ORIGINAL ARTICLE

Newborn Hearing Screening Practices in A Tertiary Healthcare Centre in the State of Meghalaya –A Clinical Audit Report

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ABSTRACT

Background: Congenital hearing impairment is a significant public health concern that can lead to irreversible delays in speech, language, cognitive and auditory development. This clinical audit evaluates the effectiveness of New Born Hearing Screening Program(NBHS) at a tertiary healthcare centre in Meghalaya.

Methods:A retrospective clinical audit was conducted on neonates screened over a defined period using a two-stage protocol. Universal Hearing Screening was performed using Distortion Product Otoacoustic Emission(DPOAE). Neonates who failed in the initial screening ("refer") underwent a second DPOAE screening. The referred DPOAE babies in the second stage was referred for Auditory Brainstem Response(ABR) and was diagnosed with Congenital Hearing loss.

Results: The data revealed that a two-stage screening protocol significantly reduced the false –positive rate , with the "pass" rate increasing substantially during the rescreening phase. Statistical analysis identifies hyperbilirubimia, low birth weight and perinatal asphyxia as statistically significant risk factors (p<0. 001) associated with referred DPOAEs. While the rescreening follow up rate was 84. 5% , the diagnostic follow up rate dropped to 48. 57% . In the present study, incidence of congenital hearing loss was estimated at 5 per 1, 000 live births per year, with an overall prevalence of 1. 4% in the screened population.

Conclusion: The institutional NBHS program is effective in early identification of hearing loss. Given the significantly high prevalence of "Refer" results observed among neonates with identified risk factors, the study finding suggests that the high risk cohort warrants mandatory diagnostic evaluation via ABR to ensure early and accurate detection.

Keywords: screening, neonates, Meghalaya, Sensorineural, hearing

INTRODUCTION

Screening involves the use of brief, standardized tests to distinguish individuals at high risk of developing a disorder from those at low risk. Within hearing conservation programs, the key considerations are selecting the target condition and assessing the effectiveness of screening methods.

Newborn Hearing Screening (NBHS) enables early identification of infants at risk for hearing loss, allowing timely diagnosis and intervention. It employs objective, non-invasive tests such as Otoacoustic Emission (OAE) and Auditory Brainstem Response (ABR) shortly after birth to detect potential hearing impairment. Early detection is vital, as the first two years of life are critical for speech, language, and cognitive development. Undetected congenital hearing loss can lead to delayed communication, poor academic performance, and psychosocial challenges. Timely intervention, including amplification and rehabilitation, significantly improves developmental outcomes, making Newborn Hearing Screening (NBHS) an essential component of paediatric healthcare.

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The Joint Committee on Infant Hearing (JCIH) provides internationally recognized guidelines for Early Hearing Detection and Intervention (EHDI). The 2007 statement introduced the "1-3-6 rule"—screening by one month, diagnosis by three months, and intervention by six months. The 2019 update further emphasized family-centered care, risk factor monitoring, and quality improvement.

The first large-scale newborn hearing screening was conducted by Marion Downs and Graham Sterritt in 1964 in the United States.[3] In India, NBHS began in the early 1970s as a research initiative, and in 2006, the National Program for Prevention and Control of Deafness (NPPCD) was launched, incorporating neonatal screening as a key community-level strategy for early detection and intervention.[4]

Incidence and prevalence of hearing loss in India and North East India:

The incidence of neonatal hearing loss in India varies by screening method and population. In Maharashtra, prevalence was 3.54/1, 000 live births,[5] while a tertiary hospital in Karnataka reported 0.717/1,000 among 13,676 newborns.[6] A North Indian district hospital recorded 8.2/1, 000 in well-baby nurseries and 18.3/1,000 in high-risk newborns.[7] Studies from Raipur and western India reported 2–5.45/1,000.[8,9]

In Northeast India, screening initiatives are emerging. A multicentric study in Agartala, Tripura, screening 2,068 newborns with a two-stage Transient Evoked Otoacoustic Emission-ABR protocol, found a prevalence of 0.4% (~4/1,000) despite follow-up challenges.[10] In Assam, studies involving high-risk NICU and paediatric cohorts reported higher prevalence rates of 7–11%.[11,12]

AIM OF STUDY: To evaluate the incidence and prevalence of hearing loss among new-borns in a tertiary healthcare centre in Meghalaya, a North Eastern state of India.

METHODOLOGY

Study Design and Setting: Retrospective clinical audit conducted in the Department of Audiology at a tertiary healthcare centre over a period of 2 years and 9 months (October 2021–July 2024).

The study was approved by the Institutional Ethics Committee and written informed consent was obtained from the parents/guardians.

Study Population and Sample Size: The study population comprised all newborns born at the tertiary healthcare centre during the study period. A total of 4, 000 newborns were included, based on parental/guardian consent for participation in the hearing screening program.

Inclusion and Exclusion Criteria

Inclusion criteria:

1. All neonates born at the tertiary healthcare centre during the study period.
2. Neonates whose parents or guardians provided written informed consent.

Exclusion criteria:

1. Neonates whose parents or guardians declined consent for participation.
2. Neonates with canal stenosis and Anotia.

Risk Factor Assessment: Each newborns was evaluated for the presence of high-risk criteria for congenital sensorineural hearing loss in accordance with the Joint Committee on Infant Hearing (JCIH) 2019 guidelines. Documented neonatal risk factors included:

1. Prematurity (<37 weeks of gestation).
2. Low birth weight (<1500 g).
3. Admission to Neonatal Intensive care Unit (NICU) for ≥48 hours.
4. APGAR score of 0–4 at 1 min or 0–6 at 5 min.
5. Septicaemia.
6. Ototoxic medication exposure.
7. Hyperbilirubinemia >10 mg/dl.
8. Syndromic features associated with hearing loss (e. g. , Down, Waardenburg, Usher syndromes).
9. Craniofacial anomalies.
10. Immunocompromised status.

Maternal risk factors assessed were:

1. Family history of congenital or delayed-onset childhood sensorineural hearing loss.
2. Consanguinity.
3. Maternal history of ototoxic drug intake.
4. Maternal infections (syphilis, Human Immunodeficiency Virus, hepatitis B, TORCH).
5. Prolonged labour or Perinatal asphyxia.

Equipments:

- **DPOAE:** ERO-SCAN (Maico, Germany) capable of performing DPOAE (4 ms) at four frequencies (2000 Hz, 3000 Hz, 4000 Hz and 5000 Hz) and Signal to Noise Ratio of 0-15 decibel.
- **ABR:** Neurosoft Neuro Audio ABR(Russia), 2-channel, window-based, utilizing click stimuli (condensation–rarefaction), delivered via insert earphones with neonatal-sized tips.

Screening Protocol:

The screening protocol adhered to the JCIH 2019 "1-3-6" guideline (screening by 1 month, diagnostic evaluation by 3 months, and intervention by 6 months).

- **Step 1:** Clinical otological examination (inspection of pre-aural region, pinna, post- aural region, and otoscopic assessment of tympanic membrane).

- **Step 2:** Initial DPOAE performed approximately 48 hours after birth.
- **Step 3:** Infants failing the initial screen underwent a re-test within 1 month during routine check-up.
- **Step 4:** Infants failing both screens underwent ABR testing between 1–3 months of age.
- **Step 5:** Infants diagnosed with hearing loss underwent further evaluation with ABR, tympanometry, and Behavioural Observation Audiometry (BOA) by 6 months of age.

Special considerations were applied for infants with Down's syndrome and other neurological or neurodevelopmental disorders, or prematurity. In premature neonates, repeated DPOAE was scheduled until 4–6 months of chronological age to account for immature auditory responses.

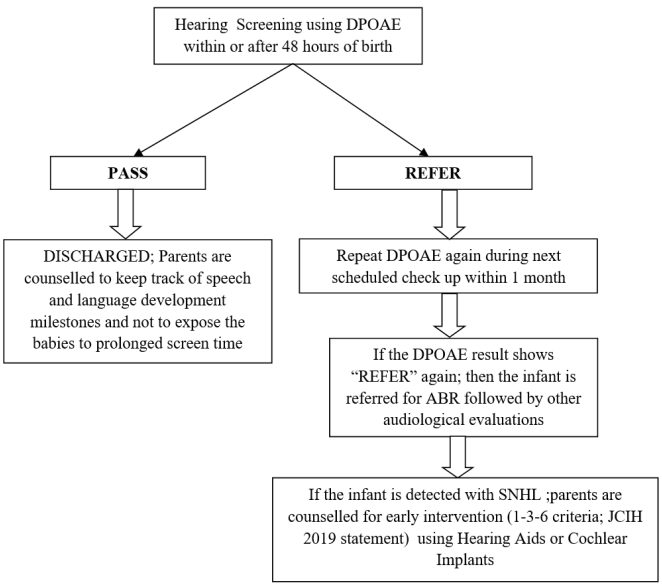

Figure 1: Flowchart of Hearing Screening protocol

ABR PROTOCOL

ABR testing was performed in an acoustically treated room, when the baby failed to pass the second OAE screening. Click stimulus, which predominantly reflects the auditory activity of cochlea from 2000 Hz to 4000 Hz, was delivered through calibrated insert earphones with neonatal tips at a repetition rate of 11.1 Hz. The rarefaction polarity was applied to improve waveform reproducibility and the click duration was 100 microseconds. Recordings were obtained using two-channel montage; with an analysis window of 15 ms. The reference electrode was placed on upper forehead, ground electrode on lower forehead and negative electrode on either left or right mastoid (M1 or M2) based on the test ear respectively. Responses were filtered using a band pass filter of 10-3000 Hz with a window of 16 milliseconds. A minimum of two reproducible waveforms was required to confirm the presence of peaks. The lowest stimulus intensity at which a replicable wave V was considered the threshold for auditory response. For this study the minimum criterion for normal hearing screening was defined as the presence of peak V at 40 dB nHL. Infants failing to show Wave V at or above this intensity were classified as having suspected hearing loss and underwent further evaluation using frequency specific-ABR, Tympanometry, and Behavioural Observation Audiometry (BOA) by 6 months of age with rigorous follow up after every 6 months.

Statistical Analysis

Demographic and screening data were recorded in Microsoft Excel 2010. Statistical analysis was performed using SPSS software (version 24). Chi-square tests were applied to assess the association between hearing screening outcomes and specific risk factors associated with referred DPOAEs. A p-value <0. 05 was considered statistically significant.

RESULTS

During the study period (October 2021–July 2024), a total of 5,326 live births were recorded, of which 4, 000 (75.1%) newborns underwent hearing screening using Distortion Product Otoacoustic Emission (DPOAE). Of these, 3,613 (90.33%) passed the initial screening, while 387 (9.67%) were referred for re-screening and diagnostic evaluation. The second-stage screening achieved a follow-up rate of 84.5%, with 15.5% of infants lost to follow-up. Among the 387 referred neonates, 188 (48.57%) underwent diagnostic testing with Auditory Brainstem Response (ABR), and 56 infants (1.4%) were confirmed to have congenital hearing loss of varying degrees. Based on these findings, the incidence of congenital hearing loss was estimated at 5 per 1000 live births per year, with an overall prevalence of 1.4% in the screened population.

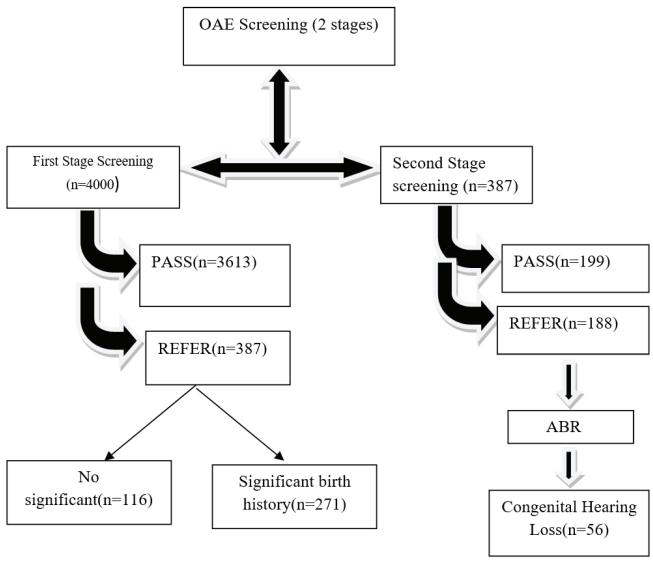

Figure 2: Flowchart depicting categorical distribution of the diagnosed cases, showing the prevalence of Congenital Hearing Loss

Association between Birth History and Screening Results:

A Chi-Square test revealed a significant association between birth history and hearing screening outcomes ($\chi^2 = 2608.52$, $p<0.001$). Neonates with significant birth history exhibited a higher rate of "Refer" results compared to those with no notable medical history.

Distribution of Risk Factors:

Among neonates with significant birth or medical history, the following risk factors were recorded.

Table 1: Distribution of medical conditions and risk factors

Risk Factors	Percentage %
Neonatal Jaundice	33.9%
Co-morbid conditions	36.68%
High-Risk Infants	21%
Pre-term and Low birth weight	2.21%
Congenital Disorders/syndromes	2.9%
High ESR	1.84%
Lymphocytosis	1.47%

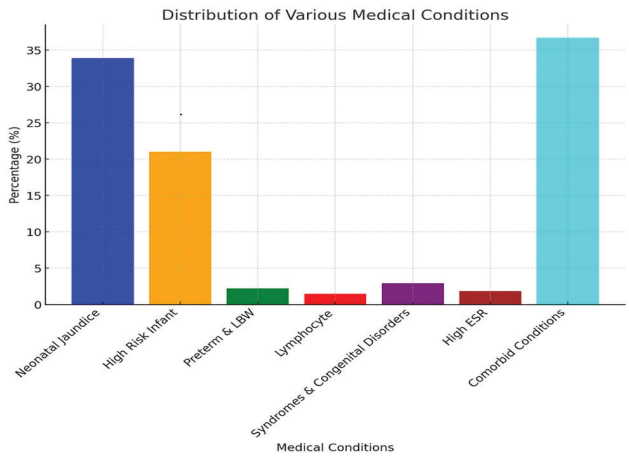

Figure 3: A bar graph showing the percentage distribution of various risk factors among the neonates

Association between Risk Factors and Hearing Outcomes:

The Chi-square analysis demonstrated a strong and statistically significant association between the presence of certain Risk Factors and DPOAE "Refer" results. Hyperbilirubine mia, perinatal asphyxia and low-birth weight(LBW) showed the highest levels of association.

Table 2: Chi-square analysis of risk factorsassociated with DPOAE "refer" results

Risk Factors	χ^2 Statistics	p-value	Interpretation
Hyperbilirubinemia	1621.62	<0.001	significant
Perinatal asphyxia	94.69	1.32×10^{-19}	significant
Low birth weight (LBW)	247.63	2.10×10^{-52}	significant

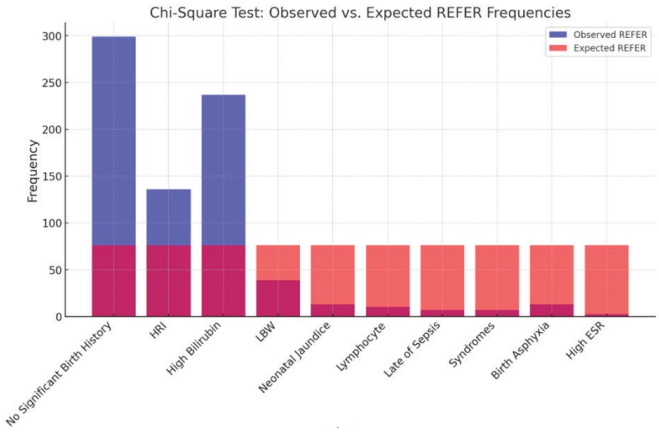

Figure 4: A bar diagram Shows observed vs. expected REFER frequencies across different risk factors.

DISCUSSION

The present clinical audit aimed to determine the prevalence and risk factors associated with congenital hearing loss among newborns screened at a tertiary healthcare centre in Meghalaya, North East India.

Prevalence and Incidence

The observed prevalence of hearing loss (1.4%) was slightly lower than the reported national range of 1.59%–8.8% per 1000 live births, while the incidence (5 per 1000 newborn per year) was marginally higher than the national average of 4 per 1000 live births.Similar trends were reported in studies by Varshney et al.and Verma et al., highlighting regional differences influenced by neonatal care quality and screening compliance.[13,14]

Role of Hyperbilirubinemia

Hyperbilirubinemia was the most prevalent risk factor (33.9%) associated with hearing loss. Studies have shown that infants with elevated bilirubin levels are 10–50 times more likely to develop sensorineural hearing loss (SNHL).[15] Unconjugated bilirubin can cross the blood–brain barrier, interfere with tyrosine uptake and N-methyl-D-aspartate (NMDA) receptor signalling, and result in auditory neuropathy or cochlear neuronal dysfunction. Premature infants are particularly vulnerable even at lower bilirubin levels, underscoring the need for routine bilirubin monitoring and early audiological assessment.[16]

Impact of Perinatal asphyxia and Low Birth Weight:

Perinatal asphyxia and LBW were also significantly associated with hearing loss ($p < 0.001$). These findings align with studies by Aziza et al.[17] and Schmutzhard et al.,[18] which demonstrated cochlear hair cell injury, neuronal hypoxia, and apoptosis in auditory structures following asphyxial insult. Infants with LBW may also exhibit immature cochlear and neural development, further predisposing them to auditory dysfunction.

Table 3: Comparison of Hearing Screening and follow up rates for screening across different Indian studies

Authors	Screening Protocol	F/U Rate for rescreening	Diangnostic Protocol	F/U Rate for diagnostics
Vignesh et. al (2015), Chennai	DPOAE	22. 13%	ABR	–
Rai et. al (2013), Northern India	2-step TEOAE	77%	ABR	69%
Paul et. al (2016) Ernakulam, Kerela	2-STEP OAE	99%	ABR	94%
Rawat et. al(2023), Panchkula, Haryana	2-step TEOAE-TEOAE	95%	ABR	–
Present study(2024) , Meghalaya	2-step DPOAE-DPOAE	84. 5%	ABR(click), Typhanometry-OAE-BOA	48. 57%

Referral and Follow-up rate

The referral rate (9.67%) in the present study was lower than the 19.1% reported in some developing countries[19] but above the ideal standard of 4% or less.[20] The follow-up rate (48.57%) was moderate, exceeding certain low-resource settings but considerably lower than the 95% reported in Haryana, India.[21]

Factors affecting follow-up included:

Limited parental awareness of screening importance

Socio-cultural beliefs

Inadequate counselling and tracking systems

Geographic and logistical constraints

Public Health Implications

Strengthening hospital-based tracking systems for at-risk neonates (hyperbilirubinemia, Low Birth Weight, asphyxia).

Routine parental counselling regarding the significance of early hearing screening and speech-language development.

Establishing state-level neonatal hearing databases for improved continuity of care.

Training pediatric and nursing staff to ensure adherence to the JCIH (2019) 1–3–6 model for early detection and intervention.

Limitations of the study

Follow-up gaps: 15.5% of neonates were lost to follow-up, possibly underestimating true prevalence. This also mandates interpretation of the incidence rates with caution.

Single-centre study: Findings may not be generalizable to other regions.

Socioeconomic factors were not analyzed, which might affect compliance.

DPOAE-only first-stage screening: A combined OAE–ABR approach could enhance sensitivity

CONCLUSION

The study demonstrates that neonatal hearing screening is feasible and essential even in resource-limited tertiary healthcare settings. High-risk neonates, particularly those with hyperbilirubinemia, perinatal asphyxia, or low birth weight, should undergo rigorous follow-up and early intervention. Strengthening awareness, parental counselling, and data tracking systems will be pivotal to achieving universal newborn hearing screening coverage in Meghalaya and similar regions of India.

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