

Characterization of otoacoustic emission services carried out in hospital graduate internship

Caracterização dos atendimentos de emissões otoacústicas realizados em estágio de graduação hospitalar

Caracterización de las consultas sobre emisiones otoacústicas realizadas por el graduado en prácticas hospitalaria

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Abstract

Introduction: Otoacoustic Emissions (OAE) is a simple and quick auditory sensory assessment, with neonatal hearing screening (NHS) as its main clinical application. In 2012, the Ministry of Health (MH) developed the Neonatal Hearing Screening Care Guidelines, with the aim of offering guidance to multidisciplinary teams for the care of hearing health in childhood, especially NHS. **Objective:** To characterize OAE exams performed on newborns during hospital graduation in relation to the general guidelines. **Method:** Descriptive, retrospective and cross-sectional study, with tabulated items from the exams performed. The tabulation contained the following data: date and place of the test and/or retest; date of birth, sex and weight of the baby; mother's age; type of birth; gestational age; existence and type of hearing impairment risk indicators; results; referrals for retesting for examination of the Brainstem Auditory Evoked Potential (ABR) and auditory monitoring. **Results:** 72 exams were performed, 76.39% passed and 23.71% failed. Of these failures, 58.82% passed the retest, 23.53% failed and were sent to the ABR, 11.77% did not attend the retest and 5.88% presented risk and were sent directly to the ABR. In the sample, 16.67% were found to be risk indicators, 50.00% of which were due to syphilis infection.

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Authors' contributions:

MVL: contributed on the study conception, methodology, critical revision and orientation.

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Conclusion: We concluded that the internship activities partially followed the guidelines of the MH guidelines, however, for the newborn at risk, due to the lack of ABR equipment in the service, OAE was performed as the first test and referral for the auditory potential evoked in another health unit.

Keywords: Neonatal Screening; Hearing loss; Hearing; Newborn.

Resumo

Introdução: Emissões Otoacústicas (EOA) é uma avaliação sensorial auditiva simples e rápida, tendo como principal aplicação clínica a triagem auditiva neonatal (TAN). Em 2012, o Ministério da Saúde (MS) elaborou as Diretrizes de Atenção da Triagem Auditiva Neonatal, com o objetivo de oferecer orientações às equipes multiprofissionais para o cuidado da saúde auditiva na infância, em especial à TAN. **Objetivo:** Caracterizar os exames de EOA realizados nos neonatos, durante estágio de graduação hospitalar com relação às orientações gerais das diretrizes. **Método:** Estudo descritivo, retrospectivo e transversal, com itens tabulados dos exames realizados. A tabulação continha os seguintes dados: data e local da realização do teste e/ou reteste; data de nascimento, sexo e peso do bebê; idade da mãe; tipo de parto; idade gestacional; existência e tipo de indicadores de risco de deficiência auditiva (IRDA); resultados; encaminhamentos para reteste, para exame do Potencial Evocado Auditivo de Tronco Encefálico (Peate) e monitoramento auditivo. **Resultados:** Foram realizados 72 exames, 76,39% passaram e 23,71% falharam. Destas falhas, 58,82% passaram no reteste, 23,53% falharam e foram encaminhados ao Peate, 11,77% não compareceram ao reteste e 5,88% apresentaram IRDA sendo encaminhados direto para o Peate. Dos 16,67% de indicadores de risco encontrados, 50% foram por sífilis. **Conclusão:** O estudo concluiu que as atividades do estágio seguiram parcialmente as orientações das diretrizes do MS, contudo para o recém-nascido de risco, pela falta do equipamento Peate no serviço, foi realizado EOA como primeira testagem e encaminhamento para o potencial auditivo evocado em outra unidade de saúde.

Palavras-chave: Triagem Neonatal; Perda Auditiva; Audição; Recém-nascido.

Resumen

Introducción: Las otoemisiones acústicas (OAE) son una evaluación sensorial auditiva sencilla y rápida, siendo el cribado auditivo neonatal su principal aplicación clínica. El Ministerio de Salud desarrolló las Guías para el Cuidado del Tamizaje Auditivo Neonatal, con el objetivo de ofrecer orientación a equipos multidisciplinarios para el cuidado de la salud auditiva en la infancia. **Objetivo:** Caracterizar los exámenes OAE realizados a los recién nacidos durante la graduación hospitalaria en relación a las pautas generales. **Método:** Estudio descriptivo, retrospectivo y transversal. La tabulación contenía los principales datos: fecha y lugar de la prueba y/o reprobación; fecha de nacimiento; edad gestacional; existencia y tipo de indicadores de riesgo de deficiencia auditiva (IRDA); resultados; derivaciones para volver a realizar pruebas, para examinar el potencial evocado auditivo del tronco encefálico (ABR) y la monitorización auditiva. **Resultados:** Se realizaron 72 exámenes, el 76,39% aprobó y el 23,71% suspendió. De estos reprobados, el 58,82% pasó, el 23,53% suspendió y fue enviado a la ABR, el 11,77% no asistió al reexamen y el 5,88% presentó IRDA y fue enviado directamente a la ABR. En la muestra se encontró que el 16,67% eran indicadores de riesgo. **Conclusión:** El estudio concluyó que las actividades de pasantía siguieron parcialmente los lineamientos de las guías del MS, sin embargo, para el RN en riesgo, debido a la falta de equipos ABR en el servicio, se realizó OAE como primera prueba y derivación para el potencial auditivo evocado en otra unidad de salud.

Palabras clave: Cribado neonatal; Pérdida auditiva; Audición; Recién nacido.

INTRODUCTION

The internship for students is defined as: *supervised school educational activity, developed in the work environment, which aims to prepare students who are attending regular education in higher education institutions for productive work* (Law no. 11,788/2008, which provides for student internships)¹. Thus, preparing students to carry out professional activities through practice in various types of internships is one of the duties of Higher Education Institutions (HEIs).

The otoacoustic emissions (OAE) test is a simple, objective and quick auditory sensory evaluation, whose main clinical application is neonatal hearing screening (NHS).^{2,3,4} The automatic brainstem auditory evoked potential (AABR) or screening mode is another test also indicated for the neonatal hearing screening program.^{2,3}

OAEs are the mechanical energy produced by the rapid contraction of the outer hair cells present in the cochlea in the inner ear, which propagates through the middle ear to the external auditory canal. There are two types of otoacoustic emissions: spontaneous, which occur without a stimulus in the cochlea, and evoked, as a result of a sound stimulus. Evoked otoacoustic emissions (EOAE) are classified as transient (TEOAE) and distortion product (DPOAE), with transient being the most commonly used type for neonatal hearing screening. Both are indicated, but TEOAEs are able to identify the majority of cochlear hearing losses around 30-35 dB, i.e. mild, while DPOAEs identify moderate hearing losses.⁴

The World Health Organization (WHO) estimates that 466 million people have some degree of hearing loss (HL), of which 34 million are children. The prevalence of congenital hearing loss is estimated at 1.7/1000. This frequency can increase up to 10 times when considering subjects with signs of risk for hearing loss.⁵ Since 2010, Federal Law no. 12,303/2010 has made it compulsory for all hospitals and maternity wards to carry out OAE tests free of charge.⁶

The NHS was the result of joint actions by various public health sectors, organized by international and national reference associations in hearing health: the Joint Committee On Infant Hearing (JCIH)⁷ and the Multiprofessional Committee on Hearing Health (COMUSA).⁸ It is one of the actions that should be carried out for comprehensive

hearing health care in childhood, and is the first step in the early diagnosis of hearing loss.⁹

In 2012, the Ministry of Health, in conjunction with various areas, health techniques and scientific societies, drew up the Neonatal Hearing Screening Care Guidelines with the aim of “offering guidance to multi-professional teams for childhood hearing health care, especially Neonatal Hearing Screening, at the different points of care in the network”. They describe the general guidelines for screening, taking into account the risk indicators for hearing loss (RIHL) and recommend techniques and protocols to be used to optimize time and reach diagnosis and intervention as early as possible.⁹

According to the guidelines, screening should preferably be carried out in maternity wards in the first few days of the baby’s life, between 24 and 48 hours, and at the latest during the first month of life. During this period, it should be carried out in two stages: test and retest. The protocols chosen and the care flowchart will be directed according to the presence or absence of RIHL.⁹

The indicators considered for HL are: consanguinity, family history of permanent deafness, congenital and postnatal bacterial and/or viral infections, Apgar score of 0 to 4 in the first minute or 0 to 6 in the fifth minute, weight below 1,500 grams, craniofacial anomalies involving the temporal region, genetic syndromes associated with hearing loss, stay of more than 5 days in the Neonatal Intensive Care Unit (NICU), exposure to ototoxic drugs, hyperbilirubin with exsanguineo-transfusion, head injury, neonatal asphyxia, and chemotherapy.^{2,7,8,9,10}

According to the flowchart of the guidelines for babies without RIHL, it is recommended to carry out the EOAE test if there is no response, repeat the same test and if the failure persists, carry out the AABR or in screening mode, immediately. All of these stages are considered tests, but if there is a failure in the potential test, we move on to the retest stage. For babies with RIHL, the recommended test is the AABR or in screening mode, since the EOAE test does not identify retrocochlear hearing loss, which is more prevalent in the at-risk group. When these newborns (NB) fail, they should be retested with the same test, i.e. AABR or in screening mode.⁹

As for the equipment used to carry out the screenings, it must be calibrated and registered by



the National Health Surveillance Agency (Anvisa), in accordance with current regulations⁹.

Knowing and characterizing the care provided in health care is essential for identifying and recognizing benchmarks and quality indicators for services. Therefore, the purpose of this study was to characterize OAE exams performed on newborns during hospital graduation in relation to the general guidelines.

Method

This is a descriptive, retrospective and cross-sectional study, carried out between May and October 2023 during the Supervised Hospital Internship of the Speech and Hearing Therapy Course at Centro Universitário Lusíada - UNILUS. This study was approved by the Research Ethics Committee under no. 6.092.515.

The Hospital Supervised Internship is a curricular subject that is held in partner public hospitals once a week, with a workload of 6 hours. In this internship, students in the 4th year of the Speech and Hearing Therapy degree carry out the NHS through the Transient Otoacoustic Emissions (TEOAE) test, popularly known as the “Little Ear Test”. Before starting the internship and practicing with the neonates, the students had access to the theoretical content and underwent training by applying the test to each other, as well as filling in the protocols under the supervision of the internship professor.

It is important to describe how hearing screening was carried out in the maternity ward in order to better understand the results obtained in this study.

At the time of data collection, there was no professional speech therapist employed at the

hospital, but a professional from another service in the municipal network came three times a week to carry out the little ear test and make the necessary referrals. Therefore, the test was only carried out four times a week, one period by the students supervised by the HEI professor and the other three by the speech therapist. All the appointments were recorded in a spreadsheet and the scheduling of tests (OAE1), retests (OAE2) and referrals was controlled by the public service speech therapist. When necessary, retesting could be carried out either by the speech therapist hired by the service or by the supervised students, due to the availability of their schedules and the neonates' discharge dates.

The babies' examinations were carried out in the rooming-in bed after 24 hours of life, when this coincided with the periods of the internship or the service's speech therapist. Babies who were discharged outside of these periods were scheduled and the tests carried out in a room in the hospital called the outpatient clinic. In the case of babies born with RIHL, three appointments were made: a return to the hospital for an OAE1 test, for the AABR at another public health unit and for hearing monitoring at the UNILUS audiology clinic.

In the first test (OAE1), in bed or in the outpatient clinic, when there was a failure in one or both ears, they were asked to return to repeat the TEOAE in approximately 15 days. If the failure in the retest (OAE2) persisted, the baby was referred for the AABR, and the screening was continued at another health unit, since the hospital did not have the equipment.

The flowchart followed was the same for both the internship at the HEI and the speech therapist who came during the other periods.



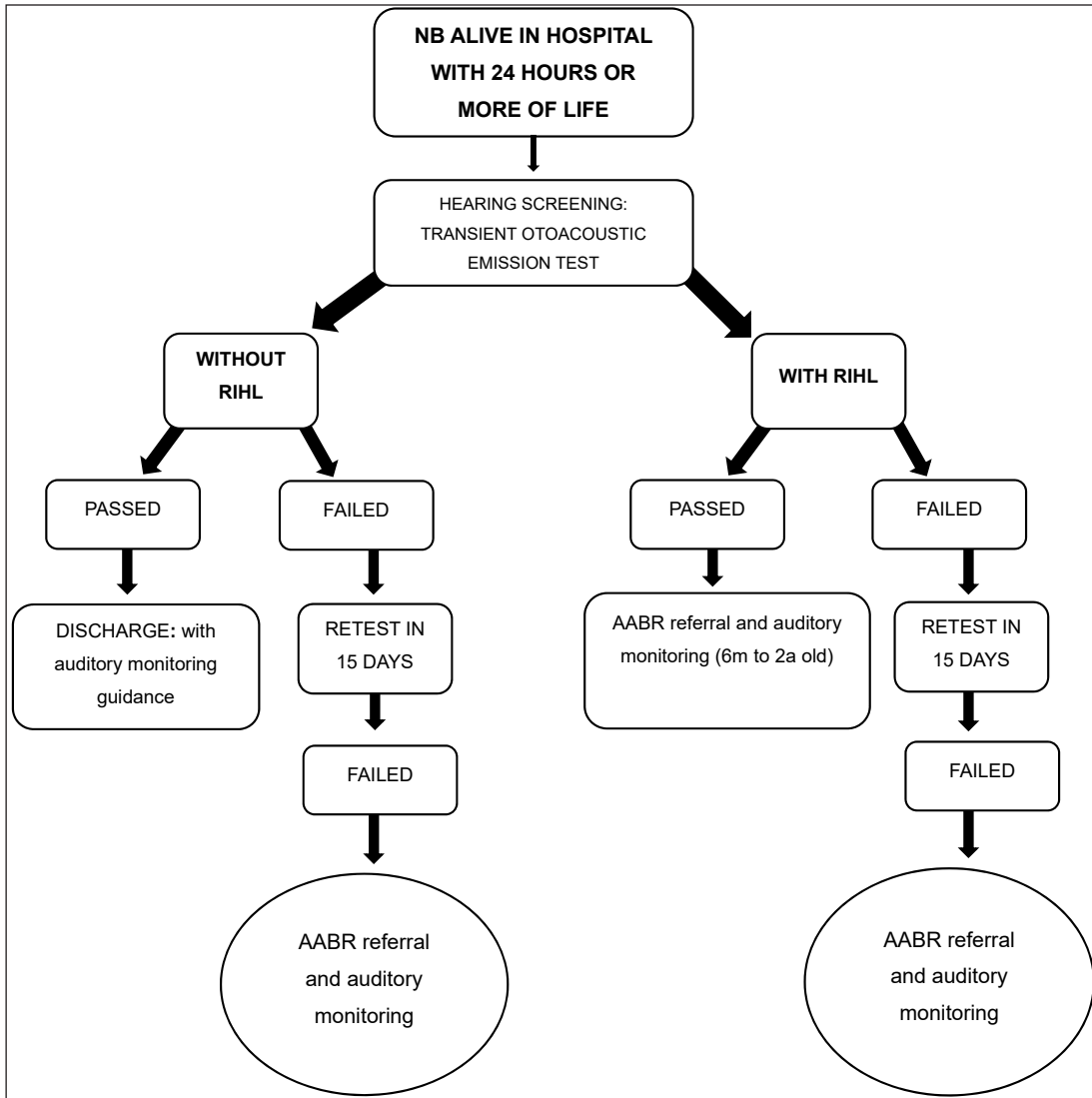


Figure 1. Neonatal hearing screening flowchart

During the internship, after the TEOAEs had been carried out, the results (passed / failed) and referrals (retest / AABR / auditory monitoring) were recorded in medical records, in the child’s card, and in all the mandatory maternity paperwork. In addition, after the appointments, the supervising professor would discuss the cases and, together with the students, enter the data collected from the completed examination protocols into spreadsheets. This tabulation was delivered monthly to the HEI’s audiology clinic and contained the following data: date of the TEOAE and location (bed or outpatient clinic) of the test (OAE1) and/or retest (OAE2),

date of birth, baby’s gender and weight, type of childbirth, gestational age, mother’s age, test result, need for retesting and referrals made (AABR and auditory monitoring). In addition, any RIHL were recorded. Thus, the research was carried out using the internship database, fed from May to October 2023.

To carry out the TEOAE tests, we used calibrated equipment from the Interacoustics brand, model Titan, serial number 0915345 with registration number 93560220062 at Anvisa. According to this equipment, the pass/fail criterion in the test considered was the presence of at least 3 frequency

bands, with reproducibility of 70% or more and a signal/noise ratio greater than 6dB.

Results

We collected and tabulated 72 OAE tests carried out during the weekly hospital stay, in different

stages of hearing screening, i.e. tests and retests, totaling 66 babies screened.

All the tests carried out in the study were dated before the first month of life, corroborating the guidelines of the Ministry of Health.

Information on the mother's age, number of pregnancies, gestational period and birth weight can be found in Table 1.

Table 1. Distribution of casualty: mother's age. number of pregnancies. gestational age. and weight of babies

Variable	Min/Max.	Média	DP
Mother's age	(16 - 45)	26.5 to	6.70
Pregnancies	(1 - 10)	2.4 to	2.13
Gestational age	(28- 45)	38.6 to	1.59
Weight of babies	(1465 kg - 4280 kg)	3.181 kg	477.52

Key: Min = minimum; Max = maximum; SD = standard deviation. Kg: Kilogram

The sample consisted of 35 male babies (53.03%) and 31 female babies (46.97%); 54 (81.82%) were born by normal birth and 12 (18.18%) by caesarean section. As for where the

tests were carried out, 34 (47.22%) were in bed and 38 (52.78%) in the outpatient clinic, as shown in Table 2.

Table 2. Distribution of casualty: type of childbirth, gender of babies, and place of testing

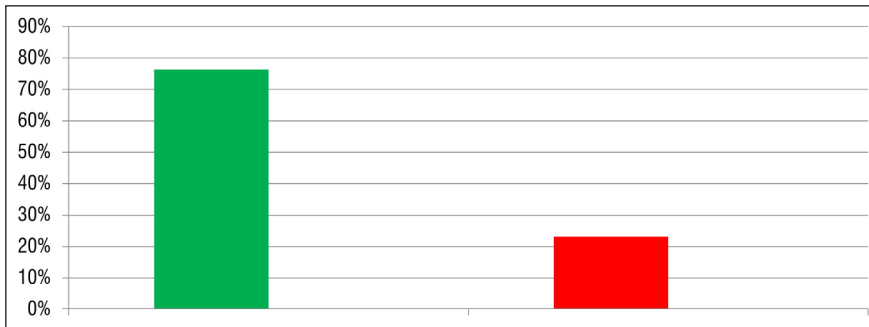
Variable	Category	N	(%)
Type of childbirth	Normal	54	(81.82)
	Cesarean section	12	(18.18)
Gender of babies	Female	31	(46.97)
	Male	35	(53.03)
Place for testing	Bed	34	(47.22)
	Outpatient	38	(52.78)

Key: N = absolute frequency; % = relative percentage frequency

Chart 1 shows the results of the tests: 55 (76.39%) passed and 17 (23.61%) failed. From these failures (Chart 2), 10 (58.82%) passed the retest, 4 (23.53%) failed again and were referred to the AABR or in screening mode; 2 (11.77%) did not show up for the retest and 1 (5.88%) had RIHL and was referred straight to the AABR exam, in order to complement the screening due to the vacation period of the internship. Of the four failures (23.53%) that persisted, two had RIHL.

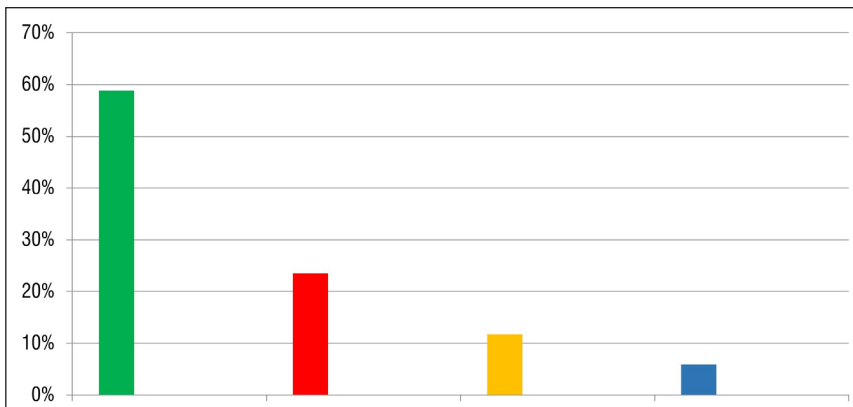
The sample showed 11 (16.67%) NBs with positive risk indicators for hearing loss one of whom had more than one risk factor. Of these 6 indicators, (50.00%) were due to syphilis infection, 4 (33.33%) due to being in the NICU for more than 5 days, 1 (8.33%) due to a family history of deafness and 1 (8.33%) due to a low Apgar score, as shown in Chart 3.

Chart 1. Distribution of neonates' results as per pass/fail criterion



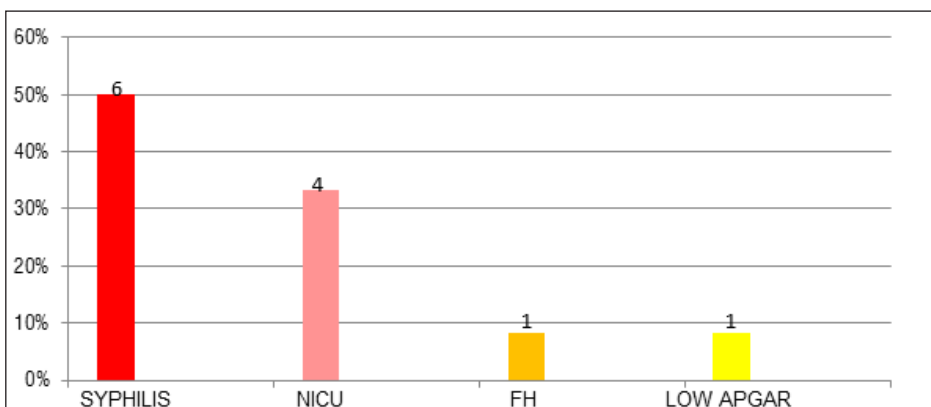
Key: Color green Pass= TEOAE response present; Color red Fail= TEOAE response absent

Chart 2. Distribution of results: retest



Key: Color Green Pass= TEOAE response present; Color Red Fail= TEOAE response absent; Color Yellow Miss= did not appear in the retest; Color Blue Referral= straight to AABR due to Risk Indicator for Hearing Impairment

Chart 3. Distribution of results: RIHL



Key: RIHL= Risk Indicator for Hearing Impairment; Color red Syphilis= Infection; Color pink NICU= Neonatal Intensive Care Unit stay for more than 5 days; Color orange F. H= Family history; Color yellow Low Apgar = 0 to 4 in the first minute or 0 to 6 in the fifth minute.

With regard to the TEOAE results of the neonates with RIHL, 9 (81.82%) passed the test and 2 (18.18%) failed (Table 3).

Table 3. Association between risk indicators and the TEOAE test result

TEOAE	PASSED	FAILED
	N (%)	N (%)
With RIHL	9 (81.82)	2 (18.18)

Key: TEOAE = transient otoacoustic emissions; N = absolute frequency; % = relative percentage frequency; Pass = TEOAE response present; Fail = TEOAE response absent; RIHL = Risk Indicator for Hearing Loss

All the neonates with RIHL, regardless of the result, were referred to another health unit to continue screening and perform the AABR, as well as for hearing monitoring at the UNILUS audiology clinic.

Discussion

This study sought to characterize the hearing health care provided in a supervised graduate internship in a hospital, according to the general guidelines of the Ministry of Health.

According to the guidelines, screening should be carried out in the first few days after birth (between 24 and 48 hours) in the maternity ward, and at the latest during the first month of life. In this study, 47.22% of the tests (OAE1) were carried out in the first few days of life, while the remaining 52.78% were scheduled to return to the hospital within 15 days. Therefore, according to the planned dates, all the tests and retests were carried out within the first month of life, as recommended by the guidelines. However, it was not possible to know whether the babies completed the screening by attending the AABR, since this final stage is carried out at another healthcare unit.

The study carried out the screening in two stages: test (OAE1) and retest (OAE2) using only the TEOAEs, due to the lack of the AABR in the service. However, according to the guidelines, the term “retest” is used after a failed AABR test. In this way, our study includes both test and retest situations, but only using the examination available at the hospital. This situation reflects the reality of services in the country, where it is not possible to

perform AABR immediately after TEOAE failures, as recommended in the Ministry of Health’s flowchart.

Brazil, as a country with diverse realities, is not always able to follow the exact recommendations of the guidelines.¹¹ It is therefore necessary for each service to be familiar with the protocols and flowcharts indicated by international and national reference associations in hearing health, in order to follow them with the least possible damage according to the availability of equipment, human resources, time, and cost.

The care flowchart for this study was defined by the presence or absence of RIHL according to the guidelines.

Chart 2 shows that all test failures were scheduled for retesting, but 2 babies (11.76%) missed the retest. The literature addresses this situation as usual in the NHS and reports that several factors compromise the low rate of attendance at retests, implying the effectiveness of the program.^{12,10,13} One study¹⁰ reported that there was a 25% dropout rate between the maternity ward and the referral for diagnosis. Another study¹² pointed to a dropout rate of 15.2% in the retesting condition. Higher dropout rates were also seen in all phases of the program, reaching 55.9%.¹³

The main justifications found to identify the reason for evasion were illnesses of the infant, distance from the home to the retest location and lack of time on the part of the parents.¹⁰ Brazilian research shows high rates of family ignorance about the importance of the NHS and many pregnant women do not receive information about the importance of screening in the prenatal period.¹² Therefore, there are several aspects involving infant health, family availability, lack of information, the relevance of the subject matter, and the organization of health services and teams. Currently, the high dropout rate from retesting can jeopardize the detection of HI and early intervention in babies, hindering good progress in the context of communication and education.¹²

Babies at risk, regardless of whether they pass or fail the TEOAE, are referred to another healthcare unit for AABR. The predominant use of TEOAEs in all stages, for all cases, and the lack of standardized protocols for performing NHS, has also been observed in other services in Brazil.¹⁴

With regard to the hearing follow-up and monitoring recommended in the guidelines, all the



mothers were instructed to monitor their children's hearing according to the WHO child hearing and language development milestones. This information was part of the feedback given by the trainees to the neonates' parents. With regard to babies at risk, the students emphasized the importance of auditory monitoring (from 6 to 24 months) and provided a written referral for an appointment at the HEI's audiology clinic. However, it is known that appointments are not made and it is estimated that this is for reasons such as: forgetfulness, lack of importance or understanding of the subject and loss of contact/referral, difficulty in mobility, and the absence of an active search.

Other studies^{10,12,15} mention the geographical location of the hospital and the fact that parents believe their child has no hearing alteration as the main reasons contributing to the gap in audiological monitoring of babies. In addition, they described the difficulties in implementing monitoring as being similar to the difficulties encountered in getting families to adhere to NHS programs. They relate this to a lack of knowledge about the importance of diagnosis and early intervention of the HI on the part of the family and the team. These obstacles have been described in both developed and emerging countries¹⁵.

The literature also points out that audiological monitoring is important because the protocols usually used in hearing screening are not capable of identifying mild, progressive and/or late hearing loss, as well as cases of false negatives.¹⁶ International recommendations advise that all children, regardless of whether or not they have a risk indicator, should be monitored. In Brazil, only newborns with RIHL are referred for monitoring, which shows that it is not yet possible to comply with the quality indicators proposed for NHS, including auditory monitoring.

In this series of 66 neonates, 16.67% of babies with RIHL, a finding similar to another study of 7,800 newborns with 12.73% of RIHL¹⁷. However, a percentage of 25.6% was found in a sample of 3,981 neonates¹⁶ and only 5.1% in 26,756 screenings¹⁸.

In the literature, there is a diversity of findings regarding the most prevalent risk factors for HI, including NICU stays of more than five days,^{10,19,20} prematurity,^{13,19,21,25} use of ototoxic medication,¹⁷ and congenital infections.¹⁸ This diversity may be related to the diagnosis of the community in which

the program is located.¹⁸ The 2022 Epidemiological Bulletin²³, of the municipality studied, Santos-SP, highlighted the annual increase in cases of acquired syphilis in pregnant women due to sexually transmitted infections. This information may explain the percentage of 50% of risk indicators for this infection found in this study.

In this study, in order to fully follow all the NHS recommendations and the flowchart proposed by the guidelines, it would be necessary to carry out the AABR at the hospital, access all the screening data and the results of referrals from the other healthcare unit, where the screening program is completed. There is still no digital data management in the municipality that allows users' information to be controlled and visualized in the various healthcare units. Therefore, this study has provided knowledge of the difficulties and inequalities that interfere with the evaluation of the NHS program.

In addition, it is important to be aware of the possibility of dropout from auditory monitoring when it is carried out in another service and to reflect on possible strategies to resolve this issue. One of them could be to establish contact with the basic healthcare units, where pediatric follow-ups are carried out monthly, to reinforce the scheduling of this monitoring. To this end, the presence of a speech therapist in these places would be essential.

It is worth noting that the failure rate found in this study may also be related to the lack of experience of the assessor (carried out by students) and the fact that this sample is a cross-section of the hearing screening service. The internship is a learning field in which the activities provide practical training in technical competencies and the development of skills and attitudes. It also showed the importance of tabulating data for research and to assess the quality of the service, encourage the search for improvements, experience teamwork, and practice professionalism.

Several studies have evaluated the NHS program based on the quality indicators recommended by the JCIH and Comusa.^{3,14,24,25} The sample for this study was limited to the care provided during the internship in accordance with the general guidelines of the Ministry of Health. In order to analyze and evaluate the NHS quality indicators, it is necessary to monitor the service for a longer period of time and collect the data in full.



Conclusion

The study concluded that the activities of the hospital internship followed the general guidelines of the Ministry of Health's Neonatal Hearing Screening Care Guidelines with regard to: being carried out between 24 and 48 hours of life in the maternity ward, taking into account the protocol with regard to the presence or absence of RIHL and using OAEs for babies with no risk of hearing loss. However, for the at-risk NB, due to the lack of AABR equipment in the service, OAE was carried out as a first test and referral was made for evoked auditory potential in another healthcare unit.

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