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Original Research Article

BERA in the detection of hearing loss in high risk children: an observational study in two tertiary care teaching hospitals in upper Assam region

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ABSTRACT

Background: Significant hearing loss affects children globally (1-3/1,000 infants at birth). Early diagnosis (<6 months age) and subsequent early intervention facilitates normal development of language, regardless of the severity of hearing loss.
Methods: A hospital-based, descriptive, retrospective study was done in two tertiary-care centres of Upper Assam region, upon total (55 + 46 =) 101 high risk children (<15 years) during a study period of 1 year. Patients were subjected to a questionnaire, and hearing tests (BERA/OAE) were performed.
Results: Majority of the cases were <5 years of age, with male preponderance (66.30% cases). NICU graduates with history of ototoxic medications/mechanical ventilation, neonatal hyperbilirubinemia and caregiver concern were the common presenting risk factors identified.
Conclusions: 49.50% cases (n=50) suffered from hearing loss [most common was severe degree of hearing loss, n= 24]. 75% cases in AMCH and 63.6% in LMCH with caregiver concern, 55.55% cases in AMCH and 50% in LMCH with past neonatal hyperbilirubinemia; 50% cases with positive family history; and 46.66% NICU graduates tested positive for hearing loss. Ideally, all high risk children <15 years should be screened for hearing loss with earliest intervention and rehabilitation, to enable them to lead a normal life and reduce the burden of handicap in the community.

Keywords: BERA, Hearing loss in infants, NICU graduates

INTRODUCTION

Hearing loss or hearing impairment is the most prevalent sensory disability globally and a condition that is of growing concern, affecting approximately 5.3% of the world's population. The prevalence of disabling hearing loss is greatest in South Asia, Asia Pacific and sub-Saharan Africa.[1,2]

Significant hearing loss is one of the most common major anomalies present at birth, occurring in approximately 1-3 infants per 1,000 infants.[1] The development of the cochlea and inner ear active mechanisms are complete at the time of birth, yet the central auditory pathway needs further maturation, which is thereafter dependent upon auditory stimulation. Hearing loss has no physical characteristics and the child with hearing loss looks

normal and often achieve normal early milestones, including babbling.[3]

In children, hearing loss interferes with the normal development of speech, language, and ultimately the cognitive as well as psychosocial development of the child is affected, thereby setting the children on a trajectory of limited educational and vocational attainment. Early diagnosis, preferably prior to the age of 6 months and subsequent early intervention, facilitates normal development of language, regardless of the severity of hearing loss.[4] If left undiagnosed and untreated, it impedes normal development of, speech, language, and ultimately the cognitive and psychosocial development of the child is affected.

If left undiagnosed and untreated, children with disabling hearing impairment progress into adulthood, which can lead to embarrassment, loneliness, social isolation and stigmatization, prejudice, abuse, psychiatric disturbance, depression, difficulties in relationships with partners and children, restricted career choices, occupational stress and relatively low earnings.[1]

Grading of hearing loss

According to the World Health Organization grading of hearing loss[5], hearing loss is classified into: 1) Normal hearing level (for practical purpose)-0 to 25 decibel hearing loss, 2) Mild hearing loss-26 to 40 decibel hearing loss, 3) Moderate hearing loss-41 to 60 decibel hearing loss, 4) Severe hearing loss-61 to 80 decibel hearing loss, 5) Profound hearing loss-over 81 decibel hearing loss.

Risk factors for hearing loss in children (aged less than 15 years): Including the risk factors stated by The Joint Committee on Infant Hearing (JCIH) Position Statement for Surveillance and Rescreening for Children with Risk Factors in 2019[5]:

(1) Significant family history of hearing loss, (2) Infants with history of stay in Neonatal Intensive Care Unit (NICU), (3) Children with history of neonatal hyperbilirubinemia (especially requiring exchange transfusion), (4) Children with history of perinatal asphyxia, (5) History of TORCH infections, (6) Drug history of ototoxic medications such as aminoglycosides, (7) All craniofacial conditions and physical conditions associated with hearing loss, (8) More than 400 syndromes and genetic disorders associated with atypical hearing thresholds, (9) Perinatal and postnatal confirmed bacterial and/or viral meningitis or encephalitis, (10) Predominantly postnatal events of significant head trauma particularly injury to the mastoid, (11) Family/caregiver concern regarding the child that his/her hearing, speech, language, or development requires attention.

In a nutshell, hearing loss not only permanently affects the development of oral language, but it may also affect development in general as well as emotional and social development in children.6 In this respect, new-born screening is also ideally mandatory to identify hearing loss in the prelinguistic period, and thereby contribute in reducing the burden of handicap in the community.[7]

Therefore, ideally all high-risk children must be screened for hearing impairment with regular follow-up, in order to initiate rehabilitative measures at the earliest. The American Academy of Audiology (2011) has recommended preschool and school-based hearing screening for permanent hearing loss and longstanding and frequently recurring conductive hearing loss, which may impact linguistic development and school performance.[8] Hence it was decided to study the hearing impairment in high-risk children under 15 years of age.

Aim of this study was to assess the hearing status amongst all high-risk children under the age of 15 years.

METHODS

This was a hospital-based, descriptive, observational study in which the hearing assessment of 101 high risk Childrens under the age of 15 years attending the Out Patient Department of ENT, Assam Medical College and Hospital (AMCH) and Lakhimpur Medical College and Hospital (LMCH), were studied. The study was conducted January 2022 to December 2022. Patients presenting to outpatient departments and fulfilling the following criteria were included in the study.

Inclusion criteria

Patients with high risk children attending the OPD of ENT, patients below 15 years of age, patients whose guardians are able to understand the questions of the questionnaire [Children Hearing Loss Database], and patients whose guardians who gave consent were included.

Exclusion criteria

Patients whose guardians were not able to understand and/or answer the questionnaire, patients with untreated otitis externa, patients with impacted cerumen/otitis media with effusion/gross deviated nasal septum/ chronic otitis media with perforated tympanic membrane, patients with atresia or stenosis of external ear canal of both ears, patients with severe multiple congenital anomalies incompatible with life were excluded.

Data collection

All children under the age of 15 years presenting with risk factor for hearing loss attending ENT OPD were considered for the study.

Full demographic profile of the patient including name, age, sex, family history of hearing loss, risk factor for hearing loss, clinical presentation, as per the questionnaire on children hearing loss database. All the patients were subjected to detail history, complete general, systemic and ENT examination after taking proper informed and written consent.

OAE (Otoacoustic Emission) test was performed as a screening tool (pass/refer) for infants less than 3 months of age. For children between 3 months to 15 years of age, the following hearing tests were performed:

BERA (Brainstem evoked response audiometry) which is an objective neurophysiological method for the evaluation of the hearing threshold in infants and children. Six to seven vertex positive waves, numbered I through VII, made up the measured recording, in accordance with Jewett and Williston's standard. BERA gave an estimate of the severity and type of hearing loss, whether hearing loss was unilateral/bilateral, whether the disease had cochlear/retro cochlear pathology and hence, it can be used for new-born hearing screening, auditory threshold estimation, intraoperative monitoring, determining hearing loss type and degree, and auditory nerve and brainstem lesion detection, and in development of cochlear implants.

The relevant details of each patient were filled in the proforma. The data collected were tabulated in Microsoft Excel worksheet and computer-based analysis was performed using Microsoft Excel 2013. The categorical variables were summarized as proportions and percentages. The study was a hospital-based descriptive study, so no statistical analysis between the parameters were evaluated

RESULTS

All children under the age of 15 years, with risk factors for hearing loss, attending Department of otorhinolaryngology during the study period, who fulfilled the inclusion criteria were included in the study. There was a total of 101(n) patients of children under 15 years during this study period; 55 cases in Assam Medical College and Hospital (AMCH) and 46 cases in Lakhimpur Medical College (LMCH).

The peak incidence of high-risk patients was found to be in age group of less than 5 years, (31 cases in Assam Medical College and Hospital, and 35 cases in Lakhimpur Medical College and Hospital), which consisted of 65.34% of total cases, while others belonged to the age group of 5 to 15 years. The oldest patient was 14 years 5 months old and youngest was 24 days old. It is noteworthy that children less than 5 years of age have better chances of rehabilitation including cochlear implant.

The study reveals that 67 of the cases were males and the rest 34 were females (Table 1). The Male: Female ratio is 1.97: 1.

Table 1: Age distribution.

Age (years)	0-5	5-15
Male	46	21
Female	20	14
Total	66	35

Table 2: Gender distribution.

Sex	No. of patients	Percentage (%)
Male	67	66.33
Female	34	33.66
Total (n)	101	100

Table 3: Religion distribution.

Religion	Males	Females	Total children	Percentage
Hinduism	55	27	82	81.18
Islam	10	05	15	14.86
Others	02	02	04	03.96
Total	67	34	101	100.00

Furthermore, in present study, it was found that the Hindus constituted the maximum number 81.18% of cases followed by Muslims 14.86%, and others 3.96%. The Upper Assam region has an estimated population of around 7.86 million (24% of Assam's population), wherein more than 80% of the people follow Hinduism with Islam being the second most prevalent religion. Also, a small section of the population practice Buddhism, Christianity, Sikhism and other religions.

In the present study, history of hospitalization in neonatal intensive care unit with administration of ototoxic medications/mechanical ventilation was the most common risk factor among the subjects (corresponding to 27.28% cases in AMCH and 36.9% cases in LMCH), followed by history of neonatal hyperbilirubinemia as the second most prevalent risk factor (16.36%) cases in AMCH and caregiver concern (23.9%) cases in LMCH was the amongst the high-risk children (Table 4 and 5).

Table 4: Distribution of risk factor in AMCH.

Risk factor	Male	Female	Total	
			Number	%
Neonatal hyperbilirubinemia	5	4	9	16.36
Birth asphyxia	3	2	5	09.09

Continued.

Risk factor	Male	Female	Total	
Torch infections	2	2	4	07.27
History of NICU stay with ototoxic medications/mechanical ventilation	8	7	15	27.28
History of bacterial meningitis or neoanatal sepsis	3	2	5	09.09
Family history of hearing loss	2	2	4	07.27
History of trauma	4	1	5	09.09
Caregiver concern	5	3	8	14.55
Total	32	23	55	100

Table 5: Distribution of risk factor in LMCH.

Risk factor	Male	Female	Total	
			Number	%
Neonatal hyperbilirubinemia	3	2	5	10.9
Birth asphyxia	3	1	4	8.7
Torch infections	5	2	7	15.2
History of NICU stay with ototoxic medications/mechanical ventilation	11	6	17	36.9
History of bacterial meningitis or neoanatal Sepsis	1	1	2	4.4
Family history of hearing loss	0	0	0	0
History of trauma	0	0	0	0
Caregiver concern	8	3	11	23.9
Total	31	15	46	100

Table 6: Unilateral Vs bilateral hearing loss.

Hearing	Normal hearing	Unilateral hearing loss	Bilateral hearing loss	Total
Number of patients	51	20	30	101
Percentage	50.50	19.80	29.70	100

Table 7: Risk factors for hearing loss (in AMCH).

Risk factor	Number of children with normal hearing	Number of children with hearing loss	Total number of children
Neonatal hyperbilirubinemia	4	5	9
Birth asphyxia	3	2	5
Torch infections	2	2	4
History of NICU stay with ototoxic medications/mechanical ventilation	8	7	15
History of bacterial meningitis or neoanatal sepsis	3	2	5
Family history of hearing loss	2	2	4
History of trauma	3	2	5
Caregiver concern	2	6	8
Total number of children	27	28	55

Table 8: Risk factors for hearing loss (in LMCH).

Risk factor	Number of children with normal hearing	Number of children with hearing loss	Total number of children
Neonatal hyperbilirubinemia	2	3	5
Birth asphyxia	3	1	4
Torch infections	4	3	7
History of NICU stay with ototoxic medications/mechanical ventilation	6	11	17
History of bacterial meningitis or neonatal sepsis	1	1	2

Continued.

Risk factor	Number of children with normal hearing	Number of children with hearing loss	Total number of children
Family history of hearing loss	0	0	0
History of trauma	0	0	0
Caregiver concern	4	7	11
Total number of children	20	26	46

DISCUSSION

In children, hearing loss interferes with the normal development of speech, language, and ultimately the cognitive as well as psychosocial development of the child is affected, thereby setting the children on a trajectory of limited educational and vocational attainment.

In our study there was 67 of the cases were males and the rest 34 were females. The Male: Female ratio is 1.97: 1. This is somewhat comparable to the study by Mehra et al (2009) which observed an (un-weighted) average male to female ratio of 1.24:1.[9] This shows there were more males in the high risk infants group than females, which may be attributed to the slightly skewed sex ratio of this region.[10] Furthermore, there exists some amount of gender difference in seeking healthcare in the Indian society, wherein the female child is often neglected, in comparison to the male counterparts.[11]

Ototoxic drugs like aminoglycosides kill off hair cells, resulting in permanent hearing loss by generation of free radicals and reactive oxygen species.[12] Mechanical ventilator support in infancy may cause mucosal injury of nasopharynx from intubation, as well as the eustachian tube (ET) to become dysfunctional, and thereby make the child 3-4 times more at risk of developing Chronic Otitis Media with effusion (OME). Hyperbilirubinemia can causes selective damage to the brainstem auditory nuclei , and also the auditory nerve and spiral ganglion cells by interfering with neuronal intracellular calcium homoeostas, while sparing the organ of Corti and thalamocortical auditory pathways which Clinically manifest as auditory neuropathy.[12] In our study, out of total 101 high-risk children, 51 children had normal hearing, corresponding to 50.49% of the cases, 20 children had unilateral hearing loss (19.80% cases), and 30 had bilateral hearing loss (29.70% cases), quite consistent with the study by Dommelen et al (2009).[13] In our study, out of total 101 high-risk children, 50 children had hearing loss (49.50% cases) while 51 had normal hearing (50.49%). Out of the 50 children who tested positive for hearing loss, 6 had mild hearing loss, 10 had moderate hearing loss, 24 children had severe hearing loss while 10 children had profound hearing loss; which correspond to respectively; 5.94%, 9.90%, 23.76% and 9.90% of the total cases included in our study.

In Assam Medical College and Hospital, 75% (6 cases out of 8 patients) cases with caregiver concern (regarding abnormal hearing and speech development) tested positive for hearing loss; whereas in Lakhimpur medical college and hospital 63.6% (7 cases out of 11 cases) with caregiver concern (regarding abnormal hearing and speech development) tested positive for hearing loss. 55.55% cases with history of neonatal hyperbilirubinemia; 50% cases with family history of hearing loss; and 46.66% cases with history of NICU stay with administration of ototoxic medications/mechanical ventilation tested positive for hearing loss are observed in Assam Medical College. In the other hand, 60% cases with neonatal hyperbilirubinemia; 64.7% cases with history of NICU stay with administration of ototoxic medications/mechanical ventilation tested positive for hearing loss are observed.

Maqbool et al (2015) observed that, the use of ototoxic drugs, exchange transfusion-required hyperbilirubinemia, prenatal asphyxia, and bacterial meningitis were the main causes of hearing loss in high-risk newborns, occurring in 45%, 30%, 26%, and 10% of children, respectively.[14] Biswas et al (2012) observed a hearing loss of 30.23% positivity amongst children having history of ototoxic drugs administration in infancy.[3]

The main limitation of this study was that it included patients who were in infancy, childhood years upto adolescence, and also patients in adolescent age group, which led to a loss of uniformity in the overall condition of the selected patients. Furthermore, there was a significant loss in follow-up of patients. Also, many patients failed to follow the intervention and rehabilitation as advised.

CONCLUSION

Hearing being one of the major special senses of a human being, a normal hearing is essential to lead an independent and self-sufficient life. As such, all high-risk children < 15 years of age should be screened and tested for hearing loss with earliest intervention and rehabilitation as possible, to enable them to lead a normal life as they step into adulthood, and thereby reduce the burden of handicap in the community. We must sensitize the general practitioners practicing in rural areas for early referral high risk children for hearing screening. All pediatricians should also sensitize regarding necessity of screening of high-risk neonates with Otoacoustic emission (OAE) and testing of high-risk children with BERA so that we can plan prompt rehabilitation

following early diagnosis. The state health department should also emphasize to the audiology assistants & multipurpose workers working under them to reach out villages so that no high-risk children left out without screening with OAE and testing with BERA.

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