Newborn hearing screening with transient evoked otoacoustic emissions and automatic auditory brainstem response

Emissões otoacústicas evocadas por estímulos transientes e potencial evocado auditivo de tronco encefálico automático na triagem auditiva neonatal

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ABSTRACT

Objective: The aim of the present investigation was to check Transient Evoked Otoacoustic Emissions and Automatic Auditory Brainstem Response tests applied together in regular nurseries and Newborn Intensive Care Units (NICU), as well as to describe and compare the results obtained in both groups. **Methods:** We tested 150 newborns from regular nurseries and 70 from NICU. **Results:** The newborn hearing screening results using Transient Evoked Otoacoustic Emissions and Automatic Auditory Brainstem Response tests could be applied to all babies. The "pass" result for the group of babies from the nursery was 94.7% using Transient Evoked Otoacoustic Emissions and 96% using Automatic Auditory Brainstem Response. The newborn intensive care unit group obtained 87.1% on Transient Evoked Otoacoustic Emissions and 80% on the Automatic Auditory Brainstem Response, and there was no statistical difference between the procedures when the groups were evaluated individually. However, comparing the groups, Transient Evoked Otoacoustic Emissions were presented in 94.7% of the nursery babies and in 87.1% in the group from the newborn intensive care unit. Considering the Automatic Auditory Brainstem Response, we found 96 and 87%, respectively. **Conclusions:** Transient Evoked Otoacoustic Emissions and Automatic Auditory Brainstem Response had similar "pass" and "fail" results when the procedures were applied to neonates from the regular nursery, and the combined tests were more precise to detect hearing impairment in the newborn intensive care unit babies.

Keywords: Neonatal screening; Hearing loss; Otoacoustic emissions, spontaneous; Evoked potentials, auditory, brain stem

RESUMO

Objetivo: O presente estudo teve como objetivo verificar a eficácia das respostas auditivas em recém-nascidos de berçário comum e de unidade de terapia intensiva neonatal, utilizando testes combinados de Emissões Otoacústicas Evocadas Transites e Potencial Evocado de Tronco Encefálico Automático, bem como descrever e comparar os resultados obtidos nos dois grupos. **Métodos:** Foram avaliados 150 recém-nascidos de berçário comum e 70 recém-nascidos de unidade de terapia intensiva neonatal. **Resultados:** A ocorrência de resultado "Passa" no grupo de berçário comum foi de 94,7% para as Emissões Otoacústicas Evocadas Transientes e de 96% para o Potencial Evocado Auditivo de Tronco Encefálico Automático. O grupo da unidade de terapia intensiva neonatal obteve ocorrência de resultados "Passa" de 87,1 e de 80,0% respectivamente nos testes citados, não havendo diferença estatisticamente significativa entre os testes ao analisar os grupos isoladamente. Porém, os dois grupos de recém-nascidos foram comparados, e as Emissões Otoacústicas Evocadas Transientes estiveram presentes em 94,7% no grupo de berçário comum e em 87,1% no grupo de Unidade de Terapia Intensiva Neonatal, enquanto que o Potencial Evocado Auditivo de Tronco Encefálico Automático em 96 e 87,1% dos respectivos recém-nascidos descritos. **Conclusões:** Foi observada equivalência de ocorrência dos resultados "Passa" e "Falha" nos procedimentos de Emissões Otoacústicas Evocadas Transientes e Potencial Evocado auditivo de Tronco Encefálico Automático para o grupo de berçário comum e maior precisão na identificação das alterações auditivas em recém-nascidos de Unidade de Terapia Intensiva Neonatal.

Descritores: Triagem neonatal; Perda auditiva; Emissões otoacústicas espontâneas; Potenciais evocados auditivos do tronco encefálico

INTRODUCTION

In their first year of life children with hearing impairment cry, smile, move, make eyes contact and, sometimes, they are so communicative that family members miss

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the hearing loss, especially because in their first months they utter sounds just like normal hearing children, even without auditory feedback; in other words, without hearing their own voice.

After a lot of research and technological development, new tests were developed to create an auditory screening, spreading it and making it universal, that is, to be performed in at least 85% of all newborns[1].

Recording the Transient Evoked Otoacoustic Emissions (TEOAE) started to be broadly used. This method does not require a sound-treated room to be carried out; it is fast, with great sensitivity in detecting cochlear hearing loss; and it assess the frequencies of 800 to 4,000 Hz in the intensities of 25 to 30 dB HL.

When present, TEOAE indicate normal hearing[2]; and their absence indicates that the patient needs to be followed up, stressing that the major limitation of the TEOAE is the impossibility of assessing central auditory processing.

Considering the TEOAE speed and objectiveness, we started screening newborns from a regular nursery, as well as newborns from a newborn intensive care unit (NICU), thus looking for hearing alterations in this population.

Many studies describe the prevalence of hearing alterations, and according to different centers, it varies between 3:800 and 3:1000 live births[1,3-5].

Such studies showed that the prevalence of hearing alterations surpassed other neonatal screening tests, such as congenital hypothyroidism (1:4500 live births) and phenylketonuria (1:15000 live births), stressing the importance of neonatal auditory screening.

The variation of this prevalence could be justified by the diversity of the local population, by the particularities of reference values and the use of different technologies, having seen that some studies screened hearing using only the Automatic Auditory Brainstem Response (AABR) and others used TEOAE or the Distortion Product Evoked Otoacoustic Emission (DPEOAE), besides different protocols.

The Joint Committee on Infant Hearing published an American federal recommendation on hearing screening for all newborns, making it mandatory to test the neonates who presented data regarding hearing alterations in their clinical history[6]. This rec ommendation no longer stresses the risk criteria for hearing alterations listed before, but rather that all newborns, with or without risk factors should have the right to be screened, besides stressing the importance of controlling the services, techniques and procedures for an effective early diagnosis of hearing alterations.

Since 1994, this committee has always stressed in their publications the importance of universal neonatal hearing screening (UNHS), stressing that, if the institution is unable to perform it, these newborn babies would have their diagnosis later on.

Studies contrary to UNHS were described, stating that the procedure was not that simple, nor necessary, and that there were no justifications to use this method in all newborns, although they recognized the importance of early diagnosis, leading to the development of many studies designed to prove that the method is indeed simple, beneficial and perfectly justifiable.

Later, the Joint Committee on Infant Hearing[7] suggested that besides assessing all the low and high risk newborns for hearing impairment, the protocol should bear the combined tests techniques – TEOAE and AABR, because the former assesses the cochlea, which is the most peripheral portion of the hearing system, and the latter – AABR, analyzes mostly the central auditory pathway.

More in-depth studies on the best technology and the best protocol to be used in neonatal hearing screening started to be discussed and developed.

Considering the importance of having intact peripheral and central auditory pathways for language development, it became essential to assess the need to include the Automatic Auditory Brainstem Response (AABR) in the neonatal hearing screening protocol, with the goal of checking the feasibility of performing both procedures in order to detect hearing alterations in newborns from regular nurseries and from NICUs, as well as describing and comparing the auditory responses from regular nursery and NICU babies using combined AABR and TEOAE; and to describe and compare the results obtained from both groups[8].

METHODS

The present investigation was carried out in newborn babies from regular nurseries and from Newborn Intensive Care Units (NICU). The data for the newborns from the regular nursery were collected at the nursery of Hospital e Maternidade Voluntários, in the city of São Paulo. The data from the NICU babies were collected at Hospital e Maternidade Voluntários and Hospital e Maternidade Santa Catarina, in the city of São Paulo.

All newborns were assessed before hospital discharge and the parents received a printed copy of the test results.

This investigation was approved by the Research Ethics Committee – CAPPesp of the Clinical Board of Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo – HC-FMUSP, according to protocol number 760/04.

The tests were carried out after the parents signed an informed consent form.

Patients

A total of 220 newborns were assessed and distributed into two groups: Group A: one hundred and fifty newborns from a regular nursery of Hospital and Maternidade Voluntários; Group B: seventy newborns from the NICU of Hospital e Maternidade Voluntários and Hospital e Maternidade Santa Catarina.

Inclusion criteria

The inclusion criteria used were as follows.

Group A

Newborns from a regular nursery, with no risk factors for hearing alterations, according to the Joint Committee on Infant Hearing[9], (Appendix); newborns admitted to the maternity nursery after 48 hours of life; gestational age between 37 and 42 weeks; birth weight of 2,500 to 4,200 grams.

Group B

Newborns who were admitted to the NICU, with or without risk factors for hearing alterations, according to the Joint Committee on Infant Hearing[9]; newborns aged over 48 hours admitted to the NICU.

Exclusion criteria

For the present investigation we excluded the following newborns.

Group A

With risk factors for hearing impairment according to the Joint Committee on Infant Hearing[9]; with no informed consent form signed by the parents; gestational age below 37 weeks; birth weight below 2,500 g.; less than 48 hours of life.

Group B

With no informed consent form signed by the parents; less than 48 hours of life.

Preliminary procedures

Preliminary procedures are described following the order they are performed.

The 220 charts were analyzed in order to check the hours of life and probable date of hospital discharge. The parents of the newborns from the regular nursery with likely hospital discharge were visited for educational purposes and to request a written permission to carry out the tests (signature of the informed consent form). The parents or guardians of the NICU babies were previously educated and requested to give a written permission to carry out the test. After the consent, all charts were evaluated to check risk factors for hearing alterations, as well as to select the newborns from the regular nursery and the NICU, who would make part of the series, according to the inclusion and exclusion criteria adopted. The data from the charts were collected and recorded for assessment purposes.

Procedures

Initially, we followed the standard protocol for the equipment to be used in combined tests, recording the TEOAE, DPEOAE, and AABR through algorithm and vectorial analyses. Since most newborns woke up before the end of the three procedures, we decided to analyze only one method used to record cochlear function (TEOAE) and one method to record the retrocochlear auditory function (AABR); therefore, we excluded the DPEOAE test.

The test was carried out with the newborns comfortably set in their bassinet (Figure 1), in natural sleep, according to Brazelton's scale[10], after being breastfed, on the day of hospital discharge, and we started the exam by recording TEOAE and, following that, the AABR. After finishing the test in one ear, the same procedure was performed in the contralateral ear.

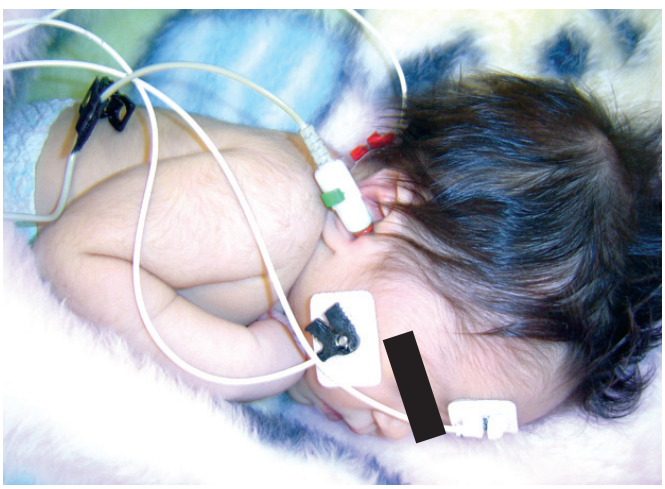

Figure 1. Newborn prepared for the TEOAE and AABR tests

The first ear to be tested was randomly chosen, according to the newborn's position in the bassinet, and after finishing the assessment procedures the results were delivered to the parents or guardians (Appendix 2).

A database of both groups was created to carry out the descriptive and inferential statistical analysis of the set of variables studied.

The newborn babies from the regular nursery and the NICU were assessed on the day of the hospital discharge. For the newborns that passed the TEOAE and AABR tests, the parents were informed and the newborns were discharged with no need for follow up. If the baby failed one of the tests, the newborn was brought back within 30 days for a second test with both procedures.

The babies that "passed" the second assessment had their parents educated and discharged. However, if a new "failure" result came up, the newborn was then referred to diagnostic evaluation, according to the protocol recommended by the Neonatal Hearing Screening Support Group (GATANU, acronym in Portuguese)[11].

Equipment

The equipment used in the study were TEOAE/DPEOAE and AABR analyzer, Accuscreen Pro, produced by Fischer-Zoth (Germany), distributed by GN-Otometrics with acculink software installed in a computer, and a printer.

Statistical method

We used the two-proportion non-parametric test for data analysis, added by the descriptive analysis, using the confidence interval for proportions.

RESULTS

The results obtained were analyzed in a descriptive fashion, and presented in a percentage of "pass" results, when both ears responded to the TEOAE or AABR tests, and "failure" when at least one of the newborn's ear did not respond to any of the tests at the time of the assessment, according to the parameters predefined by the equipment to classify responses.

The results were broken down into four parts in order to facilitate the analysis:

Part I: distribution of the "pass" and "fail" occurrences in the TEOAE and AABR tests combined in the first evaluation of regular nursery (Group A) and NICU (Group B) newborns

Both "pass" and "fail" results were seen in the TEOAE and AABR at the first evaluation, both for regular nursery (Group A), as seen in Table 1 and NICU (Group B) newborns (Table 2).

In Group A, all newborns evaluated were aged of 48 to 64 hours of life. According to the results described on Table 1, no statistically significant difference was observed in the tests for newborns in this group (p = 0.584). Of this sample, six newborns who did not respond to AABR were included in the group of eight newborns who had "failed" TEOAE. All these newborns who failed the test returned for TEOAE and AABR tests.

Table 1. Distribution of the "pass" and "fail" occurrences in the TEOAE and AABR tests combined in the first evaluation of regular nursery newborns (Group A)

Group A 1st evaluation	TEOAE			AABR			p value
	n	%	Var	n	%	Var	
Pass	142	94.7	3.6%	144	96.0	3.1%	0.584
Fail	8	5.3		6	4.0		

Table 2. Distribution of the "pass" and "fail" occurrences in the TEOAE and AABR tests combined in the first evaluation of the NICU newborns (Group B)

Group B 1st evaluation	TEOAE			AABR			p value
	n	%	Var	n	%	Var	
Pass	61	87.1	7.8%	59	84.3	8.3%	0.555
Fail	9	12.9		11	15.7		

In Group B, all newborns assessed were between 48 hours and 25 days of life, in good health conditions at hospital discharge. There was no statistically significant difference between the tests for this group (p = 0.555). Nine newborns did not respond to the TEOAE and AABR tests, and two did not respond only to the AABR. All newborns who failed the process had their parents/guardians instructed to bring them back for a TEOAE and AABR retest, even those who "failed" only the AABR.

Part II: comparing the results obtained from the TEOAE and AABR tests in the first evaluation, between the groups of newborns from the regular nursery (Group A) and the Neonatal ICU (Group B)

Table 3 compares the results obtained in the first evaluation of the TEOAE test between the groups of

Table 3. Comparing the results obtained in TEOAE test in the first evaluation between the regular nursery newborns (Group A) and the NICU newborns (Group B)

TEOAE 1st evaluation	Group A			Group B			p value
	n	%	Var	n	%	Var	
Pass	142	94.7	3.6%	61	87.1	7.84%	0.052
Fail	8	5.3		09	12.9		

newborns from the regular nursery (Group A) and the NICU (Group B). The AABR test results are depicted on Table 4.

Table 4. Comparing the results obtained in AABR test in the first evaluation between the regular nursery newborns (Group A) and the NICU newborns (group B)

AABR 1st evaluation	Group A			Group B			p value
	n	%	Var	n	%	Var	
Pass	144	96.0	3.14%	59	84.3	8.3%	0.052

Looking at Table 3 and comparing the TEOAE between the groups, we see the statistically significant difference in the TEOAE results (p = 0.052), that is, the group from the regular nursery had more "pass" answers than the NICU group.

On Table 4 we observed a higher number of no AABR response in the NICU group. Analyzing groups A and B, there was a statistically significant difference between these groups (p = 0.052).

All newborns who failed in at least one of the procedures carried out were referred back for new tests within 15 days and one month after the first evaluation, in order to confirm the results.

Part III: distribution of "pass" and "fail" results in the combined TEOAE and AABR tests in the second assessment, in newborns from the regular nursery (Group A) and the neonatal ICU (Group B) who failed the first testing

The number of "pass" and "fail" results in the combined TEOAE and AABR in the second assessment, both for Group A (Table 5) and Group B (Table 6) newborns who failed their first testing. The test was conducted to follow up these newborn babies, according to the recommendation from the Joint Committee on Infant Hearing[6].

Table 5. Distribution of the "pass" and "fail" occurrences in the TEOAE and AABR combined tests combined in the second evaluation of regular nursery newborns (Group A) who failed the first evaluation

Group A 2nd evaluation	TEOAE			AABR			p value
	n	%	Var	n	%	Var	
Pass	7	87.5	22.9%	7	87.5	22.9%	1.000

We stress that even the newborns who failed only one procedure (TEOAE or AABR) had both tests repeated in the second assessment.

Table 5 shows that all newborn babies who failed their first testing returned for a second evaluation. Among

Table 6. Distribution of the "pass" and "fail" occurrences in the TEOAE and AABR combined tests combined in the second evaluation of neonatal ICU newborns (Group B) who failed the first evaluation

Group B 2nd evaluation	TEOAE			AABR			p value
	n	%	Var	n	%	Var	
Pass	10	90.9	17.0%	9	81.8	22.8%	0.534
Fail	1	9.1		2	18.2		

Group A newborn babies who were re-evaluated, there was no statistically significant difference between the test results (p = 1.000). The newborns, who once again failed this step, were referred to further diagnostic procedures.

As shown on Table 6, all newborns from the NICU who failed their first test, returned for a new assessment by the combined TEOAE and AABR tests. In this second assessment, one newborn did not respond to both procedures and another one passed the TEOAE but failed the AABR, and there was no statistically significant difference between the tests (p = 0.534). Both were referred for further diagnosis.

Part IV: comparison of the results obtained in the second TEOAE and AABR tests between the newborns from the regular nursery (Group A) and the NICU (Group B) who failed their first testing

Comparison of the results obtained on the second TEOAE testing between Group A and B newborns who failed their first testing (Table 7), as well as the AABR test (Table 8).

Comparing the results obtained on the TEOAE testing between Group A and B newborns, on the second assessment, Table 7 shows that there were no statistically significant differences between these groups (p = 1.000).

Table 7. Comparing the results obtained in TEOAE test in the second evaluation between the regular nursery newborns (Group A) and the NICU newborns (Group B) who failed the first evaluation

TEOAE 2nd evaluation	Group A			Group B			p value
	n	%	Var	n	%	Var	
Pass	7	87.5	22.92%	10	90.9	16.99%	0.811
Fail	1	12.5		1	9.1		

Comparing the data obtained in the AABR test between Groups A and B, there were no statistically significant differences between the groups (p = 0.737), as shown on Table 8.

Table 8. Comparing the results obtained in AABR test in the second evaluation between the regular nursery newborns (Group A) and the NICU newborns (Group B) who failed the first evaluation

AABR 2nd evaluation	Group A			Group B			p value
	n	%	Var	n	%	Var	
Pass	7	87.5	22.92%	9	81.8	22.79%	0.737
Fail	1	12.5		2	18.2		

The newborns that had altered AABR in the reassessment were referred to audiological diagnosis.

DISCUSSION

The specialized literature reports the importance of assessing the entire auditory system, the periphery part by means of the TEOAE and the central part through the AABR, in order to help the individuals and their communication[12].

Most of the studies considered the prevalence of severe to profound hearing loss[13], and the exact prevalence of hearing loss in all levels is not known yet in Brazil due to the few number of services implemented in the country[14].

Even with the variables, the Joint Committee on Infant Hearing[7], the GATANU and other world organizations recognize the importance of neonatal hearing screening, studying and discussing, as from the year 2000, the feasibility of each TEOAE and AABR tests used to detect hearing alterations, considering the main advantages and disadvantages; and the cost of each or both procedures for the institution implementing the neonatal hearing screening[15-20].

The present investigation followed the protocol implemented by GATANU[11] for neonatal screening using the option of re-testing in case of "failure" in the first assessment, before referring the baby for further diagnosis. We agree that there are cases of false-positive results, and we also included AABR testing in the group of babies from the regular nursery[21-22].

The study used the recording by statistical analysis, and we observed a quick response capture by both TEOAE[22] and AABR[23]. As for the latter test, we noticed only the wave V for non-linear click-type stimuli[24] at the fixed intensity of 35 dB HL[25].

The newborns from regular nurseries were assessed at the age of 48 to 64 hours of life, in agreement to what is described in the literature, in which the authors recommend newborn hearing screening after 24 hours of life[26] with better results at the TEOAE, which are achieved after 36 hours of life[27] and with lower rates of failure and retesting when this age is above 48 hours[22].

According to the results described on Table 1, 94.7% of newborns had a "pass" result on the TEOAE and 96% passed the AABR in the group analyzed; and there was no statistically significant difference among the results of the two tests for the group of newborns from the regular nursery. This value is within the 80 to 100% of the reference for TEOAE and above 84% for the AABR test, found in studies searched in the literature[8]. In the present investigation six newborns who did not respond to the AABR were part of the group of the eight who "failed" the TEOAE. All newborns were submitted to both tests, TEOAE and AABR. The two tests were carried out, coinciding with our findings in this study[21], which used the same protocol in 99% of the newborns.

The group of newborns from the NICU was assessed between 48 hours and 25 days of life and they were found in a good state of health, right before their hospital discharge following all the recommendations from the literature of corrected age above 33 weeks to obtain more reliable responses[28]. From all newborns assessed, 87.1% responded to the TEOAE and 80% responded to the AABR, and there was no statistically significant difference between the two tests for this group; however, the values were all below 94%[29]. Nine newborns did not respond to TEOAE or AABR, and two did not respond to AABR only. All newborns who failed had their guardians instructed to return for test repetition, even when they failed only the AABR, in order to eliminate false-positives[27].

The newborns from the regular nursery and from the NICU who passed the test were free from follow-up, as long as the response received for the hearing thresholds was equal to or below 30 dB HL[28,30-31].

In the present investigation, we found a higher occurrence of individuals who passed TEOAE and AABR tests among the babies from the regular nursery than those from the NICU, in agreement with the findings by Thompson et al.[17] who reported a higher number of individuals "passing" the tests from the regular nursery in both tests.

The parents of the newborns who presented altered response in at least one ear and in one of the tests (TEOAE or AABR), in the screening were instructed to return for a retesting within 30 days[9,11,16,21].

Analyzing Tables 3 and 4 and comparing only the TEOAE tests (Table 3) between the groups of newborns, we noticed TEOAE responses in 94.7% of newborns from the regular nursery and in 87.1% of babies from the neonatal ICU. In the AABR test (Table

4), the group from the regular nursery presented 96% and the group from the NICU 87.1%, of "passing" responses, and statistically significant difference was seen in both analyses, although the newborns from the NICU were days older than their counterparts from the regular nursery.

All newborns from the regular nursery and from the NICU who "failed" their first test returned for a second assessment, within an average of 15 days, after the first screening, in agreement with the papers published which emphasize the importance of newborn follow-up[32] and parent education[7]. Among the newborns from the regular nursery (Table 5), 87.5% of the group tested "passed" the TEOAE and the AABR tests, and 12.5% of newborns did not show responses in both the TEOAE and the AABR tests.

In the group of newborns from the NICU, among ten that "passed" the TEOAE and nine who passed the AABR, only one neonate did not respond to both procedures and there was another one who passed the TEOAE but failed the AABR (Table 6). There was no statistically significant difference in both tests; however, as mentioned in other studies, each one is able to rule out changes in different regions of the auditory system, and TEOAEs are used to test the peripherical system, while AABR tests the central portion of the brainstem[12]. The newborns who "failed" only one of the tests or both were referred to further diagnostic procedures.

Although the present investigation shows results similar to those found in the literature, stating that a "failure" in the first test can be transitory[28], for the size of the sample size of both groups, it is necessary to continue to apply these tests in studies with larger populations. Many authors reported that vernix and amniotic fluid, which have not been eliminated by newborns in their first hours of life, can interfere in auditory screening[28,33]; probe size can interfere in response capture[20], and even body temperature can impact the AABR[34]. These factors may justify the results obtained in this study as far as "failures" in the first assessment are concerned.

In the literature studied, we found acceptability index of "failure" for TEOAE and AABR tests of 3%[35] and 2 to 6%[16]; however, none of them mentioned if the index had been considered when only the first test was analyzed or when the assessment was performed just before, referring the baby for further diagnostic tests. We stress that in our study, these rates were of 5.3% for TEOAE and of 4% for AABR in the group from the regular nursery; and of 12.9% and 15.7%, respectively in the group of NICU in the first test, these figures dropped significantly after the second test.

CONCLUSIONS

Based on the analysis of the results obtained from the present investigation, we conclude that: the TEOAE and AABR tests in sequence could be applied to all newborns from a regular nursery and a NICU, showing similar results when analyzed separately or in groups; the group from the regular nursery presented a higher rate of "pass" responses on TEOAE and on AABR when compared to the group from the NICU; despite the equivalence of "pass" and "fail" results observed in the TEOAE and AABR tests in neonatal auditory screening, their use in combination suggests higher precision in identifying hearing alterations; the efficacy of the neonatal auditory screening service is directly associated to the investigation of the history of the newborn and to technical knowledge of the examiner.

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Appendix 1

Risk factors for hearing loss in newborns (Joint Committee on Infant Hearing)(9):

1. Family history of hereditary sensorineural hearing loss. Maternal consanguinity.
2. Congenital infections (rubella, syphilis, cytomegalovirus, herpes and toxoplasmosis).
3. Craniofacial malformations, including those of the pinna and the external acoustic meatus.
4. Birth weight below 1,500 g.
5. Hyperbilirubinemia – exchange transfusion.
6. Ototoxic medication (aminoglycosides, association with diuretic, chemotherapeutic agents).
7. Bacterial meningitis.
8. Apgar score of zero in the first minute, failure in spontaneous breathing for more than ten minutes.
9. Mechanical ventilation.
10. Syndromes.
11. Maternal alcoholism or use of psychotropic agents during gestation.
12. Ventricular hemorrhage.
13. Permanence in the incubator for more than seven days.

Appendix 2

HOSPITAL E MATERNIDADE VOLUNTÁRIOS

Mother's name: _____

Date of birth: ____/_____/_____ time of birth: _____

Test Date: _____/_____/_____ Test time: _____

Test carried out:

Equipment used: Accuscreen Pro

The test was carried out with the newborn on _____.

TEOAE – Transient Evoked Otoacoustic Emissions:

Right ear: ( ) Present. Left ear: ( ) Present.

( ) Absent. ( ) Absent.

Artifact_____ stability: _____ Artifact_____ stability: _____

AABR screening – Brainstem evoked auditory potential:

Right ear: ( ) Present. Left ear: ( ) Present.

( ) Absent ( ) Absent.

COCHLEA-EYELID REFLEX:

( ) Present ( ) Absent

Note:

TEOAE – Analyzes cochlear activity in the frequencies of 1.4 to 4 kHZ at the intensity of 25-30 dB HL.

AABR – Analyzes Brainstem auditory responses in the frequencies of 2 to 4 kHz at the intensity of 35 dB HL.

RESPONSE PRESENT: The result shows that the newborn presented functional auditory response for the test carried out.

RESPONSE ABSENT: approximately 3% of newborn babies can present, in their first test, no response to the test because of vernix/amniotic fluid or because of hearing dysfunction. Therefore, a new test will be carried out on _____/_____/_____.

Follow the development of your baby. Should you have any doubt, please visit a specialist.