HEARING SCREENING OF HIGH RISK NEONATES IN NICU AT DISTRICT HOSPITAL, TUMKUR

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ABSTRACT

BACKGROUND

In this study, we wanted to determine the occurrence of hearing impairment by screening high risk neonates, to assess the high-risk factors associated with hearing impairment among newborns, to evaluate maternal risk factors associated with hearing impairment in newborn.

METHODS

This was a hospital based prospective observational study conducted among 400 neonates to create awareness and fulfil the need of screening of newborn to pick up the deaf child at the earliest and institute a protocol for early intervention, presenting at District Hospital, Tumkur, from June 2023 to November 2023, after obtaining clearance from institutional ethics committee and written informed consent from the study participants.

RESULTS

Among the neonates 27.40% belonged to VLBW and 28.8% belonged to LBW. The remaining neonates 43.80% were with birth weight >2500 g.

In our study, 52.20% of the neonates were born at the gestational age of 37–41 weeks, 27% between 32 and 36 weeks, and 20.80% were born before 32 weeks.

According to mode of delivery, majority of the cases were LSCS mode (52.2%) and remaining were NVD (47.8%).

APGAR at 1 min 62% had score of 4-6, and 38% has APGAR score in 7-10 range. At APAGR at 5 min 13% had score of 4-6, and 87% has APGAR score in 7-10 range.

The correlation between low APGAR scores and OAE results was statistically significant (p = 0.002 at 1 min and p=0.033 at 5 min).

Out of 386 neonates, hearing loss was confirmed in 14 neonates (3.5%) by BERA.

Risk factors, birth asphyxia(p=0.028), VLBW(p=0.04) and Hyperbilirubinemia (p=0.04) were highly statistically significant association with hearing loss.

CONCLUSION

Early detection and intervention in the form of hearing aids, cochlear implant and other forms of rehabilitation will enable the person to lead a normal life and integrate into the mainstream. Late

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detection of hearing loss and delay in intervention can lead to deaf mutism and the social and economic consequences of this are enormous on the person, family and the country.

KEYWORDS: Hearing screening, high risk neonates, NICU
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INTRODUCTION

Hearing is a vital part of newborn's contact with his environment and is crucial for the development of speech and language.[1] Most crucial time for this speech and language development is the first year of life.[2] Hearing loss very early in life can have multiple deleterious effects on the new born most commonly being related to attainment of speech and language. Also, it can affect social, emotional and academic achievement of the child. Even mild or unilateral involvement may have detrimental effect on the development and on school performance of a young child.[3] The severity of these hearing disabilities is generally related to the length of time the hearing loss is left untreated. Hence the policy of 'wait and watch' cannot be adopted with hearing impairment, hoping that the child will grow out of it.[4] Significant hearing loss is one of the most common major abnormalities present at birth and if left untreated, will impede speech, language and cognitive development.[5] Presence of hearing loss at birth is one of the major causes of disabilities occurring in childhood and its early detection could prevent further disability in speech, language and cognition as the child grows.[6] About one in every thousand children is born profoundly deaf and 4 times as many are born with moderate or severe bilateral hearing loss. Infants in neonatal intensive care units (NICUs) are 10–20 times more likely to have significant hearing loss than the healthy population. In India, the incidence of hearing loss is 1 to 6/1000 live births, with an average of 4/1000 live births. The incidence of significant bilateral hearing loss in neonates is 1-3 cases per 1000 live births and 2-4 per 100 infants surviving neonatal intensive care.[7] If hearing impaired infants are identified and treated by 6 months of age. These children (with the exception of those with bilateral impairment) should develop the same level of language as their age-matched peers who are not hearing impaired. Thus, early intervention enhances the potential of most hearing impaired children to become adults who are fully independent, participating and contributing members of society The currently acceptable methods for physiologic hearing screening in newborns are Brainstem Evoked Response audiometry (BERA) and evoked otoacoustic emissions (EOAEs).[8] BERA measures the electroencephalographic waves which are produced in response to click sounds of three electrodes placed on the infant's scalp by the auditory system. While (evoked otoacoustic emissions) OAE is cheap, quick, simple and reliable with a sensitivity of *Introduction* 80- 98% and specificity of >90%, BERA has the additional advantage of identifying newborns with auditory neuropathy unlike OAE testing. The other advantage of BERA is its high sensitivity 84-90% and high specificity>90%.[9]

Aims and Objectives

- To estimate the incidence and to determine the risk factors predictive of hearing impairment in high risk neonates admitted in NICU at District Hospital, Tumkur.
- To determine the occurrence of hearing impairment by screening high risk neonates in District Hospital, Tumkur.
- To assess the high-risk factors associated with hearing impairment among newborns born at District Hospital, Tumkur.
- To evaluate maternal risk factors associated with hearing impairment in newborn.

METHODS

This was a hospital basedprospective observational study conducted among 400 neonates to create awareness and fulfil the need of screening of newborn to pick up the deaf child at the earliest and institute a protocol for early intervention, presenting at District Hospital, Tumkur, from June 2023 to November 2023, after obtaining clearance

from institutional ethics committee and written informed consent from the study participants.

Inclusion Criteria

- Infants with atleast one of the following high-risk factors will be taken into the study:
- Family History of hereditary childhood sensori-neural hearing loss.
- Intrauterine infections (TORCH).
- Craniofacial anomalies, including those with morphologic abnormalities of the pinna and ear canal.
- Birth weight < 1500 g.
- Hyperbilirubinemia at a serum level requiring exchange transfusion.
- Ototoxic medications, including but not limited to the aminoglycosides, used for more than five days or multiple courses or in combination with loop diuretics 7)Bacterial meningitis.
- APGAR scores of less than four at one minute or less than six at fifth minute.
- Needing mechanical ventilation for more than five days.
- Other findings associated with a syndrome known to include sensorineural and/or conductive hearing loss

Exclusion Criteria

- Newborns once discharged and did not return, whose parents / relatives refuse to undergo screening test for hearing will be excluded.
- Children for whom written consent was not given by their parents/ guardians.

Sample size:

Formula used for calculating the sample size -

Alpha (a) = 0.05
Estimated proportion (p) = 0.03
Estimated Error (d) = 0.005
Population Size (N)
Minimum Sample size needed: 400

Statistical Methods

Data collected was collected and entered and tabulated in MS Excel spread sheet. Statistical software Epi info software version 7.2.5 was used for the same. Descriptive statistics like proportions, mean and standard deviation were be applied. Inferential statistics like chi-square test were applied.

RESULTS

Distribution of cases according to birth weight

Birth weight(gms)	Frequency	Percentage(%)
< 1500	110	27.4
1501-2500	115	28.8
>2501	175	43.8

Table 1

In the present study, among the neonates 27.40% belonged to VLBW and 28.8% belonged to LBW. The remaining neonates 43.80% were with birth weight >2500 g. These results were also statistically highly significant when compared to the outcomes of the hearing loss screening (p = 0.000).

Distribution of cases according to APGAR score

APGAR score range	APGAR at 1 min		APGAR at 5 min	
	Frequency	Percentage(%)	Frequency	Percentage(%)
4-6	248	62	52	13
7-10	152	38	348	87

Table 2

In our study, at APGAR at 1 min 62% had score of 4-6, and 38% has APGAR score in 7-10 range. At APAGR at 5 min 13% had score of 4-6, and 87% has APGAR score in 7-10 range. These results were also statistically significant when compared to the outcomes of the hearing loss screening (p = 0.002 at 1 min and p=0.033 at 5 min).

Distribution of cases according to risk factors

Risk factors	Frequency	Percentage(%)
Birth Asphyxia	160	40
VLBW	110	27.5
Ototoxic drugs	60	15
Hyperbilirubinemia	28	7
Meningitis	18	4.5
Ventilated babies	12	3
Craniofacial malformation	8	2
TORCH	4	1

Table 3

The risk factors most commonly associated with hearing loss in the present study were Birth Asphyxia (40%), VLBW (27.5%), Ototoxic drugs (15%), Hyperbilirubinemia (7%) and meningitis (4.5%). Out of these factors, the present study observed a highly statistically significant association of hearing loss with birth asphyxia(p=0.028), VLBW(p=0.04) and Hyperbilirubinemia (p=0.04).

DISCUSSION

Hearing loss is one of the most common abnormalities among high-risk neonates that can be picked up in early life. Timely identification and rehabilitation would help the child's comprehensive development. Congenital hearing loss is one of the common treatable conditions. Hearing impairment has an inimical impact on the development of a newborn. For the development of the brain, the first year of life is very crucial. Hearing impairment occurring very early in life affects the overall development.

Hearing is a special sense required for proper development of speech, language, mental and academic performance. When the ear is unable to transform the vibratory mechanical energy of sound into the electrical energy of nerve impulses, it results in the hearing loss in neonates.

The causes of hearing loss in newborns include infections, such as rubella, herpes simplex virus, premature neonates, low birth weight, birth injuries, drug and alcohol use during pregnancy, jaundice and Rh incompatibility, diabetes during pregnancy, maternal hypertension causing preeclampsia, fetal hypoxia and genetic problems. Hearing loss due to genetic abnormalities can be present at birth or develop later in life, or maybe syndromic like Usher syndrome, Down syndrome, Treacher Collins syndrome, Alport

syndrome, Crouzon syndrome or Waardenburg syndrome.

The language and vocabulary, the development socially, attention span and academics are severely impacted. Unilateral hearing loss or mild hearing impairment may also affect the development of the child and school performance. Permanent hearing loss is seen in about 2 to 3 per thousand live births.[10] Almost fifty percent of these infants do not have any risk factors for hearing loss.

As a result hearing loss may not be detected in them until they present with the delay of language milestones. The prevalence of permanent bilateral hearing loss in at-risk infants in India is reported to be 1.61/1000 of at-risk infants, by newborn hearing screening programs.[11] The prevalence of hearing loss including both unilateral and bilateral, conductive, and

Sensorineural hearing loss in at-risk infants is estimated to be 2.5 to 10%.[12]

The screening strategies of young infants, specially, universal screening versus selective screening (high risk targeted approach) is a debate especially in resource limited settings. The fact that selective screening may miss considerable number of cases is the justification for universal screening in less developed countries also.

Use of less reliable modalities during screening and late diagnosis are the causes for concern. This can be overcome by implementing proper hearing screening methods in newborn which can enable accurate diagnosis of the hearing loss at the earliest. This can help in early intervention. It is significant to know that the basal maturation of the auditory pathway is nearly completed at 2 years of age. Clinically, it is difficult to detect the hearing loss in newborns.

Hence, otoacoustic emission (OAE) and brain stem-evoked response audiometry (BERA) are the two tests widely used for this purpose. OAE is an objective test to determine the cochlear status, especially the outer hair cells, and BERA tests the functional integrity of the auditory pathway from the eighth nerve to lower brainstem.

Therefore, the current study was done to assess the hearing screening prevalence among high-risk new-borns admitted to inborn unit of a District Hospital, Tumakuru, using OAE. Follow up of neonates who failed OAE was done using Brainstem Auditory Evoked Responses (BERA).

This hospital based prospective observational study was conducted on a total of 400 neonates satisfying the inclusion during June 2023 to November 2023, consisting of a follow up at 6 weeks, 10 weeks, 14 weeks and 6th month. The objectives of the study were to estimate the incidence and to determine the risk factors predictive of hearing impairment in high risk neonates admitted in NICU at District hospital, Tumkur.

SEX:

In the current study, among 400 cases, Majority of the cases belonged to males 219(54.8%) and remaining 181(45.3%) were females. Results indicated significant differences due to gender (female hearing more sensitive than male) and frequency (least sensitive hearing recorded at 1.6 kHz, most sensitive hearing recorded at 3.2 kHz). In this study, no significant difference in hearing loss based on gender was seen.

Global estimates have revealed that hearing impairment was greater for males than females. Although hereditary etiology was spread equally over both sexes, an explanation for this male predominance is still lacking.

Our study results were supported by Nishad A et al[13], concluded that 535 (53.5%) were male and 465 (46.5%) were female. A similar study by Maina J et al[14], reported out of 931 neonates 51.77% were males and 48.22 % were female. Shukla A et al[15] study also reported that about 59% of infants in the present study were males whereas only 41% were female infants. A study by Srinivas C[16] concluded that 34 (68%) were males and 16 (32%) were females.

AGE:

In the present study, 64% of infants belonged to 1- 7 days of age followed by 29.8% of infants in the age range of 8 to 28 days and 6.20% of infants belonged to >28 days. In this

present study, no significant difference in hearing loss based on age was seen.

A similar study by Shukla A et al reported that the subjects included in the study were less than 1 year of age (infants). About 48%, 44%, and 8% of infants belonged 1- 7 days, 8 to 28 days, and more than 28 days of age similar to our results. In contrast a study by Thomas K et al[17] concluded that the highest number of neonates 117 (58.50%) were seen in the group of 6–10 days of age followed by 69 (34.50%) neonates in the group of 0–5 days.

BIRTH WEIGHT:

The mean birth weight in our study was 2.21+0.76 kg. A study conducted by Mandal S et al reported mean birth weight of the cases was 2.54 + 0.48 kg and controls were 3.14 + 0.22 kg. In a similar study by Sudharahan RC et al[18], the mean birth weight of neonates studied was 2.60±0.67 kg which supported our study.

In the present study, among the neonates 27.4% belonged to VLBW and 28.8% belonged to LBW. The remaining neonates 43.80% were with birth weight >2500 g.

These results were also statistically highly significant when compared to the outcomes of the hearing loss screening (p = 0.000).

A similar study was conducted by Thomas K et al, the study included the neonates with very LBW who were 34.50% supporting our results. The remaining neonates were 34.50% with birth weight between 2500 and 3499 g, 30.5% with BW between 1500 and 2499 g, and 0.5% with BW more than 3500 g. Gupta et al[19], in their study on 105 neonates, 10 were extremely low birth weight, 51 were very low birth weight, 24 were low birth weight and 19 babies were born with normal weight (>2.5kg).

GESTATIONAL AGE:

In our study, 52.20% of the neonates were born at the gestational age of 37–41 weeks, 27% between 32 and 36 weeks, and 20.80% were born before 32 weeks.

Similar results were reported by Thomas K et al, 65% of the neonates were born at the gestational age of 37–41 weeks, 22% between 32 and 36 weeks, and 13% were born before 32 weeks.

MODE OF DELIVERY:

In the study, according to mode of delivery, majority of the cases were LSCS mode (52.2%) and remaining were NVD(47.8%). The results were not statistically significant when compared to the outcomes of the hearing loss screening (p = 0.303).

In contrast, in a study by Shukla A et al, majority of the cases were NVD mode (80%) and remaining were LSCS(20%). Results observed where of no statistically significant association

APGAR VALUE:

In our study, at APGAR at 1 min 62% had score of 4-6, and 38% has APGAR score in 7-10 range. At APAGR at 5 min 13% had score of 4-6, and 87% has APGAR score in 7-10 range. It indicates that a low APGAR score can be a predictor of abnormal OAE results. A similar pattern was noted with the APGAR score at 5 min.

The correlation between low APGAR scores and OAE results was statistically significant (p = 0.002 at 1 min and p=0.033 at 5 min). APGAR score at 1 and 5 min, had a statistically significant correlation with the outcomes of OAE screening. We observed that lower APGAR scores at 1 and 5 min were associated with abnormal OAE results. Apgar scores of <4 at 1 min or >6 at 5th min is one of the major risk factors associated with hearing loss.

A study Chawla et al[20], reported the correlation between low APGAR scores and OAE results was statistically significant (p = 0.002 at 1 min and p=0.006 at 5 min).

HEARING LOSS:

Our study included 400 high-risk neonates who were screened for hearing loss in three stages. The first OAE was conducted before the neonate's discharge from the hospital. The neonates with referred OAE were screened again with a second OAE after 4 weeks or the first immunization visit. Failed repeat OAE neonates were subjected to BERA with no more than 3 months.

All the infants were subjected to an initial screening by OAE. Out of 400 infants, 77.5% of infants passed the first screening by OAE whereas 22.5% had referred OAE. Out of 90, 38 failed in repeat OAE. Out of these 386 neonates, hearing loss was confirmed in 14

neonates (3.5%) by BERA. Overall incidence of hearing impairment among high risk neonates is 3.5%. The higher incidence in our study group is either due to a smaller sample size or due to the severity of illness of the study group.

A study by Thomas K et al reported, in the initial screening, 49 out of 200 high-risk neonates had referred OAE. Out of 49, 20 failed in repeat OAE. Out of these 20 neonates, hearing loss was confirmed in 15 neonates (7.5%) by BERA. A study by Shukla A et al, infants were subjected to an initial screening by TEOAE. Out of 100 infants, 73% of infants passed the first screening by TEOAE whereas 27% failed.

Similar results were seen in the study by Zamani et al[21](8%), Chan et al [22](6.47%), Regina et al[23] (6.76%), and Srisuparp et al[24](8%). However, Fakhraee et al[25] and Maisoun et al[26] found hearing loss in 28% and 13.5%, respectively, which were higher than our result. Nagapoornima et al[27] and Finckh-Krämer et al[28] found hearing loss only in 1.07% and 1.3%, respectively.

RISK FACTORS:

The risk factors studied in our present study were birth asphyxia, VLBW, meningitis, hyperbilirubinemia, ototoxic drugs, ventilated babies, craniofacial malformation and TORCH. The risk factors most commonly associated with hearing loss in the present study were Birth asphyxia (40%), VLBW (27.5%), ototoxic drugs(15%), hyperbilirubinemia (7%) and meningitis (4.5%). Out of these factors, the present study observed a highly statistically significant association of hearing loss with birth asphyxia(p=0.028), VLBW(p=0.04) and Hyperbilirubinemia (p=0.04). The less incidence of hearing loss in our study might be due to the immediate intervention for birth asphyxia and thereby auditory system is spared from getting affected. In our study, hyperbilirubinemia neonates had a bilirubin level of more than 20 mg/dl which increased the possibility of sensorineural hearing loss.

A study by Thomas K et al reported, that risk factors most commonly associated with hearing loss in the present study were neonatal intensive care unit admission >24 h (7%), hyperbilirubinemia (3%), meningitis (3%), and ototoxic drugs (3%). In the neonates who had hearing loss (15), 93.33% were having more than one risk factor. Birth asphyxia and fetal distress were reported as significant risk factors for the occurrence of hearing loss in a study by Al-Meqbel A et al[29]. Zamini A et al also suggested birth weight <1500 g as the major risk factors for hearing loss. In the study by Meyer et al[30], birth weight <1500 g was a major risk factor, whereas LBW was not a significant risk factor for hearing loss in our study.

Shukla A et al in their study observed a highly statistically significant association of OAE with birth asphyxia, NICU admission, and Apgar score at 5 min i.e. birth asphyxia, NICU admission >15 days, and Apgar score >6 were significantly associated risk factors for poor outcome (refer) with OAE.

In a study conducted by Mandal S et al, risk factors in 65 cases, 15 (23.1%) had birth asphyxia, 20 (30.8%) had hyperbilirubinemia, 10 (15.4%) had neonatal sepsis/ meningitis and 20 (30.8%) were premature. And 8 (53.33%) cases of birth asphyxia, 9 (45%) cases of hyperbilirubinemia, 2 (20%) cases of sepsis/meningitis and 6 (30%) premature babies had abnormal BERA results.

In a similar study conducted by Chawla et al, APGAR score and perinatal asphyxia were statistically significant correlation with the results of OAE.

A study conducted by Maqbool M et al showed no significant hearing loss, whereas the study conducted by Zamani et alshowed significant hearing loss in hyperbilirubinemia cases which is consistent with our study.

In the study by Nagapoornima et al[31] who screened 51 babies with severe birth asphyxia, neonates had hearing impairment as in our study. Similarly, Regina et al[32] also showed a higher incidence of hearing loss in their study.

MATERNAL RISK FACTORS:

The prenatal risk factors screened in the present study were HTN, leaking PV, obstructed labour, GDM, Rh negative, fever, prolonged labour and UTI.

In the present study, majority of the mothers 86% did not have any risk factors. Remaining risk factors present were HTN(4.8%), Leaking PV(2.3%), Obstructed Labour (2%),

GDM(1.8%), Rh Negative(1.8%), Fever(0.5%), Prolonged Labour(0.5%) and UTI(0.3%). These results were not statistically significant when compared to the outcomes of the hearing loss screening in BERA.

In a similar study by Shukla A et al,,risk factors screened were family history of consanguineous marriage, family history of hearing loss, type of delivery, maternal infection, ototoxic medication in mothers during pregnancy, maternal hypertension or hypotension, and gestational diabetes. The hearing loss was not observed to be significantly associated with any of the prenatal risk factors screened by TEOAE.

CONCLUSION

Hearing impairment is common in high risk NICU neonates. Newborn screening is mandatory to identify hearing loss in the prelinguistic period to reduce the burden of handicap in the community. OAE screening of neonates should be done at the earliest to detect hearing impairment so that hearing and speech rehabilitation can be started at the earliest. All high risk infants must be screened for hearing impairment prior to discharge and retesting of infants with abnormal BERA after 3 months and subsequently if necessary. Early detection and intervention in the form of hearing aids, cochlear implant and other forms of rehabilitation will enable the person to lead a normal life and integrate into the mainstream. Late detection of hearing loss and delay in intervention can lead to deaf mutism and the social and economic consequences of this are enormous on the person, family and the country.

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