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ORIGINAL RESEARCH

A study on clinical profile of neonates with hearing loss admitted in NICU

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ABSTRACT
Approx. 30% of infants with hearing loss are linked to other associated medical problems that are part of a syndrome, as more than 400 syndromes are known to include hearing loss (e.g., Usher, neurofibromatosis type 2, Waardenburg syndrome, branchio-oto-renal syndrome, Robin sequence, trisomy 21). Data was collected using a standard proforma on admission. After collecting basic information based on predesigned proforma screening for hearing loss was first performed at the time of discharge from NICU with the OAE measurement. For babies who failed to pass the initial screening, another OAE test was performed on the day of first immunization visit i.e.,6weeks(45days), and those failing to pass 2nd time were referred to a pediatric otologist for comprehensive audiological assessments at 3months. Among 320 neonates, 197 (61.6%) neonates developed hyperbilirubinemia. Out of 197 neonates with hyperbilirubinemia, 24.4% (48) received phototherapy for less than 24 hours,65.46% (127) received for 25-48hours and remaining 11.34% (22) received for more than 48 hours.
Key words: Clinical profile, neonates, hearing loss

INTRODUCTION

The World Health Organization estimates that approximately 360 million people (5% of the world's population, including 32 million children) have moderate to severe hearing impairment and 364 million people have been reported to have mild hearing loss. It is found that, incidence of severe congenital hearing loss is 1 to 3 per 1,000 live births, also 2 to 4 per 100 infants in the intensive care unit population have some degree of sensorineural hearing loss[1].

Approximately 50% of congenital hearing loss is believed to be of genetic origin (30% syndromic and 70% nonsyndromic).Out of the nonsyndromic,75% to85% are autosomal recessive, 15% to 24% autosomaldominant and 1% to 2% X-linked disorders[2].

Approx. 30% of infants with hearing loss are linked to other associated medical problems that are part of a syndrome, as more than 400 syndromes are known to include hearing loss (e.g., Usher, neurofibromatosis type 2, Waardenburg syndrome, branchio-oto-renal syndrome, Robin sequence, trisomy 21)[3].

It includes around 25% of hearing impairment among children. The hearing loss was found to be secondary to the injury to developing auditory system in the intrapartum or perinatal period. The causes for this include infection, hypoxia, ischemia, metabolic disease, hyperbilirubinemia, or ototoxic medication.

Preterm infants and infants who require newborn intensive care or a special care nursery are often exposed to the above causative factors[4].

Risk factors given by JCIH are constantly been studied and modified as well as new risk factors are being included based on multidisciplinary studies and also based on new data appearing in the medical literature. However, the indication mentioned by JCIH are not always gold standard, as these risk factors tends to change constantly based on regional and seasonal factors. So, depend on institutional data other risk factors that may increase chance of hearing impairment may be included[5, 6].

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Hence, it is advisable to constantly evaluate the relative importance of risk indicators, in order to improve and modify lists according to current clinical practice. Some risk factors deserve special mention as they pose a higher chance of causing hearing impairment than the rest.

METHODOLOGY

STUDY POPULATION

All neonates admitted in NICU for more than 48 hours.

INCLUSION CRITERIA

a) All neonates admitted in NICU for more than 48 hours.

EXCLUSION CRITERIA

a) Neonates with congenital anomalies (craniofacial malformation).
b) Neonates admitted for less than 48 hours.
c) Neonates with family history of deafness.
d) Neonates who died or who have not completed OAE.

SAMPLE SIZE AND SAMPLING

The sample size for the study was calculated based on the 50.5% prevalence of hearing impairment reported in the study by Nair VS *et al*.Based on this, the required sample size with 6% absolute precision and a confidence level of 95% was calculated using the formula,

$$\text{Sample size, } n = \frac{z^2pq}{d2}$$

Where, z=1.96, Z score for 95% confidence level
p=0.50, prevalence of hearing impairment [13].
q=0.495
d=0.6, absolute precision of 6%. Thus

$$n = 1.962 \times \frac{50.5 \times 49.5}{6^2} = 267$$

Taking into account a non-response rate of 20% i.e. 53, the total sample size will be 320.

SYSTEMATIC SAMPLING

Technique was used where all neonates meeting the criteria was included in the study during the study duration until the sample size was reached.

STUDY PROCEDURE

After obtaining permission from the institutional ethical committee all neonates admitted in NICU fulfilling the inclusion and exclusion criteria were taken into the study after obtaining written informed consent from parents/guardian. Information regarding the condition of each neonate was collected in the form of a predesigned questionnaire which included: gestational age; family history of congenital hearing loss and consanguinity; presence of conditions including asphyxia(APGAR score<4), sepsis, respiratory distress syndrome, transient tachypnoea of newborn(TTN),congenital pneumonia, congenial heart disease(CHD) or hyperbilirubinemia(≥18 mg/d1);and treatments used including phototherapy (>2 days),mechanical ventilation (>5 days),antibiotic therapy including aminoglycosides(>5 days),or oxygen therapy(>1 week and > 40% FIO2).
The screening procedure was done in a sound treated room in the department or in a quiet room adjacent to the respective wards of concerned departments. The presence of unilateral or bilateral hearing loss was considered as deafness in this study. The Instruments used is Transitory evoked otoacoustic emission (TEOAE) set at a 1.5kHZ to 4 kHz screen with 3 of 4 frequency bands being required to be present for a pass. The intensity was calibrated at an 83 dB sound pressure level peak equivalent (3dB).
The firststepof thescreeningwasperformedatdischarge fromNICUwiththeOAE measurement. For babies who failed to pass the initial screening, another OAE test wasperformed within 1 month after discharge, and those failing to pass the test again were referred to a pediatric otologist for comprehensive audiological assessments at 3 months.

DATA COLLECTION METHODS

Data was collected using a standard proforma on admission. After collecting basic information based on predesigned proforma screening for hearing loss was first performed at the time of discharge from NICU with the OAE measurement. For babies who failed to pass the initial screening, another OAE test was performed on the day of first immunization visit i.e.,6weeks(45days), and those failing to pass 2nd time were referred to a pediatric otologist for comprehensive audiological assessments at 3months.

RESULTS

Out of all the neonates admitted to the NICU 320 neonates meeting the criteria were taken into the study based on systematic method during the study period.

Table 1: Sociodemographic details of the study population

Variables	Number of neonates (n)	Percentage (%)
Maternal age		
18-30	237	74.1
31-40	81	25.3
41-50	2	0.6
Gender		
Male	205	64.1

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Female	115	35.9
Gravida		
Primi	143	44.68
Multi	177	55.312
Gestational age		
<28weeks	6	1.9
28-34weeks	97	30.3
35-37weeks	68	21.3
>37weeks	149	46.6

Our study sample compromised of 320 neonates in which 74.1% of mothers age were between 18-30 years and 55.3% were multigravida.

Table 2: Clinical Variables of the Study Sample (N=320)

Variables	Number of neonates(n)	Percentage (%)
Birth weight		
<1kg	1	2.2
1-1.5	31	9.7
1.5-2.5	130	40.6
>2.5	150	47.5
Consanguinity of marriage		
Consanguineous Non consanguineous	22 298	6.9 93.1
Complications during pregnancy		
Present Absent	225	70.3
	95	29.7
Drugs taken during pregnancy		
Yes No	201	62.8
	119	37.2
APGAR at 1 minute		
>7	232	72.5
4-6	71	22.2
<3	17	5.3
APGAR at 5 minutes		
>7	300	93.8
4-6	19	5.9
<3	1	0.0
Duration of phototherapy		
<24hours	48	24.4
25-48hours	127	65.46
>48hours	22	11.34
Mode of oxygen delivery		
Hood box	43	20.6
HFNC	114	54.5
CPAP	25	11.9
Ventilation	27	12.9

Among 320 neonates, 2.2% of them were ELBW (i.e., <1 kg), 9.7% were VLBW (i.e.,1-1.5kg), 40.6% were LBW (1.5-2.5kg) and remaining 47.5% neonates were >2.5kg weight. 93.1% (298) of neonates were born to non-consanguineous couple and remaining 6.9% (22) born to consanguineous couple. Pregnancy associated risk factors like gestational diabetes mellitus, gestational hypertension, hypothyroidism, PROM, UTI, COVID-19, oligohydramnios and polyhydramnios were found in 225 (70.3%) of the sample. Intake of drugs by the mother like OHA, Insulin, Labetalol, Nifedipine, Thyronorm, Antibiotics and Steroids were found in 201 (62.8%) of the sample.

Among 320 neonates, 197 (61.6%) neonates developed hyperbilirubinemia. Out of 197 neonates with hyperbilirubinemia, 24.4% (48) received phototherapy for less than 24 hours,65.46% (127) received for 25-48hours and remaining 11.34% (22) received for more than 48 hours.

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Table 3: Percentage Distribution of Selected Variables Based on Risk Factors for Hearing Loss. (n=320)

Risk factors	Count	Percentage (%)
Birth asphyxia	22	6.7
RDS	180	**56.3**
MAS	31	9.7
TTN	6	1.9
CHD	35	10.9
Seizures	29	9.1
Sepsis	105	32.8
Hyperbilirubinemia	197	**61.6**
Phototherapy	197	**61.6**
Antibiotics	127	39.7
NEC	10	3.1
Oxygen requirement	209	**65.3**

DISCUSSION

Hypoxia is one of the risk factors that has a strong association with hearing impairment. Adequate oxygenation and perfusion are essential for normal functioning of cochlea. Spiral ganglion cells are first to be affected in case of perinatal asphyxia. More severe hypoxia may cause irreversible cellular damage to the cochlea (outer hair cells andstria vascularis). However, there is no clear-cut threshold value of Apgar score at birth that leads to hearing loss. There is also wide variability among newborn with asphyxia having hearing loss. Also, in NICU, babies with respiratory distress on ventilator have hyperoxygenation which may itself cause hypoxic damage to outer hair cells. Although the prevalence of sensorineural hearing loss in NICU graduates is 1-3%,one study found that 0.50% of survivors of severe neonatal respiratory failure had sensorineural hearing loss at 4 years of age.Fligor *et al*. found that, among children who had received extracorporeal membrane oxygenation, it was found that among patients with hearing loss 70% had progressive worsening. Also,35% of the children developed hearing loss in a delayed fashion, supporting the need for close monitoring of hearing throughout childhood in these patients[7, 8].

Hyperbilirubinemia is one of main problem usually seen in neonatal period and is usually present along with other risk factors.It causes neurological Sequela such as acute encephalopathy and kernicterus. We can prevent these neurological problems by means of phototherapy andexchange transfusion.But evenphototherapycan't reduce the riskof developing hearing impairment. There is no correlation between level of unconjugated bilirubin and hearing loss because of presence of other risk factors(prematurity, low birth weight, hypoxia, metabolic acidosis or perinatal infections).In these patients, bilirubin levels above 14 mg/dl represent a risk for hearing loss in 30% of cases.Unconjugated bilirubin crosses blood brain barrier in presence of acidosis, hypoxia, hypercapnia or hyperosmolarity.Hyperbilirubinemia can cause selective damage to the brainstem auditory nuclei and may also damage the auditory nerve and spiral ganglion cells.OAE is normal because of normal cochlear function but BERA shows abnormality. Many cases may develop late-onset, progressive hearing loss. Regular hearing checks are recommended, since there is a possibility that children may develop hearing loss later, as well as fitting of prosthetics when required[9, 10].

This indicator was removed from 2000 list as there is no clear-cut evidence and association with hearing loss. This indicator increases in importance when associated with other common disorders in the population of infants requiring admissions over 5 days at a NICU[11].

This factor includes all newborn admitted in a NICU for more than 5 days irrespective of the cause. This risk factor was introduced in 2007 statement instead of 48 hrs. In previous statement. Although this factor has no pathophysiological basis, it has high degree of association with hearing loss. Mencher and Mencher[12]found that a combination of hypoxic--ischemic encephalopathy, seizures, associated organ damage and delayed intrauterine growth represented a firm indicator of probable hearing loss and newborns with this kind of disease far exceed 5 days admission at a NICU. Other advantages of this risk indicator are that it also includes other adverse factors which are unique to NICU admission, such as ambient noise at those units. Children may be exposed to noise levels between 45 and 135 dB,thus exceeding the maximum recommended level of 58 dB,for extended periods of time, which has a synergistic action with the administration of aminoglycosides in producing auditory damage.

CONCLUSION

Hearing is one of the important senses and it is essential for normal speech and language development as it depends on the child's ability to hear spoken language. Early infancy is the most important time to acquire the foundation of language and communication. Therefore, early detection of hearing loss and its timely intervention will help minimize the negative effects of hearing loss on the development of cognitive, psychosocial and verbal communication skills and social interactions.

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