hearing Screening.

METHODS

This study was analyzed and approved by the Research Ethics Committee of CEFAC/São Paulo under protocol nº. 004/12.

It is a retrospective and documentary study.

Study of Cases

Medical records of infants treated at the Neonatal Hearing Screening Clinic, at the Audiology Services in the Federal University of Bahia.

Size of the Sample

The sample was made of 702 medical records of infants treated at the Neonatal Hearing Screening Clinic in the Federal University of Bahia. An analysis of medical records/forms of all the infants evaluated in the period from 2007 to 2011 was carried out.

Criteria of Inclusion

Medical records showing the following conditions were considered:

- Record of the neonatal hearing screening (NHS) (test and/or retest);
- Record of screening carried out with both Transient and Distortion Product Evoked Otoacoustic Emissions;
- Presence of risk indices for hearing loss used by the *Joint Committee on Infant Hearing*[23].

Criteria of Exclusion

- Medical records from before 2007 and after 2011;
- Medical records without the Free and Clarified Consent Term signed.

Data Collection

Standardized interview forms applied to the person accountable for the infant were consulted with the purpose of obtaining sociodemographic data and risk indices for hearing impairment of the NBs. The records of the results of the evoked otoacoustic emissions research (EOAE) were obtained from the NBs' medical records. The result of examinations carried out during the previous evaluation was considered, in case patients were asked to return for re-evaluation. This study did not use the free and clarified consent form, since it is part of the clinic's routine.

Statistical Analysis

To analyze the data, two-dimensional contingency tables were built with the objective of quantifying the relative risk inherent to the indices under study about the observation of failure in the hearing test. The chi-square test was applied for the hypothesis of absence of association between the index and the failure in the test with level of significance of 5% and, at that moment, the relative risk with the respective confidence intervals (95%) was also calculated. The calculations were made by means of the FREQ procedure of the SAS system (SAS Institute Inc. The SAS System, release 9.2. SAS Institute Inc., Cary:NC. 2008).

RESULTS

Medical records/forms of 702 infants treated in the period from 2007 to 2011 at the Phonoaudiology Service in the Federal University of Bahia were consulted. Table 1 summarizes the main sociodemographic characteristics of this study's population. Among these infants, 352 (50.29%) were male and 348 (49.71%) were female; two did not have references as to their gender. Most babies were between one and three months old and 45.40% of the babies were born prematurely.

Among the risk indices, 28.83% of the infants had *hyperbilirubinemia*, 22.54% had *a history of congenital infection*, 15.06% were born *weighing less than 1,500g*, 8.21% had an *Apgar score of 0 to 4 at the 1st minute*, 5.07% showed an *Apgar score of 0 to 6 at the 5th minute*, 9.09% received *artificial respiration*, 4.09% had *syndromes associated to hearing loss* and only 1 (0.84%) had *bacterial meningitis*. Among these infants, 92.45% did not have *a*

Table 1 – Sociodemographic characteristics of the subjects of the study

Characteristics	Frequency (n)	Percentage (%)
Gender		
Male	352	50.29
Female	348	49.71
Not imformed	2	-
Age		
NB	127	18.09
1 to 3 months	414	58.97
4 to 6 months	106	15.10
> 6 months	55	7.83
Gestational age (GA)		
24 to 37 weeks	316	45.40
38 to 42 weeks	376	54.02
43 to 46 weeks	4	0.57
Not informed	6	-
Weight at birth		
SGA*	71	10.23
Low weight (<1,500g)	100	14.41
AGA**	450	64.84
LGA***	73	10.52
Not informed	38	-
Place of birth		
Salvador	661	94.43
Countryside	36	5.14
Another state	3	0.43
Not informed	2	-
Family income		
< 1 MW	263	40.15
1 MW	48	7.33
1-3 MW	310	47.33
> 3 MW	34	5.19
Not informed	47	-

* Small for gestational age.
** Adequate for gestational age.
*** Large for gestational age

family history of hearing impairment and 97.09% did not present *craniofacial malformation* (Table 2).

Of the 678 infants sent to undergo NHS, 599 (89.67%) passed in the right ear and 69 (10.33%) were sent for re-test, 600 (90.09%) passed in the left ear and 66 (9.91%) were sent for re-test. The infants sent for re-test showed failure in the right ear in 17 (31.48%) of the cases and in the left ear in 13 (25.49%).

No associations were found between *family history and congenital infections* (TORCHS) and 'failure' in NHS**.** Nevertheless, at the analysis of *craniofacial malformation*, an association was observed between the occurrence of this risk index and 'failure' in NHS. The relative risk of failure in the test when *craniofacial malformation* occurs was 1.67 times greater than in the group without malformation (Table 3).

Table 2 – Distribution of population according to prenatal, perinatal and postnatal risk indices for hearing loss (JCIH, 2007)

Risk Indicator for Hearing Loss	Frequency (n)	Percentage (%)
Family history for hearing loss		
Yes	49	7.55
No	600	92.45
Not informed	53	-
Congenital Infection – TORCHS*		
Yes	32	22.54
No	110	77.46
Not informed	560	-
Craniofacial malformation		
Yes	20	2.91
No	668	97.09
Not informed	14	-
Weight at birth inferior to a 1,500g		
Yes	100	15.06
No	564	84.94
Not informed	38	-
Hyperbilirubinemia		
Yes	192	28.83
No	474	71.17
Not informed	36	-
Bacterial meningitis		
Yes	1	0.84
No	118	99.16
Not informed	583	-
Apgar 0/4 1st minute		
Yes	11	8.21
No	123	91.79
Not informed	568	-
Apgar 0/6 5th minute		
Yes	7	5.07
No	131	94.93
Not informed	564	-
Artificial respiration		
Yes	12	9.09
No	120	90.91
Not informed	270	-
Syndromes associated to hearing loss		
Yes	28	4.09
No	657	95.91
Not informed	17	-
UTI > 5 days		
Yes	201	28.63
No	501	71.37
Use of ototoxic drugs		
Yes	107	15.24
No	595	84.76

*Toxoplasmosis, Rubella, Cytomegalovirus, Herpes, Syphilis.

Table 3 – Description of failure in the Neonatal Hearing Screening associates to the risk index craniofacial malformation (n=656)

Craniofacial malformation	Failure in the Test				Relative Risk (IC 95%)	Chi-square test (p-value)
	No		Yes			
	n	%	n	%		
No	601	93.91	39	6.09	1.000	
Yes	9	56.25	7	43.75	1.6694 (1.0832 – 2.5730)	0.0001

Frequency and percentage of occurrence or not of failure in the test according to the risk index; relative risk and p-value of the chi--square test for the hypothesis of absence of association.

As for index *weight at birth inferior to 1,500g*, a proportion of failures of 5.32% were found. This percentage was similar to the one presented by the group with weight over 1,500g (6.88%), (p>0.05).

In NHS, the proportion of failures in the test of the group with *hyperbilirubinemia* (8.38%) was superior to the one presented by the group without *hyperbilirubinemia* (6.35%). Nonetheless, the chi-square test did not detect any difference between the two groups concerning their behavior (p: 0.3633).

An association between the occurrence of *Apgar from 0 to 4 at the 1st minute* and from *0 to 6 at the 5th minute* with 'failure' in NHS (p<0.01) was observed. The relative risk of failure in the test involving *Apgar from 0 to 4 at the 1st minute* was 1.76 times greater than the one found in the group with Apgar within the normal range. Regarding *Apgar from 0 to 6 at the 5th minute*, it was found that the aforementioned risk was of 1.45 times (Table 4).

Table 4 - Description of failure in the Neonatal Hearing Screening associated to risk index Apgar score 0 to 4 at the 1st minute (n=123) and Apgar score 0 to 6 at the 5th minute (n=127)

Apgar 0 to 4 (1st minute)	Failure in the Test				Relative Risk (IC 95%)	Chi-square test (p-value)
	No		Yes			
	n	%	n	%		
No	112	98.25	2	6.76	1.000	
Yes	5	55.56	4	44.44	1.7684 (0.9853 – 3.1739)	0.0001
Apgar 0 to 6 (5th minute)	**Failure in the Test**				**Relative Risk (IC 95%)**	**Chi-square test (p-value)**
	No		**Yes**			
	n	**%**	**n**	**%**		
No	117	96.69	4	3,31	1.000	
Yes	4	66.67	2	33,33	1.4504 (0.8229 – 2.5564)	0.0007

There was an association between the use of *artificial respiration* and 'failure' in NHS (p=0.03). Patients submitted to *artificial respiration* presented a relative risk of failure in the test 1.17 times greater than those in the group without such recourse. The observation of proportions shows that the occurrence of failure in the test is more recurrent (18.18%) in the group exposed to *artificial respiration* than in the group without this risk index. In the latter, the occurrence of just 3.74% of failure was verified in the test.

The association between *syndromes related to hearing impairment* and 'failure' was also verified in the screening (p<0.01). In this case, the relative risk of failure was 1.47 times greater than the one found in the group without the syndromes. The limits of the confidence interval do not incorporate the value 1.00, which indicates that these syndromes may be an effective risk index. The comparison of proportions shows that the occurrence of failure in the test is much more recurrent (36.00%) in the group with syndromes than in the group without this risk index, since only 5.73% of the occurrences of 'failure' are verified in it in NHS.

DISCUSSION

Out of the screenings carried out in this study, 89.69% in the right ear and 90.09% in the left ear has 'pass' as a result in the first stage of screening. This coverage index is in accordance with the 95% recommended to consider it an effective Neonatal Hearing Screening Program[17,23]. The 'failure' index in NHS (10%) in newborns with and without risk indices for hearing impairment conforms to the *Joint Committee on Infant Hearing's* recommendation from 2007, which suggests that failures in the first stage should not go over 10%[21].

The most frequent risk indices observed are *hyperbilirubinemia*, *congenital infection, Apgar score from 0 to 4 at the 1st minute, weight at birth inferior to 1,500g, permanence at ICU, use of ototoxics, artificial respiration* and occurrence of *family history of hearing loss*, these were similar to the ones most frequently found in literature[4,5,13,24-27].

Family history of hearing impairment, although not having shown a statistically significant association with a 'failure' result in the screening, is a risk index that can interfere in the screening's result[13,15]. Children with a *family history positive for hearing impairment* in childhood should be considered at risk of progressive and/or late hearing loss[25].

This study did not find a statistically significant association between *congenital infections* (TORCHS) and failures in NHS[5,16,27]. Nevertheless, the existence of association between this risk index and hearing loss cannot be ignored, because the p-value is very close to the limit of acceptance[8,25]. Moreover, the association between some congenital infections and hearing loss has already been established in literature[22].

This study revealed a statistically significant association between failure in NHS and the risk index *craniofacial malformation*. This association has also been described by Onoda *et al*., 2011[25]; Korres *et al*., 2005[26]; Kiatchoosakun *et al*., 2012[27], who observed that *craniofacial malformation* is one of the risks associated to hearing impairment. In addition, the relative risk of failure in the test, when *craniofacial malformation* occurs, is 1.67 times greater than in the group without malformation.

In this study, the proportion of failures in the test of the group with *weight inferior to 1,500g* (5.32%) was very close to the failures in the test of the group that do not present low weight (6.88%). Therefore, there was no statistically significant association between *weight at birth inferior to 1,500g* and failure in NHS, which is compatible with the findings of Botelho *et al*., 2010[8]. However, this lack of association goes against the results found by Tiensoli *et al*. (2007)[5]; Griz *et al*. (2010)[16]; Onoda *et al*. (2011)[25], which revealed that children with *weight at birth inferior to 1,500g* presented hearing impairment.

The analysis of results involving the association of *hyperbilirubinemia* with failure in NHS was not statistically significant, which corroborates with the findings observed by Griz *et al*., 2010[16]. However, the analysis of the aforementioned results differ from those of other studies in literature[5,8,25]. Such studies refer that *hyperbilirubinemia* is a toxic condition for auditory pathways, for the central nervous system, being able to leave sequelae such as deafness, auditory neuropathy and encephalopathy. Therefore, considering that high levels of bilirubin may lead to hearing impairment, it is important to identify newborns and infants affected by it as soon as possible. Such identification aims to have these children undergo a battery of audiological and electrophysiological tests with the objective of offering them precise diagnoses, allowing for fast and adequate interventions[16].

Apgar scores from 0 to 4 at the 1st minute and *from 0 to 6 at the 5th minute* associated to failure in NHS was statistically significant. For babies who showed *Apgar scores from 0 to 4 at the 1st minute*, it was found the existence of a risk 1.76 times greater of having failure in NHS when compared with babies with Apgar within the normal range. Also, it was verified that this risk was 1.45 times greater in *Apgar scores from 0 to 6 at the 5th minute*, when compared with the group with Apgar within the normal range. These findings support the ones by Tiensoli *et al*., 2007[5]; Kiatchoosakun *et al*., 2012[27], which indicate that low Apgar indices may pose a risk of hearing impairment.

In this study, it was also found the existence of statistically significant association between *artificial respiration* and failure in NHS and that these findings are in accordance with data found in literature[5,16,26,27].

The present study allowed for identification of a statistically significant relationship between the risk index *syndromes associated with hearing loss* and failure in screening, which is in accordance with the findings of Pereira *et al*., 2007[19].

It was observed that the health professionals did not properly register data from patients regarding *permanence in neonatal ICU* and use of *ototoxic drugs* in the medical records. Even with the failure in the records, it was observed that the analyses of the valid data found were in accordance with the findings in literature. There, analyses showed that the permanence in ICU and the use of ototoxic drugs may lead to irreversible hearing loss[10, 13,16,20,21].

CONCLUSION

Based on the results obtained in the present study, it is possible to conclude that, among the risk indices studied, there was an association between five of these indices and 'failure' in the neonatal hearing screening. In this association, the risk indices showed the following decreasing order of prevalence:

- Apgar scores from 0 to 4 at the 1st minute;
- Craniofacial malformations;
- Syndromes associated to hearing loss;
- Apgar scores from 0 to 6 at the 5th minute;
- Artificial respiration.

RESUMO

Objetivo: estabelecer qual indicador de risco para perda auditiva apresenta maior prevalência de resultados 'falha' da Triagem Auditiva Neonatal. **Métodos:** a partir de análise retrospectiva de 702 prontuários de lactentes submetidos à triagem auditiva neonatal no Ambulatório de Audiologia da Universidade Federal da Bahia no período de 2007 a 2011, foi realizado o teste do qui-quadrado para a hipótese de ausência de associação entre os indicadores de risco e a 'falha' da Triagem Auditiva Neonatal. **Resultados:** dos lactentes pesquisados, 352 (50,29%) foram do sexo masculino e 348 (49,71%) do sexo feminino, dois não tinham referências quanto ao gênero. A maioria dos bebês tinha idade entre um a três meses de vida e 45,40% dos bebês nasceram prematuros. Verificou-se que os bebês apresentaram os seguintes indicadores de risco: 28,83% tinham hiperbilirrubinemia; 22,54% tinham história de infecção congênita; 15,06% nasceram com peso inferior a 1.500g; 8,21% tiveram boletim Apgar de 0 a 4 no 1º minuto; 5,07% apresentaram boletim Apgar de 0 a 6 no 5º minuto; 9,09% receberam ventilação mecânica; 4,09% tinham síndromes associadas à perda auditiva e apenas 1 (0,84%) lactente teve meningite bacteriana. Entre esses lactentes, 92,45% não tinham histórico familiar de deficiência auditiva e 97,09% não apresentavam malformação craniofacial. **Conclusão:** houve associações entre cinco indicadores de risco e 'falha' na triagem auditiva neonatal. Os indicadores de risco apresentaram a seguinte ordem decrescente de prevalência: boletim de Apgar de 0 a 4 no 1º minuto; malformações craniofaciais; síndrome associadas a perdas auditivas; boletim de Apgar de 0 a 6 no 5º minuto; ventilação mecânica.

DESCRITORES: Indicador de Risco; Perda Auditiva; Triagem Neonatal.

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