

## Assessment of the Prevalence and Risk Factors of Hearing Loss using Measurements of Otoacoustic Emission (OAE) in Newborns Admitted to NICU at Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar.

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### Abstract

**Aim:** The aim of the present study was to assess the prevalence of hearing loss using measurements of otoacoustic emission (OAE) in newborns admitted to NICU in department of pediatrics, Anugrah Narayan Magadh Medical College and hospital, Gaya Bihar (ANMMCH, Gaya, Bihar) and to determine the risk factors predictive of hearing impairment in these newborns.

**Methods:** This was a hospital-based prospective observational study carried out among the neonates admitted to NICU at ANMMCH, Gaya Bihar. Parents or guardians were counselled regarding the OAE screening test. A total of 200 neonates were included.

**Results:** Out of a total of 200 study participants, there were 34 (17%) patients who were referred after the initial screening. Out of which there were 24 (12%) patients who had hearing loss at 4 weeks after rescreening. In the present study among the total participants (200), the majority were males. A majority of the participants had a weight range between 1.5 to 2.0 kg, followed by 1.0 to 1.5 kg. Out of all the participants, 110 (55%) had a normal vaginal delivery, and 90 (45%) had LSCS. Among the newborns, 50 (25%) had a history of assisted ventilation, and 10 (5%) of them had hearing loss. Additionally, 50 newborns (25%) had a history of ototoxic medications, and 10 (5%) of them had hearing loss. Out of 14 (7%) patients who had a history of neonatal jaundice requiring exchange transfusion, 4 (2%) had hearing loss.

**Conclusion:** According to our study, the rate of hearing problems among high-risk newborns admitted to the neonatal intensive care unit (NICU) was 12%. We found preterm and low birth weight babies, perinatal asphyxia, culture-positive sepsis, and male gender as risk factors for hearing loss in the newborn period. It's the need of the hour to address these risk factors in preventing hearing impairment among neonates admitted to NICU and Successful implementation of universal newborn hearing screening should be the goal of every nation. It is important to establish good practices and promote teamwork among healthcare professionals in order to prevent risk factors that may cause hearing loss.

**Keywords:** otoacoustic emission, Hearing screening, Newborn hearing impairment

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### Introduction

Early screening and detection of hearing loss in infants and children to intervene and reduce the adverse effects of hearing loss are essential. Delay in the process of diagnostic hearing loss will lead to adverse consequences on the development of the child's speech-language and cognitive skills. [1] More than 80% of hearing loss in children is congenital or occurs in infancy. Bilateral deafness is

reported in 1-3% of births and in 2-4% of neonates in the intensive care unit, which is more common than disorders such as congenital hypothyroidism and phenylketonuria. [2] The frequency of hearing loss in high-risk infants is 10-20 times [3] and sometimes even 10-50 times [4] higher than infants without risk factors for hearing loss. In 1994, 2000, and 2007, the Joint Committee of Infant Hearing

(JCIH) published the risk factors for hearing loss and set standards for the identification of hearing loss. [5]

Significant hearing loss present at birth is one of the most common major disabilities. It is well recognized that unidentified hearing loss can adversely affect optimal speech and language development, acquisition of literacy skills, and academic, social and emotional development. The risk is even more in a country like India where infrastructure is abysmally inadequate for prevention and remediation. Early detection can prevent further disabilities in speech, language and cognition in the child's development. It is established that hearing loss, if present, should be detected before the infant is 6 months old. [6] Ideally, efforts should be made to organize Universal newborn hearing screening because up to 42% of profoundly hearing impaired children may be missed using only risk-based screening. However short of universal screening, high risk screening should be mandatory. [7]

For the development of speech and language skills, Auditory stimulation during the first 6 months of life is critical. [8] The factors that are expected to affect the normal development of speech and language skills that will eventually also predict cognitive development in children include hearing capacity, mild to profound degree of Hearing Impairment (HI), age of identification of hearing loss, age of intervention, aided audibility, duration, consistency of hearing aid use, and characteristics of the child's language environment. To mitigate its adverse effects on the development of cognitive, psychological and verbal communication skills, early detection of HI accompanied by a timely and efficient intervention is necessary. [9] Multiple studies have shown that infants who obtain intervention before the age of 6 months have better school results, improved Vocabulary and communication skills by ages 2–5 years. [10]

The aim of the present study was to assess the prevalence of hearing loss using measurements of otoacoustic emission (OAE) in newborns admitted to NICU and to determine the risk factors predictive of hearing impairment in these newborns.

### Materials and Methods

This was a hospital-based prospective observational study carried out among the neonates admitted to NICU, Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India between January 2022 to December 2022 (one year). Parents or guardians were counselled regarding the OAE screening test.

### Inclusion Criteria

High-risk neonates with the family history of hereditary childhood sensorineural hearing loss, in utero infections (Toxoplasmosis, Rubella, Cytomegalovirus, Herpes simplex virus infections, and Syphilis), craniofacial anomalies, low birth weight <2500 g, hyperbilirubinemia (at serum levels requiring exchange transfusion), use of ototoxic medications, bacterial meningitis, perinatal asphyxia (APGAR of 5 at 1 min or of 6 at 5 min), mechanical ventilation lasting 5 days or longer and stigmata or other findings associated with a syndrome known to include a sensorineural hearing loss were included in the study.

### Exclusion Criteria

Neonates with congenital external ear malformation precluding the use of OAE as a screening tool those who expired before the screening test was conducted, those who were referred to higher centre for urgent intervention and neonates whose guardians did not provide consent for participation in the study were excluded from study.

### Study Population

During the study period, all neonates who were admitted to the NICU at Anugrah Narayan Magadh Medical College and Hospital, Gaya, Bihar, India and met the inclusion criteria were included in the study. A total of 200 neonates were included.

### Data Collection

The study was carried out after obtaining approval from the institutional ethics committee. The parents/guardians were explained about the purpose and nature of the study in the language they understand. Written informed consent was obtained from the guardians willing to participate in the study. The mother/parent was interviewed; the mother and baby's records were reviewed and the babies were examined to ensure that inclusion and exclusion criteria were satisfied.

Data was collected by a screening test called OAE [Oto- acoustic Emission] in the neonatal intensive care unit. OAE are low-intensity sounds produced by the outer hair cells of a normal cochlea. The outer hair cells travel in a reverse direction: outer hair cells, basilar membrane, perilymph, oval window, ossicles, tympanic membrane, and ear canal. OAEs are present when the outer hair cells are healthy and absent when they are damaged. Therefore, OAEs help to test the function of the cochlea.

Information about the condition of each neonate was collected in the form of a questionnaire and included: gestational age; family history of congenital hearing loss and consanguinity; presence of risk factors including birth asphyxia, sepsis, respiratory distress syndrome, transient tachypnea of

newborn (TTN), congenital pneumonia, congenital heart disease (CHD), or hyperbilirubinemia requiring exchange transfusion; mechanical ventilation (>5 days), antibiotic therapy including aminoglycosides or oxygen therapy (>1 week and >40% FiO<sub>2</sub>), OAE results were noted and findings of general physical and systemic examination were entered in the predesigned proforma. Other factors associated with hearing impairment were noted.

The results of the OAE test (pass or refer) in both ears were noted and correlated with the number of associated risk factors. Follow-up of those babies

was done who did not pass the OAE test after 4 weeks.

### Statistical Analysis

Statistical analysis was done using the computer software SPSS 20. Data was expressed in frequency and percentage. To elucidate the associations the chi-square test and student's t test were used. For all statistical evaluations, a two-tailed probability of value, <0.05 was considered significant.

### Results

**Table 1: Distribution of patients based on results of initial screening of OAE and rescreening at 4 weeks**

OAE initial screen	N (%)
Pass	166 (83)
Refer	34 (17)
OAE rescreen of initial refer cases after 4 weeks	
Pass (no hearing loss)	10 (5)
Refer (hearing loss present)	24 (12)

Out of a total of 200 study participants, there were 34 (17%) patients who were referred after the initial screening. Out of which there were 24 (12%) patients who had hearing loss at 4 weeks after rescreening.

**Table 2: Association of hearing impairment with age, sex, weight, and type of delivery**

Hearingloss	Present (Refer in OAE test), n (%)	Absent (Pass in OAE test), n (%)	p value
<b>Sex</b>			
Male	14 (7)	80 (40)	0.316
Females	10 (5)	96 (48)	
<b>Mode of delivery</b>			
LSCS	12 (6)	78 (39)	0.343
Vaginaldelivery	12 (6)	98 (49)	
<b>Gestational age (Weeks)</b>			
<34	10 (5)	32 (16)	0.07
>34	14 (7)	144 (72)	
<b>Birth weight (gram)</b>			
<1500	8 (4)	36 (18)	0.220
>1500	16 (8)	140 (70)	

In the present study among the total participants (200), the majority were males. A majority of the participants had a weight range between 1.5 to 2.0 kg, followed by 1.0 to 1.5 kg. Out of all the participants, 110 (55%) had a normal vaginal delivery, and 90 (45%) had LSCS.

**Table 3: Association of hearing impairment with perinatal and natal factors**

Hearingloss	Present (Refer in OAE test), n (%)	Absent (Pass in OAE test), n (%)	p value
<b>H/O perinatal asphyxia</b>			
Yes	20 (10)	64 (32)	<0.001
No	4 (2)	112 (56)	
<b>H/O assisted ventilation</b>			
Yes	10 (5)	40 (20)	0.007
No	14 (7)	136 (68)	
<b>H/O ototoxic medication</b>			
Yes	10 (5)	40 (20)	0.005
No	14 (7)	136 (68)	
<b>Neonatal jaundice requiring exchange transfusion</b>			
Yes	4 (2)	10 (5)	0.003
No	20 (10)	166 (83)	

APGAR score at 5 mins			
<7	16 (8)	44 (22)	<0.001
>7	8 (4)	132 (66)	
H/o culture-positive post-natal infection			
Yes	10 (5)	20 (10)	<0.001
No	14 (7)	156 (78)	
H/o intrauterine infections			
Yes	1 (0.5)	10 (5)	0.240
No	23 (11.50)	166 (83)	
Family history of childhood hearing loss			
Yes	0 (0)	10 (5)	NA
No	24 (12)	166 (878)	
Syndromes or anomalies associated with hearingloss			
Yes	1 (0.5)	6 (3)	0.50
No	23 (11.50)	170 (85)	

Among the newborns, 50 (25%) had a history of assisted ventilation, and 10 (5%) of them had hearing loss. Additionally, 50 newborns (25%) had a history of ototoxic medications, and 10 (5%) of them had hearing loss. Out of 14 (7%) patients who had a history of neonatal jaundice requiring exchange transfusion, 4 (2%) had hearing loss.

### Discussion

Hearing impairment in children is a serious problem that can affect their optimal development and education, especially their language acquisition. Approximately 0.5-6 in every 1000 neonates and infants are born with congenital or early childhood onset sensorineural deafness or severe-to-profound hearing impairment, and this can have significant consequences for their lives. Therefore, early detection is essential to provide appropriate support for deaf and hearing-impaired babies to ensure they have the same opportunities as other children in society. [11] High-risk screening can miss nearly 50% of deaf children. Therefore, universal screening is indispensable in identifying early deafness. [12]

Out of a total of 200 study participants, there were 34 (17%) patients who were referred after the initial screening. Out of which there were 24 (12%) patients who had hearing loss at 4 weeks after rescreening. In the present study among the total participants (200), the majority were males. The findings are similar to the study conducted by Pourarian et al. [13] A majority of the participants had a weight range between 1.5 to 2.0 kg, followed by 1.0 to 1.5 kg. According to Amini et al [14] abnormal OAE was found in those newborns born with birth weight between 1.7-2.3 kg. Out of all the participants, 110 (55%) had a normal vaginal delivery, and 90 (45%) had LSCS which is correlating to a study done by Güven et al. [15]

Among the newborns, 50 (25%) had a history of assisted ventilation, and 10 (5%) of them had hearing loss. Additionally, 50 newborns (25%) had a history of ototoxic medications, and 10 (5%) of

them had hearing loss related to a study done by Maqbool et al [16] and the study done by Bielecki et al. [17] Out of 14 (7%) patients who had a history of neonatal jaundice requiring exchange transfusion, 4 (2%) had hearing loss. The showed that there was no positive correlation between intrauterine infection and hearing loss but there was a positive correlation between culture-positive post- natal infection and hearing loss in newborns, and related to a study done by Maqbool et al [16] and study done by Coenraad et al. [18]

According to Recchia et al [19], the use of ototoxic drugs is one of the causes of hearing loss in infants hospitalized in the NICU. A pilot study in India has shown that screening of only at risk neonates can miss detection of 70% of the newborns with hearing impairment. If the resources are limited, then one could focus initially on at risk neonates and gradually implement universal screening. [20]

### Conclusion

According to our study, the rate of hearing problems among high-risk newborns admitted to the neonatal intensive care unit (NICU) was 12%. We found preterm and low birth weight babies, perinatal asphyxia, culture-positive sepsis, and male gender as risk factors for hearing loss in the newborn period. It's the need of the hour to address these risk factors in preventing hearing impairment among neonates admitted to NICU and Successful implementation of universal newborn hearing screening should be the goal of every nation. It is important to establish good practices and promote teamwork among healthcare professionals in order to prevent risk factors that may cause hearing loss.

### References

1. Jakubíková J, Kabátová Z, Pavlovcinová G, Profant M. Newborn hearing screening and strategy for early detection of hearing loss in infants. *Int J Pediatr Otorhinolaryngol.* 2009 Apr;73(4):607-12.

2. De Capua B, De Felice C, Costantini D, Bagnoli F, Passali D. Newborn hearing screening by transient evoked otoacoustic emissions: analysis of response as a function of risk factors. *Acta Otorhinolaryngol Ital.* 2003 Feb;23(1):16-20.
3. ZAMANI A, DANESHJOU K, Ameni A, Takand J. Estimating the incidence of neonatal hearing loss in high risk neonates.
4. Ohl C, Dornier L, Czajka C, Chobaut JC, Tavernier L. Newborn hearing screening on infants at risk. *Int J Pediatr Otorhinolaryngol.* 2009 Dec;73(12):1691-5.
5. Bielecki I, Horbulewicz A, Wolan T. Risk factors associated with hearing loss in infants: an analysis of 5282 referred neonates. *Int J Pediatr Otorhinolaryngol.* 2011 Jul;75(7):925-30.
6. Paul AK. Early identification of hearing loss and centralized newborn hearing screening facility-the Cochin experience. *Indian pediatrics.* 2011 May;48(5):355-9.
7. Evidence based clinical practice guidelines. National Neonatology Forum, India. October 2010.p. 265-270.
8. Galhotra A, Sahu P. Challenges and solutions in implementing hearing screening program in India. *Indian Journal of Community Medicine.* 2019 Oct 1;44(4):299-302.
9. Roth DA, Hildesheimer M, Maayan-Metzger A, Muchnik C, Hamburger A, Mazkeret R, Kuint J. Low prevalence of hearing impairment among very low birthweight infants as detected by universal neonatal hearing screening. *Archives of Disease in Childhood-Fetal and Neonatal Edition.* 2006 Jul 1;91(4):F257-62.
10. Kumar S, Mohapatra B. Status of newborn hearing screening program in India. *Int J Pediatr Otorhinolaryngol* 2011;75(1):20-6.
11. Declau F, Boudewyns A, Van den Ende J, Peeters A, van den Heyning P. Etiologic and audiologic evaluations after universal neonatal hearing screening: analysis of 170 referred neonates. *Pediatrics.* 2008;121(6):1119-26.
12. Nagapoornima P, Ramesh A; Srilakshmi, Rao S, Patricia PL, Gore M, Dominic M; Swarnarekha. Universal hearing screening. *Indian J Pediatr.* 2007;74(6):545-9.
13. Pourarian S, Khademi B, Pishva N, Jamali A. Prevalence of hearing loss in newborns admitted to neonatal intensive care unit. *Iranian journal of otorhinolaryngology.* 2012; 24(68):129.
14. Amini E, Farahani ZK, Samani MR, Hamed H, Zamani A, Yazdi AK, Nayeri F, Nili F, Rezaeizadeh G. Assessment of hearing loss by OAE in asphyxiated newborns. *Iranian Red Crescent Medical Journal.* 2014 Jan;16(1).
15. Güven SG. The effect of mode of delivery on newborn hearing screening results. *Turk Arch Otorhinolaryngol.* 2019;57(1):19.
16. Maqbool M, Najjar BA, Gattoo I, Chowdhary J. Screening for hearing impairment in high risk neonates: a hospital based study. *Journal of clinical and diagnostic research: JCDR.* 2015 Jun;9(6):SC18.
17. Bielecki I, Horbulewicz A, Wolan T. Risk factors associated with hearing loss in infants: an analysis of 5282 referred neonates. *Int J Pediatr Otorhinolaryngol.* 2011;75(7):925-30.
18. Coenraad S, Goedegebure A, Van Goudoever JB, Hoeve LJ. Risk factors for sensorineural hearing loss in NICU infants compared to normal hearing NICU controls. *Int J Pediatr Otorhinolaryngol.* 2010;74(9):999-1002.
19. Rechia IC, Liberalesso KP, Angst OV, Mahl FD, Garcia MV, Biaggio EP. Intensive care unit: results of the Newborn Hearing Screening. *Braz J Otorhinolaryngol.* 2016 Jan-Feb;82(1):76-81.
20. Nagapoornima P, Ramesh A, Srilakshmi, Rao S, Patricia PL, Gore M, Dominic M, Swarnarekha. Universal hearing screening. *The Indian Journal of Pediatrics.* 2007 Jun;74:545-9.