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Outcome of Screening for Hearing Impairment in the New Born: Hospital-Based Study

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ABSTRACT

Background and Objective: Loss of hearing is a non-visible disability (NVD) and the second most common congenital pathology. Apart from hearing loss, further disability in these domains has been reported development of language, speech, cognition, and other evolving domains. The aim of this study was to assess the outcomes of neonatal hearing screening programs in hospitals.

Methods: This retrospective study was conducted at the Department of Pediatrics and Neonatology (Southern India). The records of 426 newborns who underwent hearing screening from Jan 2020 to Jan 2021 were analyzed. All healthy newborns underwent first screening between 48-72 hours with transient evoked otoacoustic emission (TEOAE) test, and babies admitted to NICU were screened once the condition stabilized. OAE and brainstem evoked response audiometry (BERA) results were considered outcome variables, and coGuide software, V.1.03 was used for statistical analysis.

Findings: Totally, 221 out of 426 (51.88%) neonates were males, and appropriate for gestational age (AGA) babies' proportion was 381 out of 426 (89.44%) cases. Among the 37 preterm deliveries, 31(86.11%) were delivered during 34-37 weeks. Out of 426 neonates, 28(6.57%) had some risk factors. OAE-1 was referred in 30 neonates (7.04%), OAE-2 was referred in 10% (3 out of 30) and BERA was referred in 33.33% (1 out of 3).

Conclusion: The frequency of hearing loss among screened babies confirmed by BERA was 0.23% (1 out of 426). Neonatal hearing screening in hospitals can aid in early diagnosis of hearing impairment thereby enabling appropriate and timely intervention.

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Introduction

Hearing impairment is a term that covers varying degrees of hearing loss, ranging from hard-of-hearing to total deafness [1]. The inborn hearing loss is projected to be 1.2–5.7/1000 neonates [2, 3] and even greater in neonates with high risk. According to to the CDC (center for disease control and prevention) 2019 data, 1.7 / 1000 babies screened have a hearing impairment [4].

Hearing is a crucial component of speech and linguistic development in children. Hearing impairment is considered a non-visible disability (NVD) that disturbs—education, communication ability, personal success, social, quality of life and financial independence.

The causes of permanent inborn and early-onset hearing loss (PCEHL) are numerous and result in language and cognitive defects [5, 6]. Primary prevention methods like immunization, genetic counseling, and improved antenatal and perinatal care may help in reducing some of the causes. But they have a limited impact on genetic or hereditary aetiologies- connexin 26, Pendred and Usher syndromes [7, 8]. Moreover, in developing countries, there are 38–60% of children with idiopathic PCEHL, and it is rarely possible to achieve complete and effective primary prevention for them [9]. Nonetheless, according to reports, such infants can indeed develop essential language and cognitive skills provided that the condition is detected early and appropriate intervention services are provided within the first year of life [10, 11].

Newborn hearing screening programs have early identification and managing of hearing loss as their primary focus. Studies report: "newborn screening should be within one month of age, diagnosis within three months of age, and rehabilitation should be started at the age of 6 months" [12, 13]. During the key development phase (birth to 5 years), early detection and intervention should be carried out through aural habitation and speech and language therapy [1]. It has also been shown that neonatal risk factors can be linked to hearing loss [14].

Hospital-based neonatal screening employs two tests that are (i) automated auditory brain stem response (AABR) and (ii) otoacoustic emission audiometry (OAEs). Both are non-invasive recordings and can be easily in infants and neonates [15]. Professional organizations have validated these techniques as reliable and objective screening methods [14, 16]. In their study, Eiserman et al. examined the multistep screening methodology of 4,519 children aged 0–3 years and found the positive predictive value of OAE to be 67.3 percent, with an estimated negative yield of 98.9 percent [17]. To our best knowledge, there are no studies available on the outcomes of hospital-based hearing screening programs in the current study's location. Hence, this study emphasized the need for such a program in the study area. Hence the present aimed to assess the outcomes of the newborn hearing screening program in the teriary center.

Methods

Design and participants

This retrospective study was conducted at the newborn ward (newborn intensive care unit (NICU) and postnatal ward), Department of Pediatrics and Neonatology, Melmaruvathur Adhiparasakthi Institute of Medical Sciences and Research Tamilnadu-India. The records of 426 newborns screened for hearing from Jan 2020 to Jan 2021 were retrieved. Institutional ethical clearance was obtained. A universal sampling technique was followed. All available records were analyzed. Newborns were delivered to the medical college hospital and underwent hearing screening were included. Newborns were discharged within 48 hours of delivery and not returned for follow-up, and incomplete records were excluded from the study.

Data collection

Newborns were subjected to otoacoustic emission audiometry (OAE) screening in both ears as part of the hearing screening program. A trained audiologist did OAE screening in the ENT department. All healthy newborn babies underwent first screening between 48 to 72 hours with transient evoked otoacoustic emission audiometry (TEOAE), and babies admitted to NICU were screened once their condition was stabilized. The first screen was followed by the second screen at six weeks by

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TEOAE if the newborn failed at the first screen. Those who failed the second screening were given a brainstem evoked response audiometry (BERA) test at three months and recommended for further treatment.

Information like sociodemographic profile (gender, bright weight, weight based on gestational age, NICU stay, duration of stay), risk factors (hypoxic ischemic encephalopathy, hyperbilirubinemia > 20 mg/dl, hypoglycemia, hypoglycemia, perinatal depression and so on) and first screening results were collected from the newborn case record retrieved from the Medical Records Department using a case report proforma. Second screening and third test results were collected from records of the ear, nose and throat (ENT) department for those infants who underwent the above test.

OAE recording takes less than 1 min and can be accomplished without any audiological proficiency [15]. Sound stimuli are produced for the test by a tiny probe implanted in the ear canal. Sound stimuli enter the inner ear via the middle ear, resulting in emissions [18].

The probe identifies these emissions and the screening unit analyses them. The unit displays an automated "pass" or "refer" result. Such screening is highly sensitive (85-100%) and specific (91-95%) [18].

Statistical analysis

Descriptive statistics were used to analyze data following the study's objectives. Descriptive analysis was supported by mean and standard deviation for quantitative variables like NICU admission, duration of NICU stay, and mothers' age and frequency and proportion for categorical variables like the neonatal outcome (gender, birth weight and weight based on gestational age) and maternal parameters (mode of delivery, maternal disease, gestational age, and preterm), as appropriate. Data were analyzed by using coGuide V 1.03 [19].

Results

Final analysis was done for 426 subjects. Among the study neonates, 221 and 205 out of 426 (51.88%) cases were males and females, respectively, and 366 (85.92%) neonates' birth weights were between 2500-3999 grams. AGA babies were 381 out of 426 (89.44%), 153(35.92%) reported NICU stay, and the mean duration of NICU stay was 2.87 ± 2.64 days ranging between 1-15 days (Table 1).

Among the study population, 233 out of 426 (54.69%) mothers had C-sections, the mean mothers' age was 26.22±3.94 years ranging between 17-42 years, 39 (9.15%) had hypothyroidism, 18 (4.23%) had gestational diabetes,15(3.52%) had anemia, and 37(8.69%) were preterm births. Among the 37 preterm deliveries, 31(86.11%) cases were delivered during 34-37 weeks (Table 2).

Out of 426 participants, 28(6.57%) had some risk factors for developing hearing impairment, 2(0.47%) had hypoxic-ischemic encephalopathy, 3(0.70%) had hyperbilirubinemia > 20 mg/dl, 11 (2.58%) had hypoglycaemia, 6 (1.41%) had sepsis, 3(0.70%) had perinatal depression, 5(1.17%) had preterm <34 weeks and 1(0.23%) had hypothyroidism. OAE-1 was referred in 30(7.04%), right ear alone was refer in 13 (3.05%), left ear alone was refer in 2(0.47%), and 15(3.52%) had both ears as refer. OAE-2 was refer in 10% (3 out of 30), right ear alone and left ear alone was refer in 0(0%) cases where 3 out of 30 (10%) cases was refer in both ears.

BERA was refer in 33.33% (1 out of 3), right and left ear alone was refer in 0(0%) where 1 out of 3 (33.33%) cases reported refer in both ears in BERA (Table 3). The incidence of hearing loss among screened babies confirmed by BERA was 0.0023%.

Discussion

The current study evaluated the outcomes of the neonatal hearing screening program in the teriary centre. The results showed that 6.57% were high-risk babies, and among the 426 screened babies, one baby was diagnosed to have hearing impairment in both ears after performing BERA. Thus, the incidence of hearing loss among screened babies confirmed by BERA was 0.23% (1 out of 426).

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Thus, newborn hearing screening is essential; universal newborn hearing screening (UNHS) is better than screening just at-risk neonates. This method is recommended because 50% of high-risk neonates can be missed, and in universal screening, all neonates will be screened; hence, the chances of diagnosing hearing impairment are high [20]. According to the the recent study, inborn sensorineural auditory loss prevalence is 1–5/1000 babies, and this frequency can be greater in high-risk neonates [21]. In India, it is 10.2% among new borns [22]. In India, the prevalence of hearing loss in newborns ranges between 1 and 8 per 1000 infants examined, owing to methodological discrepancies between studies [21, 23, 24]. The current study found a somewhat lower incidence of hearing loss, which might be attributed to a lack of knowledge, testing for both regular and high-risk factors, and a paucity of workforce, resulting in a greater coverage area for screening and referral rate. Previous research has found that the prevalence of hearing loss is greater in rural communities than in urban populations [22] and high-risk neonates [20].

Table 1. Summary of neonatal outcome parameter (N=426)

Parameter		Summary
Gender	Male	221 (51.88%)
	Female	205 (48.12%)
Birth weight (in gram)	1500-2499 g	52 (12.21%)
	2500-3999 g	366 (85.92%)
	4000 and above	8 (1.88%)
Weight-based on gestational age	AGA *	381 (89.44%)
	SGA *	37 (8.69%)
	LGA *	8 (1.88%)
NICU # Stay		153 (35.92%)
Duration of NICU Stay(N=153)		2.87 ± 2.64 (ranged 1 to 15)

* AGA: Appropriate for gestational age, SGA: Small for gestational age, LGA: Large for gestational age,
# NICU: Neonatal intensive care unit.

Table 2. Summary of the maternal parameter (N=426)

Parameter		Summary
Mode of delivery	Normal Vaginal Delivery	152(35.68%)
	Lower Segment Cesarean Section (LSCS)	233(54.69%)
	Assisted Vaginal Delivery Forceps/Vacuum	41(9.62%)
Mothers age (in years)		26.22±3.94 (ranged 17 to 42)
Maternal Disease	Hypothyroidism	39(9.15%)
	Gestational Diabetes	18(4.23%)
	Anemia	15(3.52%)
	Gestational Hypertension	14(3.29%)
	Preeclampsia	2(0.47%)
	Urinary Tract Infection (UTI)	2(0.47%)
	Others	1(0.23%)
	No disease	335(78.64%)
Gestational age (in weeks)	Term	387(90.85%)
	Preterm	37(8.69%)
	Post term	2(0.47%)
Preterm	28 to 32 weeks	2(5.56%)
	32 to 34 weeks	3(8.33%)
	34 to 37 weeks	31(86.11%)

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Table 3. Summary of risk factors and screening outcome (N=426)

Parameter			Summary	
Risk Factors	No		398(93.43%)	
	Yes	28(6.57%)	Hypoxic Ischemic Encephalopathy	2(0.47%)
			Hyperbilirubinemia> 20 mg/dl	3(0.70%)
			Hypoglycemia	11(2.58%)
			Sepsis	6(1.41%)
			Perinatal Depression	3(0.70%)
			Preterm <34 Weeks	5(1.17%)
			Hypothyroidism	1(0.23%)
OAE-1	Pass		396(92.96%)	
	Refer		30(7.04%)	
Right Ear(alone)	Pass		413(96.95%)	
	Refer		13(3.05%)	
Left Ear(alone)	Pass		424(99.53%)	
	Refer		2(0.47%)	
Both Ears	Pass		411(96.48%)	
	Refer		15(3.52%)	
OAE *-2 (N=30)	Pass		27(90%)	
	Refer		3(10%)	
Right Ear alone (N=27)	Pass		27(100%)	
	Refer		0(00%)	
Left Ear alone (N=27)	Pass		27(100%)	
	Refer		0(00%)	
Both Ears (N=30)	Pass		27(90%)	
	Refer		3(10%)	
BERA # (N=3)	Pass	2(66.67%)		
	Refer	1(33.33%)		
Right Ear alone (N=2)	Pass	2(100%)		
	Refer	0(0%)		
Left Ear alone(N=2)	Pass	2(100%)		
	Refer	0(0%)		
Both Ears (N=3)	Pass	2(66.67%)		
	Refer	1(33.33%)		

* OAE- otoacoustic emissions, # BERA- brainstem evoked response audiometry

Hearing aids, cochlear implants, auditory training, and speech and language therapy are all viable management options for the hearing impaired [25]. For bilateral severe to profound hearing loss with normal auditory nerve activity, a cochlear implant is advised. As a result, in the current investigation, one person identified with bilateral severe to profound hearing loss according to BERA was advised to use a hearing aid with a future plan for a cochlear implant. Cases with OAE-1 and -2 were referred for further evaluation. All high-risk newborns who passed hearing test were recommended to have regular follow-ups at 3, 6, and 12 months since it might cause late-onset or progressive hearing loss. In the prior study, a similar follow-up approach was proposed [27]. Follow-up is a major concern in newborn hearing screening programmes for a variety of reasons, including a change of address, difficulty contacting, rural population, poor parental response, illiteracy, and lower economic status. As a result of these difficulties, early hearing loss and deferred speech and language development may be missed. To boost the rate of follow-up, speech therapy and milestone performance lists were supplied.

Limitations of the study

The constraint of the current study is that it was an experience at a single hospital with limited sample size. Hence, multi-centric studies with large

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populations, including high-risk babies, are recommended in the future.

Conclusion

The screening protocol with OAE and BERA has shown that hearing screening will aid in early diagnosis, and hospitals should adopt newborn hearing screening programs.

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Ethical approval

Institutional ethical clearance was obtained

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Conflict of interest

There was no conflict of interest.

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