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Original Research Article

Retrospective analysis of prognostic determinants of neonatal hearing loss: an Indian experience in a tertiary care hospital

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ABSTRACT

Background: Childhood hearing impairment is a result of combination of intrauterine environment, perinatal and postnatal factors. The Joint Committee on Infant Hearing (JCIH) has been providing guidelines for early detection of infants with or at risk of hearing loss. In India, UNHSP (Universal neonatal hearing screening program) as a part of NPPCD (National Program for Prevention and Control of Deafness) is a strategy that enables to identify congenital deafness and hearing loss.
Methods: Retrospective cross-sectional study was carried out of a database of newborn hearing screening at a tertiary care hospital of New Delhi, India. The screening results, the risk indicators for hearing loss, diagnosis and the prognosis were descriptively analysed.
Results: 3640 neonates were included in the study between January 2021 and November 2023. It was observed that, of the 25 babies diagnosed with hearing loss the common risk factors were low birth weight with preterm delivery, hyperbilirubinemia, low birth weight, preterm delivery, NICU stay>05 days and syndromes.
Conclusions: UNHSP (Universal Neonatal Hearing Screening Program) aids in early diagnosis of hearing loss using DPOAE (distortion product otoacoustic emission) and BERA (brainstem evoked response audiometry) and significantly reduces the referral rate. Babies with hyperbilirubinemia, preterm delivery and low birth weight have a poor prognosis and are at a higher risk for neonatal hearing loss as per our study. Hearing augmentation in early years of life reduces morbidity and aids better quality of life.

Keywords: Hearing loss, Neonatal hearing screening, Prognosis, Risk factors

INTRODUCTION

Neonatal Hearing loss can cause significant hearing impairment and can have a negative outcome on the speech and language development of the infant which further impacts the psychological and mental behaviour and affects social and academic skills.[1] The incidence of sensorineural hearing loss ranges from 1 to 3 per 1000 live births in term healthy neonates and 2-4 per 100 in high-risk infants, a ten-fold increase.[2]

Prevalence of neonatal hearing loss as per studies in India range from 1 to 8 per 1000 babies.[3] Childhood hearing impairment is a result of combination of intrauterine environment, perinatal and postnatal factors.[4]

The joint committee on infant hearing (JCIH) has been providing guidelines for early detection of infants with or at risk of hearing loss. In 1994, the JCIH suggested the 1-3-6 rule of screening by 01 month, identifying by 03 months and early intervention by 06 months of age 5. In 2007 guidelines, they employed separate protocols for well-baby and neonatal intensive care unit (NICU) infant.

The current 2019 document builds on, updating practices through literature reviews and expert consensus opinion on screening; identification; audiological, medical and educational management of infants and their families.[5] In India, UNHSP (Universal neonatal hearing screening program) as a part of NPPCD (National Program for Prevention and Control of Deafness) is a strategy that enables to identify congenital deafness and hearing loss.[6]

There is wide variation in aetiology of deafness in infants and it is a challenge to know to diagnosis behind childhood deafness. Preterm babies have higher incidence of hearing loss than normal because of prolonged hypoxia or acidosis.[7] The auditory brainstem nuclei and the inferior colliculi are thought to be affected by bilirubin toxicity with the consequent development of hearing defects.[8]

There are few studies which have shown that the hearing system is affected in babies with neonatal jaundice.[9] The association between birth weight and neonatal hearing loss has not been well studied. Among LBW infants, the prevalence of sensorineural hearing loss is higher likely due to complications such as hypoxia, infection, ototoxic medications and hyperbilirubinemia.[10]

The aim of this study is to determine the prevalence of neonatal hearing loss and retrospectively analyses the prognostic determinants of neonatal hearing loss using DPOAE (distortion product otoacoustic emission) and BERA (brainstem evoked response audiometry) in a tertiary care hospital.

METHODS

All newborn babies of our hospital and referred cases from other hospitals were included in the study. The exclusion criteria excluded those with congenital ear anomalies.

A retrospective cross-sectional study, approved by the Institutional Research Ethics Committee was carried out and data was collected between January 2020 to November 2023.

Existing data on hearing screening as per protocol is given in appendix 'A', was scrutinized to identify the number of infants who had a status of "PASS" or "REFER" during the screening, the number of newborns with hearing risk indicators and the frequency of each risk indicator.

The information was obtained telephonically from the parents of infants who failed the hearing screening. Parents were asked questions as per a detailed questionnaire attached as "Appendix B." Based on this data, babies were evaluated for association of hearing loss in well babies and those with high risk factors. The screening was carried out by electrophysiological measures with Echolab, Labat Asia Pvt. Ltd., Italy for DPOAE and EPIC- PLUS SN EPC 13029, LABAT Asia Pvt. Ltd. for BERA.

The study considered criteria used to identify newborns at high risk for hearing loss as recommended by the Joint Committee on Infant Hearing (JCIH), which considers a high risk infant with any of the following indicators: having been admitted to the neonatal intensive care unit (NICU) for more than 5 days, exposure to ototoxic medications, assisted ventilation, hyperbilirubinemia, syndromes associated with hearing loss, family history of childhood hearing loss, craniofacial abnormalities and in utero infections, such as cytomegalovirus, rubella, toxoplasmosis, herpes or syphilis.[5]

RESULTS

As per the data 3640 newborns were enrolled in the screening, of which 2975 (84%) passed the screening and the remaining 565 (15.96%) underwent rescreening. Of the 565 babies screened, 300 were males and 265 females.

During rescreening, 71 (12.7%) infants had loss to follow up, 05 were deceased, 247 (6.9%) passed the retest and 242 (6.8%) were further assessed using Brainstem evoked response audiometry (BERA). Of the 242 babies referred for BERA, 217 (6.1%) had normal hearing thresholds. 25 infants were diagnosed with hearing loss which required further evaluation and management.

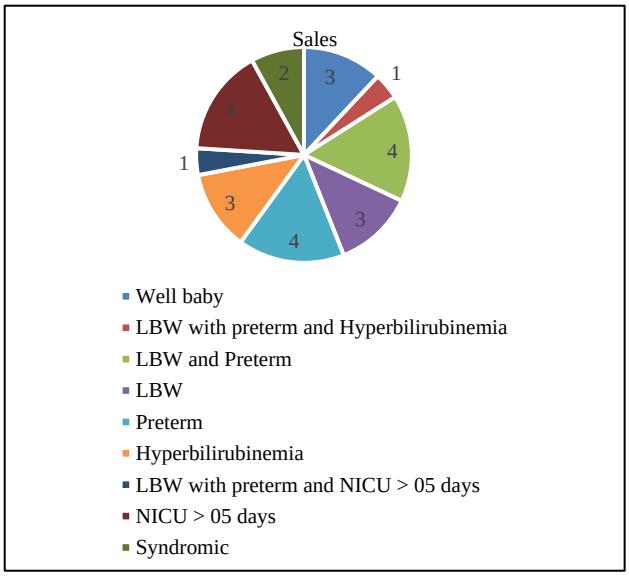

Figure 1: Distribution of high-risk babies.

At our centre, 15 infants underwent intervention with cochlear implant and 10 infants have been augmented with hearing aids. All the children with hearing augmentation have joined regular schools and are on monthly follow up for speech therapy. Out of 489 babies excluding loss to follow up and deceased, 370 were well babies and 119 had association with high risk factors.

It was observed that, 36 infants had low birth weight with preterm delivery, 18 were born with low birth weight, 24 infants had hyperbilirubinemia (>20 mg/ dl), 23 had preterm delivery, 14 infants were admitted in NICU>05 days, 04 infants had syndromes (02 had Downs syndrome, 01 Waardenburg syndrome and 01 of Hunter's syndrome). The prevalence of hearing loss as per the study is 6.8% per 1000 live births.

Table 1: Shows results of hearing loss in well babies.

		Hearing loss		Total
		No	Yes	
Well baby	No	101	22	123
	Yes	363	3	366
Total		464	25	489

Table 2: Shows results of hearing loss in babies with LBW and preterm delivery.

		Hearing loss		Total
		No	Yes	
Low birth weight and preterm	No	431	21	452
	Yes	33	4	37
Total		464	25	489
Chi-square tests				
Pearson chi-square	**Value**	**df**	**P value (<0.05 is significant)**	
	10.174	1	0.001	

Table 3: Shows results of hearing loss in babies with LBW.

		Hearing loss		Total
		No	Yes	
LBW	No	449	22	471
	Yes	15	3	18
Total		464	25	489
Chi-square tests				
Pearson chi-square	**Value**	**df**	**P value (<0.05 is significant)**	
	5.143	1	0.023	

Table 4: Shows results of hearing loss in babies with preterm delivery.

		Hearing loss		Total
		No	Yes	
Preterm	No	445	21	466
	Yes	19	4	23
Total		464	25	489
Chi-square tests				
Pearson chi-square	**Value**	**df**	**P value (<0.05 is significant)**	
	7.501	1	0.006	

Table 5: Shows results of hearing loss in babies with hyperbilirubinemia.

		Hearing loss		Total
		No	Yes	
Hyperbilirubinemia	No	442	22	464
	Yes	22	3	25
Total		464	25	489
Chi-square tests				
Pearson chi-square	**Value**	**df**	**P value (<0.05 is significant)**	
	6.414	1	0.011	

Table 6: Shows results of hearing loss in babies with NICU stay>05 days.

		Hearing loss		Total
		No	Yes	
NICU > 05 days	No	452	21	473
	Yes	12	4	16
Total		464	25	489
Chi-square tests				
Pearson chi-square	Value	df	P value (<0.05 is significant)	
	23.295	1	<0.001	

Table 7: Shows results of hearing loss in babies with syndromes.

		Hearing Loss		Total
		No	Yes	
Syndromes	No	460	23	483
	Yes	4	2	6
Total		464	25	489
Chi-square tests				
Pearson chi-square	Value	df	P value (<0.05 is significant)	
	9.973	1	0.002	

Table 8: Shows results of hearing loss in premature babies with LBW and NICU>05 days.

		Hearing loss		Total
		No	Yes	
Premature babies with LBW and NICU > 05 days	No	459	24	483
	Yes	5	1	6
Total		464	25	489
Chi-square tests				
Pearson chi-square	Value	df	P value (<0.05 is significant)	
	8.973	1	0.002	

Table 9: Shows results of hearing loss in premature babies with LBW and hyperbilirubinemia.

		Hearing loss		Total
		No	Yes	
Premature babies with LBW and Hyperbilirubinemia	No	459	24	483
	Yes	5	1	6
Total		464	25	489
Chi-square tests				
Pearson chi-square	Value	df	P value (<0.05 is significant)	
	8.973	1	0.002	

DISCUSSION

It has been observed that early detection and intervention of neonatal hearing loss helps in development of speech and language skills in early stages of life. The primary aim of early intervention is to restore and improve the cognitive and socioemotional behaviour.[11] Newborn hearing screening is carried out using DPOAE and BERA. Both these tests provide recordings of physiologic activity of the normal auditory function. DPOAE screening has a sensitivity rate of 85–100% and specificity of 91-95%.[12] BERA is an auditory evoked potential and plays a great role in testing the site of lesion. As per recommendations, it is now observed that all infants with NICU admission of more than 05 days should include BERA as part of neonatal hearing screening.

An important point to note here is that prior to UNHSP, hearing loss was diagnosed on an average at the age of 2-4 years.[13] Since UNHSP have been implemented, the mean time of detection of neonatal hearing loss has become shorter and for most children it is now at the age of few months. As per JCIH guidelines 2007, the neonatal hearing screening schedule should be performed within the first month, comprehensive audiological

testing should be accomplished by 3 months of age and appropriate treatment should begin before 6 months of age.[14] The 2019 JCIH guidelines states that the screening to be completed by 1 month, audiologic diagnosis by 2 months and enrolment in early intervention by 3 months.[15]

The prevalence of neonatal hearing loss in our study was 6.8% per 1000 babies screened. The value obtained lies in similar range as other studies done in India, as per study by Rai et al, the prevalence of hearing loss is 08 per 1000 live births in Indian population.[16] It is still an underestimation considering the large number of babies who were lost to follow-up. More than 50% children with neonatal hearing loss had association with one or more risk factors. As per our analysis, babies with low birth weight, hyperbilirubinemia and preterm delivery have increased risk of association with neonatal hearing loss.

Of the 25 babies with neonatal hearing loss, 03 were well babies and other 22 babies had association with one or more risk factors. Of the 22 babies with high risk factors for hearing loss, 04 babies had low birth weight with preterm delivery, 03 had low birth weight, 01 premature baby had low birth weight with hyperbilirubinemia, 01 preterm baby was admitted in NICU>05 days with low birth weight, 04 were premature births, 03 had hyperbilirubinemia, 04 had NICU stay>05 days and 02 were syndromic.

Jiang et al, in his study observed an incidence of 9.6% once hyperbilirubinemia was confirmed; however, patients in this series required phototherapy or exchange blood transfusion and there is no mention whether the newborns were already exposed to treatment when the blood sample was taken.[17] In our study it was observed that out of 25 children with hyperbilirubinemia, 04 had hearing loss with an incidence of 3.3%.

Singh et al, shared his 10 years of experience of assessment of deaf-mute child and has mentioned non-genetic causes for hearing loss as 33% of his total patients as the etiological agents, whereas genetic causes are responsible for 15.8% and remaining as idiopathic.[18,19]

There are studies which showed the association of LBW and prevalent hearing loss among children, but there was uncertainty on when the hearing loss began.[20,21] In a Norwegian study by Nafstad et al, the risk of hearing loss was higher infants with birth weight<1500 grams, when compared with a birth weight between 3000 and 3499 g. This was similar to the results from another study using national health examination survey data as stated by Hoffman et al, in his article.[22] The percentage of children with low birth weight and hearing loss as per our study was 3.6 %.

In our study, 4.0% of preterm babies<37 weeks of gestation were diagnosed with hearing impairment, similarly to the findings of Meyer et al.[23] The pathogenesis of hearing loss in preterm infants is very complex, though prematurity alone does not have a significant impact on hearing, it is associated with other risk factors which can influence hearing in a synergistic fashion. Therefore, the risk of hearing loss in preterm babies is higher than in the general population.

There is 15.1 times higher chance of neonatal hearing loss in babies exhibiting targeted risk factors. There is an association between low birth weight, preterm delivery, NICU stay>05 days, hyperbilirubinemia and syndromes and it is statistically significant.

The relevance of the study lies in the fact that there are very few studies with a limited sample size corelating between the risk factors and neonatal hearing loss and emphasizing the potential hurdles including large number of infants with loss to follow up. Our study has emphasized on the causal relationship between the risk factors and neonatal hearing loss at a tertiary care hospital of North India.

In this study, it was observed that there was a poor follow-up return rate of participants which resulted in insufficient information to know the true hearing function of the study cohort. A screening policy with proper follow up of the participant should be implemented which will help in changing the perceptions of the importance of hearing screening. With the use of tests like OAE and automated auditory brainstem response (AABR) when combined in a screening protocol, it helps to reduce the referral rates and ensures timely management of the patient. However, in developing countries the high cost of AABR may pose a limitation.

CONCLUSION

We conclude that UNHSP provides the most accurate diagnosis of hearing loss using DPOAE (distortion product otoacoustic emission) and BERA (brainstem evoked response audiometry) and significantly reduces the referral rate. Babies with hyperbilirubinemia, preterm delivery and low birth weight have a poor prognosis and are at a higher risk for neonatal hearing loss as per our study. In India, a catering of systematic approach for early detection and intervention should be implemented. Early detection and intervention should be carried out at the earliest so that the newborn would benefit from hearing augmentation in early years of life.

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