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ORIGINAL RESEARCH

Neonatal Screening Of Hearing In High-Risk Newborns In Mother & Child Care Centre

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Abstract

Introduction: Neonatal hearing impairment is a critical developmental issue, especially among high-risk newborns, where early detection and intervention can significantly influence speech, language, and cognitive outcomes.

Aim: This cross-sectional study investigates the prevalence of hearing impairment in high-risk neonates admitted to the NICU of GMC, Amritsar, from December 2022 to May 2024, focusing on objective screening through Otoacoustic Emission (OAE) and Brainstem Evoked Response Audiometry (BERA) tests.

Material and Methods: A total of 180 high-risk neonates underwent OAE screening within the first month, with BERA follow-up at three months for those with "REFER" results.

Results and observations: The findings reveal a REFER rate of 29.4% in the right ear and 32.2% in the left ear using OAE, with lower REFER rates in BERA (8.3% in the right ear and 11.1% in the left ear), underscoring the importance of two-stage screening. Prematurity, severe hyperbilirubinemia, extended NICU stays, neonatal sepsis, and mechanical ventilation emerged as significant risk factors for hearing loss.

Conclusion: The study highlights the necessity of implementing targeted neonatal hearing screening protocols for high-risk populations to facilitate timely intervention and improve long-term developmental outcomes, aligning with public health objectives to enhance quality of life in affected children.

Introduction

The first few years of life are crucial for speech and language development. Early identification of hearing impairment is essential for timely intervention, which supports normal cognitive, social, and emotional development. Delayed diagnosis can lead to significant delays in speech, language, and overall cognitive growth, impacting a child's quality of life and social interactions. The prevalence of neonatal hearing impairment, identified through objective screening methods such as Auditory Brainstem Response (ABR) and Auditory Steady State Response (ASSR), varies significantly. Among the general newborn population, prevalence ranges from 1.59 to 8.8 per 1,000 births. Among those categorized as "at risk," the prevalence widens to between 7 and 49.18 per 1,000 births.[1]

The World Health Organization defines hearing loss as a hearing threshold greater than 20 dB in both ears.[2] Recognizing the significant developmental impacts of undiagnosed hearing impairment, many developed countries have implemented Universal Neonatal Hearing Screening (UNHS) programs. UNHS utilizes objective and reliable screening tools like Otoacoustic Emission (OAE) and Brainstem Auditory Response Audiometry (BERA) to screen newborns.[3] Selective screening approaches, also known as targeted newborn hearing screenings, focus on specific subgroups within a population, particularly NICU neonates or newborns who meet Joint Committee on Infant Hearing (JCIH) criteria.

The etiology of neonatal hearing impairment is typically divided into genetic and non-genetic causes. Genetic factors account for about 50% of congenital hearing loss, with a breakdown of 30% syndromic and 70% non-syndromic presentations. Non-genetic factors, accounting for roughly 33% of cases, include hyperbilirubinemia, infections like cytomegalovirus (CMV), perinatal asphyxia, exposure to ototoxic drugs, prematurity, and low birth weight.[4] Early

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identification and intervention are particularly crucial, as about 50% of infants diagnosed with hearing loss lack identifiable risk factors, underscoring the need for universal screening protocols.[5]

This article explores the multifaceted nature of neonatal hearing impairment—its causes, types, screening methods, diagnostic criteria, and the importance of early intervention. Current guidelines, including those from the JCIH, the Indian Academy of Pediatrics (IAP), and the National Neonatal Forum (NNF), are reviewed alongside national initiatives for early detection and rehabilitation, such as the National Programme for Prevention and Control of Deafness and the Rashtriya Bal Swasthya Karyakram (RBSK).[6,7] By examining these elements, the article highlights the essential practices and policies that shape neonatal hearing care worldwide.

This study focuses on identifying hearing impairment as early as possible in high-risk neonates, enabling prompt intervention. A cross-sectional study was conducted on 180 newborns admitted to the NICU in the Department of Pediatrics to achieve this goal.

Material and Methods

Study Design: Cross-sectional

Location: Department of Pediatrics, GMC, Amritsar

Duration: December 2022 – May 2024

Population: High-risk newborns (per JCIH criteria)

Ethical approval was obtained from the institute's ethics committee, and written consent was gathered from parents. The study population comprised high-risk newborns admitted to the NICU within 28 days of life. Data collected included newborns' demographics, gestational age, birth weight, NICU course details (such as perinatal asphyxia and ototoxic drug exposure), and family history of hearing loss.

Screening Protocol

- **First-stage Screening:** Otoacoustic Emission (OAE) conducted within the first month.
- **Second-stage Screening:** Brainstem Evoked Response Audiometry (BERA) conducted at 3 months in the ENT Department, Ramlal Eye and ENT Hospital, GMC, Amritsar.
- **Intervention:** Early intervention was recommended for infants diagnosed with hearing impairment.

Inclusion Criteria:

- NICU stay >5 days, with:
- Use of ototoxic drugs or assisted ventilation
- Hyperbilirubinemia requiring exchange transfusion
- Postnatal infections (e.g., meningitis, sepsis)
- High-risk newborns per JCIH criteria

Exclusion Criteria:

- In utero infections (e.g., TORCH infections)
- Anomalies of ear structure, cleft palate, or craniofacial anomalies
- Syndromic causes of hearing loss (e.g. Neurofibromatosis, Waardenburg syndrome, Pendred syndrome)

Study Procedures

OAE Methodology: A probe placed in the external auditory canal delivered an 80 dB click stimulus. For "REFER" results with ear canal obstruction, a follow-up was conducted after two days.

BERA Methodology: Stimuli were delivered through headphones with scalp electrodes recording wave patterns from the brainstem. The minimum intensity at which wave V was detected was set as the hearing threshold.

Statistical Analysis

Data analysis was performed using online software. Pearson's Chi-square test identified correlations between hearing loss and risk factors, with a p-value <0.05 considered statistically significant.

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Results and Observation

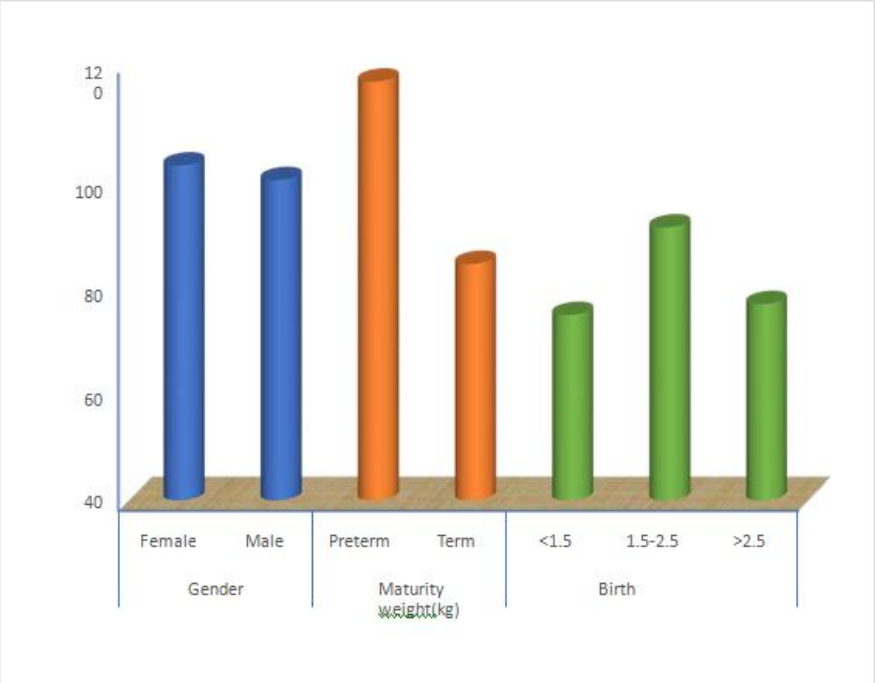

Figure 1: Demographic profile

Figure: 1 shows that in our study 51.1% patients were females while 48.9% were males. According to the gestational age at birth, 115 newborns in our study were born prematurely (63.89%) while 65 were term babies (36.11%). Majority of newborns were in the weight category of 1.5-2.5 kg- 75 newborn (41.7%), 54 newborns >2.5 kg (30%) and 51 newborns <1.5 kg (28.3%).

		OAE RT		OAE LT	
		Pass	Refer	Pass	Refer
		No. (%)	No. (%)	No. (%)	No. (%)
Gender	Female	63 (49.61)	29 (54.72)	60 (49.18)	32 (55.17)
	Male	64 (50.39)	24 (45.28)	62 (50.82)	26 (44.83)
Maturity	Preterm	87 (68.5)	28 (52.83)	77 (63.11)	38 (65.52)
	Term	40 (31.5)	25 (47.17)	45 (36.89)	20 (34.48)
Weight (kg)	<1.5	40 (31.5)	11 (20.75)	34 (27.87)	17 (29.31)
	1.5-2.5	47 (37.01)	28 (52.83)	49 (40.16)	26 (44.83)
	>2.5	40 (31.5)	14 (26.42)	39 (31.97)	15 (25.86)
Perinatal Asphyxia	No	83 (65.35)	31 (58.49)	81 (66.39)	33 (56.9)
	Yes	44 (34.65)	22 (41.51)	41 (33.61)	25 (43.1)
IUGR	No	109(85.83)	47 (88.68)	105(86.07)	51 (87.93)
	Yes	18 (14.17)	6 (11.32)	17 (13.93)	7 (12.07)
Phototherapy(severe hyperbilirubinemia)	No	26 (20.47)	20 (37.74)	27 (22.13)	19 (32.76)
	Yes	101(79.53)	33 (62.26)	95 (77.87)	39 (67.24)
Exchange Transfusion(severe hyperbilirubinemia)	No	118(92.91)	49 (92.45)	115(94.26)	52 (89.66)
	Yes	9 (7.09)	4 (7.55)	7 (5.74)	6 (10.34)
Early Onset(septicemia)	No	35 (27.56)	14 (26.42)	32 (26.23)	17 (29.31)
	Yes	92 (72.44)	39 (73.58)	90 (73.77)	41 (70.69)
Late Onset(septicemia)	No	109(85.83)	43 (81.13)	105(86.07)	47 (81.03)
	Yes	18 (14.17)	10 (18.87)	17 (13.93)	11 (18.97)
NICU Stay (Days)	<10	55 (43.31)	18 (33.96)	55 (45.08)	18 (31.03)
	11-20	29 (22.83)	24 (45.28)	28 (22.95)	25 (43.1)
	21-30	13 (10.24)	6 (11.32)	13 (10.66)	6 (10.34)
	>30	30 (23.62)	5 (9.43)	26 (21.31)	9 (15.52)
Ototoxic Drug	No	31 (24.41)	12 (22.64)	29 (23.77)	14 (24.14)
	Yes	96 (75.59)	41 (77.36)	93 (76.23)	44 (75.86)

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Mode of Delivery	LSCS	66 (51.97)	28 (52.83)	64 (52.46)	30 (51.72)
	NVD	61 (48.03)	25 (47.17)	58 (47.54)	28 (48.28)
Neonatal Seizures	No	96 (75.59)	32 (60.38)	92 (75.41)	36 (62.07)
	Yes	31 (24.41)	21 (39.62)	30 (24.59)	22 (37.93)
Mechanical Ventilation	No	99 (77.95)	45 (84.91)	97 (79.51)	47 (81.03)
	Yes	28 (22.05)	8 (15.09)	25 (20.49)	11 (18.97)

Table 2: Factors influencing neonatal hearing screening (OAE)

This analysis examines factors influencing neonatal hearing screening (OAE) results in both ears, highlighting significant associations. Gender, weight, perinatal asphyxia, IUGR, exposure to ototoxic drugs, and delivery mode showed no significant effect on hearing outcomes. However, preterm neonates, those with severe hyperbilirubinemia requiring phototherapy, longer NICU stays, and those experiencing neonatal seizures had higher "refer" rates, particularly in the right ear. These findings suggest that preterm birth, jaundice treatment, extended hospital stays, and seizures may elevate the risk of initial hearing screening challenges, indicating the need for careful monitoring in these groups.

		BERA RT		**BERA LT**	
		Pass	Refer	Pass	Refer
		No. (%)	No. (%)	No. (%)	No. (%)
Gender	Female	83 (50.3)	9 (60)	80 (50)	12 (60)
	Male	82 (49.7)	6 (40)	80 (50)	8 (40)
Maturity	Preterm	110(66.67)	5 (33.33)	101(63.13)	14 (70)
	Term	55 (33.33)	10 (66.67)	59 (36.87)	6 (30)
Weight (kg)	<1.5	44 (26.67)	7 (46.67)	42 (26.25)	9 (45)
	1.5-2.5	72 (43.64)	3 (20)	69 (43.13)	6 (30)
	>2.5	49 (29.7)	5 (33.33)	49 (30.63)	5 (25)
Perinatal Asphyxia	No	106(64.24)	8 (53.33)	104 (65)	10 (50)
	Yes	59 (35.76)	7 (46.67)	56 (35)	10 (50)
IUGR	No	143(86.67)	13 (86.67)	140 (87.5)	16 (80)
	Yes	22 (13.33)	2 (13.33)	20 (12.5)	4 (20)
Phototherapy(severe hyperbilirubinemia)	No	44 (26.67)	2 (13.33)	43 (26.88)	3 (15)
	Yes	121(73.33)	13 (86.67)	117(73.13)	17 (85)
Exchange Transfusion(severe hyperbilirubinemia)	No	157(95.15)	10 (66.67)	153(95.63)	14 (70)
	Yes	8 (4.85)	5 (33.33)	7 (4.38)	6 (30)
Early Onset(septicemia)	No	44 (26.67)	5 (33.33)	43 (26.87)	6 (30)
	Yes	121(73.33)	10 (66.67)	117 (73.13)	14 (70)
Late Onset(septicemia)	No	141(85.45)	11 (73.33)	136 (85)	16 (80)
	Yes	24 (14.55)	4 (26.67)	24 (15)	4 (20)
NICU Stay (Days)	<10	71 (43.03)	2 (13.33)	68 (42.5)	5 (25)
	11-20	47 (28.48)	6 (40)	46 (28.75)	7 (35)
	21-30	18 (10.91)	1 (6.67)	17 (10.63)	2 (10)
	>30	29 (17.58)	6 (40)	29 (18.13)	6 (30)
Ototoxic Drug	No	41 (24.85)	2 (13.33)	41 (25.62)	2 (10)
	Yes	124(75.15)	13 (86.67)	1193(74.38)	18 (90)
Mode of Delivery	LSCS	88 (53.33)	6 (40)	85 (53.12)	9 (45)
	NVD	77 (46.67)	9 (60)	75 (46.88)	11 (55)
Neonatal Seizures	No	120(72.73)	8 (53.33)	117(73.12)	11 (55)
	Yes	45 (27.27)	7 (46.67)	43 (26.88)	9 (45)
Mechanical Ventilation	No	136(82.42)	8 (53.33)	131(81.87)	13 (65)
	Yes	29 (17.58)	7 (46.67)	29 (18.12)	7 (35)

Table 3: factors influencing Brainstem Evoked Response Audiometry (BERA) results

On analyzing the Brainstem Evoked Response Audiometry (BERA) results, several variables were evaluated. Gender did not significantly impact BERA outcomes, with similar pass rates for both males and females. Gestational age revealed term infants had a higher referral rate than preterm ones, but the effect was only significant in right ear responses. Birth weight showed no significant impact on BERA results, although lower birth weights analysingsaw a higher referral rate. Perinatal asphyxia also did not show a significant association, despite slightly higher referrals among affected infants. Similarly, IUGR

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status had no significant effect on BERA outcomes. Severe hyperbilirubinemia requiring exchange transfusion was significantly associated with BERA referral rates, indicating a possible risk factor. Septicemia did not yield significant results in either early or late onset. NICU stay duration showed some effect on referrals, especially for prolonged stays over 30 days. Ototoxic drugs, mode of delivery, and neonatal seizures were not significantly associated with referrals, though mechanical ventilation was significantly linked to higher referral rates in the right ear. These findings suggest that certain neonatal factors, like hyperbilirubinemia and mechanical ventilation, may influence auditory outcomes more than others, and thus could be areas for focused monitoring in neonatal care.

Discussion

In Present study included 180 NICU-admitted newborns between December 2022 and January 2024, with follow-up until May 2024. Institutional ethics approval and informed consent were obtained. After initial stabilization, newborns underwent OAE screening in the ENT department. Those with a "REFER" result had a repeat OAE test after two weeks, with BERA testing at 3-4 months to confirm hearing status and assess related risk factors. Profound hearing loss ranged from 8.3% in the right ear to 11.1% in the left ear, consistent with findings from Regina M et al.,[8] who reported 8.2 per 1000 in healthy neonates and 18.3 per 1000 in high-risk cases. The study sample had a 51.1% female prevalence, with 52.2% of newborns delivered via LSCS and a majority (63.89%) born preterm. Prematurity showed a significant correlation with hearing loss, similar to Han JH et al.,[9] where gestational age and low birth weight correlated with auditory impairment (p=0.011).

No significant hearing loss correlation was observed based on gender, birth weight, IUGR, or mode of delivery, diverging from Al-Balas HI et al.[10] and Gonzalez JC et al.,[11] who found some associations. Neonates with early-onset sepsis had a PASS rate of 73.33%, but late-onset sepsis showed a significant relationship with hearing loss (p=0.022), consistent with Siddique AK et al.[12] and Maqbool M et al.[13] No link between seizures and hearing loss was observed, aligning with Regina M et al., while no significant hearing impairment was found with ototoxic drugs, unlike Pourarian S et al.[14] Hyperbilirubinemia and exchange transfusion cases did show hearing loss risk, agreeing with Agrawal VK et al. and Boskabadi H et al. No association was found with perinatal asphyxia (p=0.384 for OAE; p=0.40 for BERA), similar to Boskabadi H et al.[15]

NICU stay duration showed a significant link with hearing loss (p=0.011), with longer stays associated with prematurity, as noted in Shukla A et al.[16] Mechanical ventilation was significantly associated with hearing impairment (p=0.046), consistent with Rastogi S et al.[17] The two-stage OAE and BERA testing method showed a high REFER rate in OAE (29.4%) but lower in BERA (8.3%), reflecting findings by Dhawan R et al.[18] and Vaid N et al.[19] Similar to Bai JS et al., the study found higher hearing loss prevalence in high-risk neonates (8.3% right ear, 11.1% left ear). Key risk factors included prematurity, hyperbilirubinemia, extended NICU stays, sepsis, and mechanical ventilation, emphasizing the importance of early intervention for high-risk groups.

Conclusion

Our study concluded that a multitude of risk factors such as prematurity, low birth weight, neonatal jaundice, birth asphyxia, presence of septicemia and use of mechanical ventilation had a significant impact on hearing impairment in newborns. REFER result with OAE was seen in 29.4% cases in Right ear and 32.2% cases in Left ear which was lower than BERA. BERA had a lower REFER result of 8.3% in Right ear and 11.1 % in Left ear thus highlighting the need for 2 stage screening tool in assessment of hearing impairment.

This universal hearing screening aligns with the public health goals to improve early childhood health and development outcomes. The number of preterm and critically cared for babies is predicted to climb, which will increase the burden of hearing impairment making hearing assessment essential for early detection of hearing impairments, which leads to timely intervention and support, thereby improving development outcomes and quality of life of affected children.

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