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Original Research Article

Universal newborn hearing screening program – success story or a burden: experience from a tertiary care centre in North India

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ABSTRACT

Background: Aim of the study was to find out the prevalence of congenital hearing loss in a tertiary care hospital in North India under the Universal Neonatal Hearing Screening Program, with a specific focus on identifying the association between neonatal hearing loss and neonatal intensive care unit (NICU) admission, low birth weight, or advanced maternal age.
Methods: A prospective cohort study of all newborns in a tertiary care center over 1.5 years.
Results: A total of 2891 babies were born during the study period, of which 2693 underwent newborn hearing screening, of which 2.4% (n=7) were detected to have neonatal hearing loss. Among the neonates admitted to NICU (n=76), a total of 2.7% (n=2) were confirmed to have hearing loss. None of the babies with low birth weight or with a history of advanced maternal age (>35 years) were detected to have hearing loss.
Conclusions: Our study primarily dealt with evaluating the key outcomes of a universal hearing screening program utilizing distortion product otoacoustic emission (DPOAE) and brainstem evoked response audiometry (BERA). NICU admission was identified as a specific neonatal risk factor correlating to hearing impairment (2.7%), with minimal or no correlation between low birth weight and increased maternal age.

Keywords: Universal Newborn Hearing Screening Program, Neonatal SNHL, Congenital SNHL, NICU, Maternal age, Low birth weight

INTRODUCTION

Hearing plays a significant role in the development of speech, language, and intellectual development.[1] Hearing loss in early life displays a disability that delays the evolution of language and speech skills. Individuals with hearing loss are less likely to attend college, experience more work stress, and get fewer job opportunities than normal hearing individuals.[2] A neonate born with hearing impairment (HI) appears normal and healthy like any other child. However, if HI is ignored at the time of birth, it might result in adverse effects on the development of the auditory pathway, which in turn impedes the development of primary and secondary language.[3,4] As per the World Health Organization (WHO), the importance of early diagnosis of hearing loss in newborns is vital to provide support to children with HI and to provide them equal opportunities in society. Children who receive timely management and rehabilitation are found to have better linguistic skills than those who are not provided with early rehabilitation.[3] Earlier, only those neonates who were in the "high-risk register" were screened. Over the years, it was noticed that more than half of the children with hearing impairment were overlooked because they were not high-risk babies.[5]

Approximately 1-3 cases per 1000 live births are estimated to have neonatal hearing loss and increase to 1-5% in infants hospitalized in neonatal intensive care units (NICU).[6] As per WHO, in 2017, the prevalence of hearing loss was 1.7 per 1000 babies screened for hearing impairment in the USA, while in children and adolescents, the average prevalence of mild or worse unilateral or bilateral hearing impairment was found to be over 3%.[7] A community-based study in India, supported by the Indian Council of Medical Research, reported that the prevalence of congenital hearing loss is 10/1000 live births in rural and 20/1000 in urban population of India.[8] Another study in Karnataka showed that 8/1000 newborns in the rural population had congenital hearing loss.[9]

Universal Newborn Hearing Screening (UNHS) Program was introduced by the Government of India in 2006.[10] UNHS program consists of a stepped protocol in which the initial screening is done by otoacoustic emissions (OAE), and the second step confirmation of hearing loss is done with brainstem evoked response audiometry (BERA).[11] This study was designed as a prospective observational study (Figure 1) with an aim to find out the prevalence and patterns of congenital hearing loss in a tertiary care hospital in North India under the UNHS Program. Specific focus was placed on identifying the association between neonatal hearing loss and NICU admission, low birth weight or advanced maternal age.

METHODS

The present study is a prospective, cohort observational study conducted at a tertiary care center (Base Hospital, Delhi) in North India. Based on the review of literature, neonatal hearing loss is known to be between 1 to 3 per 1000 live births. The required sample size was calculated by using a prevalence study formula.

$$n = (Z^2 \times p \times (1 - p))/d^2$$

Assuming a 95% confidence level, an estimated disease prevalence of 1 per 1000 (0.001), and a desired precision of ±0.005 (0.5 per 1000), the calculated sample size was a minimum of 1533. Considering the study period within which the study had to be completed and based on the available birth record data of the hospital, the planned sample size was decided between 2500 to 3000 over 18 months. Accordingly, all the booked deliveries in the hospital during the period between January 2023 to June 2024 were included in the study.

It included an assessment of the hearing status of all neonates born in the hospital by ABR and DPOAE over a period of 18 months**.** All the newborns born during this period underwent hearing assessment using DPOAE within three days of birth. Pass results were documented, and 'refer' cases were recalled at six weeks. DPOAE was repeated at 6 weeks for these 'refer' cases. If 'pass', the findings were documented. If 'refer', BERA was done at our ENT center. Data was collected to include complete maternal antenatal history and any high-risk factors, as well as the neonatal progress of the child. Main outcome measures included the number and percentage of neonates found PASS/REFER, the number of children diagnosed with confirmed hearing loss, and the distribution of hearing loss. The statistical analysis was performed using statistical package for the social sciences (SPSS) version 24 (IBM Corp, Armonk, USA).

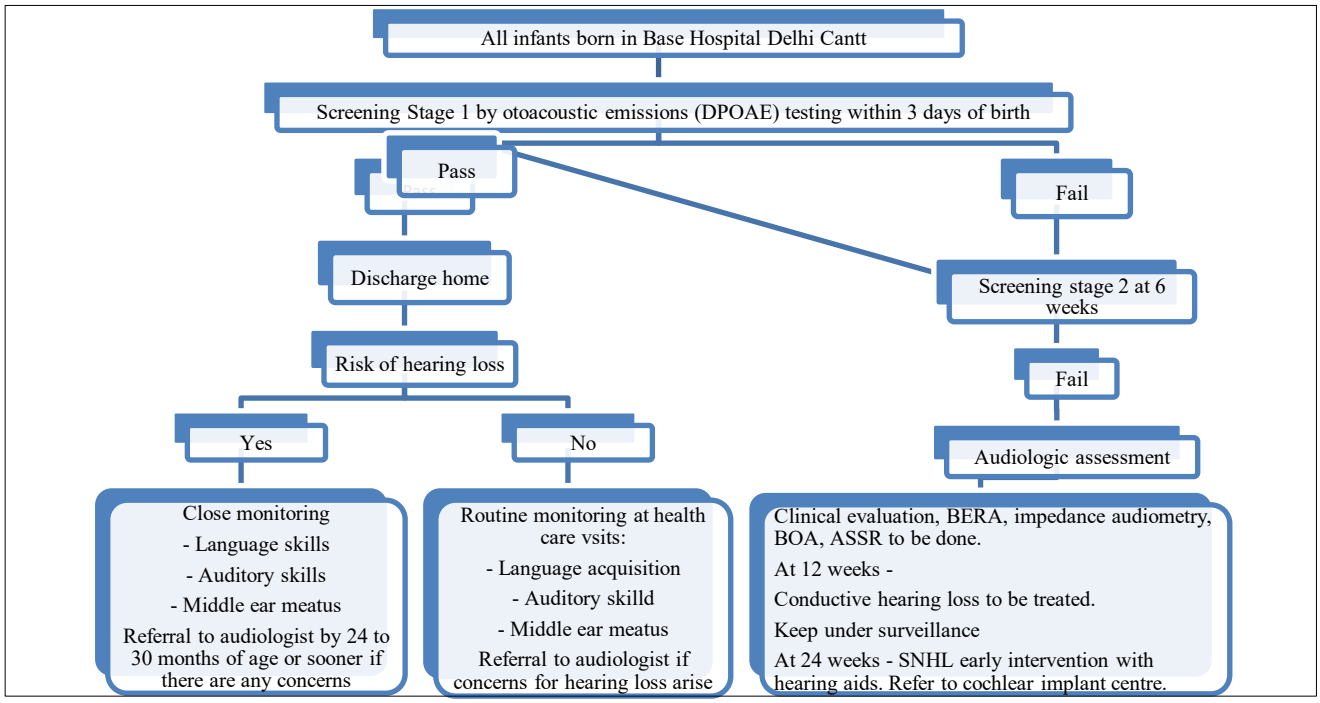

Figure 1: Study design.

RESULTS

A total of 2891 babies were born at our tertiary care center during the period of study of 18 months. As per the inclusion criteria, all newborns during this period were included in the study. A total of 46% of the newborns were females while 54% were males.

Prevalence

Table 1 shows the screening of subjects for OAE, OAE stage II, and BERA. A total of 2891 subjects were screened for OAE. Out of 2891 subjects, 76 subjects did not report for screening, 2693 subjects had bilateral pass and 122 subjects were referred for OAE stage II. Out of 122 subjects, 63 were bilaterally affected, 35 were referred for the left ear, and 24 for the right ear. On the OAE stage II screening on 122 subjects, 90 subjects were found to be bilateral pass while 32 were bilateral referred. On the BERA screening on 32 referred subjects, it was found that 25 were bilateral pass while 7 were bilateral referred.

So, overall 122 out of 2891 were referred from stage I OAE screening, and 32 were referred from stage II OAE screening and after the BERA test, 7 newborns were confirmed to have Congenital SNHL bringing the prevalence to 2.42/1000 newborns.

Table 1: Distribution of subjects across the three stages of screening.

Parameters	OAE		OAE stage II		BERA	
	Number of cases	%	Number of cases	%	Number of cases	%
Not done	76	2.6				
B/L pass	2693	93.2	90	73.8	25	78.1
Refer						
Total	122	4.2	32	26.2	**7**	21.9
B/L	63	2.2	32	26.2	**7**	21.9
Left ear	35	1.2				
Right ear	24	0.8				
Total	2891	100	122	100	32	100

Age

During the study, it was observed that the mean age of the infants included in the study was 1.42±3.31 days while the mean age of the mothers was 27.37±4.11 years. Further, it was observed that the minimum and maximum age of infants were 1 day and 74 days, respectively, while for mother's minimum and maximum age were 18 years and 50 years respectively (Table 2).

Table 2: Mean age of subjects and their mothers.

Variables	Mean±SD	Min-max	Median (IQR)
Age (days)	1.42±3.31	1-74	1.0 (1.0-1.0)
Mother's age (years)	27.37±4.11	18-50	27.0 (24.0-30.0)

Mode of delivery

As per the mode of delivery, it was observed that 55.4% of the subjects had full-term normal vaginal delivery (FT NVD), 19% had emergency LSCS, 17.4% had elective LSCS, 4.35 had vacuum delivery, 2% had forceps delivery, 1.8% had pre-term NVD and 0.1% had vaginal breech delivery (Figure 2).

NICU stays

Neonatal intensive care unit (NICU) stay has been considered an important factor in the possibility of association with Congenital SNHL. Accordingly, an assessment was done for the distribution of the subjects according to NICU stay. It was observed that 97.4% of the subjects did not stay in the NICU while 2.6% of subjects stayed in the NICU (Table 3).

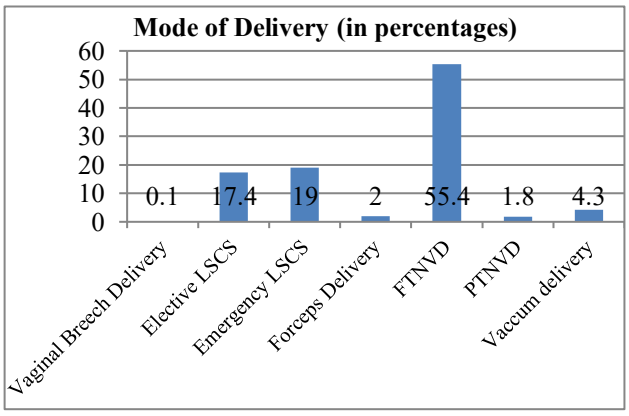

Figure 2: Distribution of subjects according to mode of delivery.

Table 3: Distribution of subjects according to NICU stay.

NICU stay	Frequency	%
No	2817	97.4
Yes	74	2.6
Total	2891	100

Table 4 shows the distribution of subjects according to NICU stay across the three stages of screening i.e. OAE, OAE stage II and BERA. Under the category where subjects did not stay in NICU (n=2817), it was observed that 2.7% (n=76) of the subjects did not report for OAE screening, 94.4% (n=2660) of subjects were pass cases, and 3.8% were referred cases for OAE stage II screening. During OAE stage II screening, 3.1% (n=107) of subjects were pass cases while 0.7% (n=21) were referred cases for BERA. Under BERA screening, 0.6% (n=16) of subjects were pass cases while 0.2% (n=5) were refer cases thereby confirming hearing loss in them.

Table 4: Distribution of subjects according to the NICU stay across the three stages of screening.

Parameters	OAE		OAE stage II		BERA	
	Number of cases	%	Number of cases	%	Number of cases	%
No NICU stay (n=2817)						
Not done	76	2.7				
Pass cases	2660	94.4	86	3.1	16	0.6
Refer case	107	3.8	21	0.7	5	0.2
NICU stay (n=74)						
Not done	0	0				
Pass cases	59	79.7	4	5.4	9	12.2
Refer case	15	20.3	11	14.9	2	2.7

Table 5: Comparison of incidence cases found 'refer' on BERA wrt NICU admission.

Parameters	NICU stay		P value
	No	Yes	
Total cases	2817	74	
BERA	5	2	
%	0.20	2.70	0.013*

*Statistically significant.

Table 6: Distribution of subjects according to birth weight.

Birth weight	Frequency	%
<1.5	77	2.7
≥1.5	2814	97.3
Total	2891	100
Mean±SD	2.85±0.56	
Min-max	0.36-4.90	
Median (IQR)	2.90 (2.60-3.20)	

Under the category where subjects stayed in NICU (n=74), it was ensured that all newborns underwent newborn hearing screening. After the initial screening of these 76 newborns, 79.7% (n=59) were pass cases and 20.3% (n=23) were refer cases for OAE stage II screening. During OAE stage II screening, 5.4% (n=4) of subjects were pass cases while 14.9% (n=11) were refer cases for BERA. Under BERA screening, 12.2% (n=9) of subjects were pass, while 2.7% (n=2) were confirmed to have a hearing loss. Based on the above values (Table 5), it was analyzed that there was a significant difference in neonates developing hearing loss between the subjects who did not stay in the NICU and subjects who stayed in the NICU (p value 0.013).

Birth weight

Distribution of SNHL was assessed as per birth weight as well. It was observed that 97.3% of the subjects had a birth weight ≥1.5 kg while 2.7% had a birth weight <1.5 kg (Table 6). Further, it was observed that the mean birth weight of the subjects under the study was 2.85±0.56 kg. Table 7 shows the distribution of subjects according to birth weight across the three stages of screening i.e. OAE, OAE stage II and BERA. Under the category of subjects with birth weight <1.5 kg (n=77), it was observed that OAE screening was not done on 10.4% of subjects as subjects did not report, 84.4% of subjects were pass cases and 5.2% were refer cases for OAE stage II screening. During OAE stage II screening, 3.9% of subjects were pass cases while 1.3% were referred cases for BERA. However, under BERA screening, none of the newborns of this cohort was detected to have SNHL.

Mother's age

Analysis of data was also done for advanced mother age (age >35 years). It was observed that there was no significant difference in neonatal SNHL cases between the category of mother's age <35 years (n=7) and mothers >35 years (n=0) (Table 8).

Table 7: Distribution of subjects according to the patient's birth weight across the three stages of screening.

Parameters	OAE		OAE stage II		BERA	
	Number of cases	%	Number of cases	%	Number of cases	%
Birth weight ≥1.5 (n=2814)						
Not done	68	2.4				
Pass cases	2628	93.4	87	3.1	24	0.9

Continued.

Parameters	OAE		OAE stage II		BERA	
	Number of cases	%	Number of cases	%	Number of cases	%
Refer case	118	4.2	31	1.1	7	0.2
Birth weight <1.5 (n=77)						
Not done	8	10.4				
Pass cases	65	84.4	3	3.9	1	1.3
Refer case	4	5.2	1	1.3	0	0.0

Table 8: Comparison of incidence of cases found 'refer' on BERA with respect to mother's age.

Parameters	Mother's age (years)		P value
	<35	>35	
Total cases	2734	157	
BERA	7	0	
%	0.30	0.00	1.000

DISCUSSION

Hearing disorder is one of the most common sensory disorders in the world which may lead to temporary or permanent deafness.[12] In neonates, deafness is the most frequent treatable disability provided it is evaluated at the right time. Hearing loss in children adversely affects health, language acquisition, and speech, leading to delays in emotional, social, learning, and mental development. Early detection and intervention at a younger age are crucial for the future speech, language, and cognitive development of newborns. Introducing high risk neonatal screening, detecting hearing loss within 3 months and intervention within 6 months will result in better speech performance in newborns.[10] The UNHS Program was introduced by the Government of India in 2006.[10] In this study, we have aimed not only to find out the prevalence of congenital hearing loss in a tertiary care hospital in North India over a large dataset of patients but also to evaluate the possible associations with NICU admissions, low birth weight and hitherto unchartered advanced maternal age association with neonatal hearing loss.

Demography and prevalence

In our study, a total of 2891 neonates were enrolled. The prevalence of congenital SNHL in our study was 2.4 per thousand which was higher than that reported by Pasha et al, Lima et al, and Erenberg et al in their studies.[5,13,14] However, similar studies previously done in India have mentioned the prevalence of congenital hearing loss as 10/1000 live births in rural and 20/1000 in urban populations.[8] A study in Karnataka showed that 8/1000 newborns in the rural population had congenital hearing loss.[9]

NICU stays

Various studies in the past have suggested a higher prevalence of SNHL in neonates admitted to the NICU.[15,16] While Hillie et al mentioned a prevalence of 3.2% SNHL in such a cohort, Fakhim et al. brought out this rate to be as high as 4.2%. A recent report by Farhat et al, exhibited that the impairment occurred 6.5 times more in NICU newborns (1.94%) compared with infants in the rooming-in unit (0.3%), suggesting that hearing impairment screening is more necessary for high-risk newborns.[17] In our study, 74 neonates received NICU care. As compared to non-NICU neonates, a significantly higher number required referrals for BERA (14.9% (n=11/74) versus 0.7% (n=21/2817)). Of these 11 infants, 2 were confirmed to have SNHL bringing the percentage in our study to 2.7% prevalence of SNHL in the population of neonates undergoing NICU admission.

Birth weight

It has been often highlighted in the literature about an association between low birth weight and neonatal SNHL. While Waters et al brought out this association to be as high as 14% among very low birth weight newborns, Mohammedzadeh et al mentioned it as 2.1% prevalence in children born with weight less than 1500 gm.[18,19] Other studies mentioning such an association include those by Cristobal et al and Xoinis et al.[20,21] Our data showed that a significantly higher number of infants who had birth weight <1.5 kg (p=0.013) (Table 8) required referral for BERA. However, none of them was diagnosed to have SNHL after BERA. Therefore, in our study, we did not find any association between low birth weight (<1500 gms) and neonatal SNHL.

Maternal age

There are various studies available that bring out the increased prevalence of congenital anomalies in newborns with higher maternal age.[22,23] However, there is very limited literature on the direct association of increased maternal age with congenital SNHL. There is one study by Sutton et al that mentions an increased risk of congenital SNHL with increased maternal age (odds ratio 1.7). Our study tried to focus on the same. In our dataset, there were 157 mothers with age greater than 35 years. However, on screening none of the babies born to these mothers had neonatal SNHL. Therefore, in our study, we found no association between increased maternal age and neonatal SNHL.

Limitations

It is acknowledged that there are a few limitations in the study, namely, that less severe congenital hearing loss (less than 30 dB to 40 dB) may not be detected by newborn

hearing screening methods. Similarly, progressive or late-onset hearing impairment may also be missed. So, it may be prudent to counsel the parents on the possibility of late-onset hearing loss, especially in high-risk cases, so that such infants may be brought for early investigation and intervention.

CONCLUSION

Our study primarily dealt with evaluating the key outcomes of a universal hearing screening program utilizing DPOAE and BERA in terms of the identification of neonatal hearing loss. This study identified NICU admission as a specific neonatal risk factor correlating to hearing impairment, with minimal or no correlation between low birth weight and increased maternal age.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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