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Original Article

Risk Factors Associated with Newborn Hearing Impairment in the Neonatal ICU of a Tertiary Hospital

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Abstract

Introduction: Hearing impairment has a devastating, detrimental, and adverse impact on the development of the newborn. Unfortunately, this hidden disability remains undetected for many newborns until it is too late to prevent undesirable and often irreversible damage. It has long been recognized that undiagnosed hearing loss, even a mild loss at birth, can negatively affect speech and language development, resulting in poor academic achievement and social-emotional development. According to WHO 2009, newborns in the NICU are 10-20 times at higher risk of developing hearing loss. The risk factors associated with newborn hearing impairment vary from country to country and even within countries. There has been a paucity of studies on this topic from Bangladesh. This study was done to identify the risk factors associated with newborn hearing impairment in the study place.

The objective of the study: To identify risk factors associated with newborn hearing impairment in the study group.

Methodology: A prospective observational study was conducted in the department of neonatology, BSMMU. After taking consent from the parents/guardians, a thorough history of these newborns, including particulars of the neonates, family history of hearing loss, treatment history, antenatal, natal, and postnatal history, was recorded in a data collection form. Newborn admitted to the NICU during the study period was the study population. The newborn who meet the inclusion criteria was screened with Transient Evoked Otoacoustic Emissions (TEOAE) close to discharge from the NICU or before one month of age. A second screen was done with TEOAE again after one month of 1st screen but prior to 3 months of postnatal age if referred in 1st screen. Diagnostic Auditory Brain stem Response (ABR) was made to confirm the hearing impairment, and it was done prior to 3 months of postnatal age if referred in both the 1st and 2nd screens. Data were analyzed by statistical package for social sciences (SPSS) version 20.

Results: 426 valid recordings from 493 newborns admitted in the NICU enrolled consecutively constitute the basis of this study. 14 newborns were found to have hearing impairment among 426 newborns. APGAR ≤ 6 at 5 minutes (odds ratio 20.34, p-value 0.01), TORCH infection (odds ratio 0.64, p-value 0.01), IUGR odds ratio 8.92, p-value 0.02) were independent significant risk factors for hearing impairment.

Conclusion: APGAR ≤ 6 at 5 minutes, TORCH infection, and IUGR are independent significant risk factors for newborn hearing impairment. Newborns in NICU with these risk factors should have mandatory audiological evaluation.

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Introduction

One-third of the world's hearing-impaired population lives in South East Asia. It contributes to the largest number of hearing impairments in the world. WHO estimates that every year about 38,000 deaf children are born in this region.[1]

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Newborns in NICU are at high risk for developing hearing loss.[2] One to three per 1000 live births suffers from significant hearing impairment. In neonatal intensive care unit, this number is up to 2-4% live birth which is a ten times increase in number.[3]

Early detection and the treatment of childhood hearing loss are essential for the development of communication skills, social skills, emotional well-being, and positive self-esteem. Hearing impairment in early life causes inadequate auditory input during the critical period of language development and adversely affects receptive and expressive speech during the first few years of life. It also has negative effects on academic and vocational achievements.[1,4] Without appropriate opportunities to learn a language, these children will face difficulty in communication and reading. Such delays may lead to lower educational and employment levels in adulthood.[5] Hearing disorders have also been associated with increased behavior problems, decreased psychosocial well-being, and poor adaptive skills.[6,7] This ultimately affects successful integration into society and the prospects of leading a productive life.[8] Several prospective studies have consistently demonstrated that early diagnosis of hearing impairment and intervention can improve intellectual, language, and speech development.[9,10]

According to one study done by Yoshinago, the only significant variable to affect the development of language skills is the age at which hearing impairment was diagnosed.[11] Robinshaw reported that children who were identified and who wore hearing aids by the age of six months acquired age-appropriate vocal communicative and linguistic skills well before children who were identified at a later age.[12]

Approximately 50% of congenital hearing loss is thought to be of genetic origin. Among them, 30% are associated with a syndrome. More than 400 syndromes are known to include hearing loss (e.g., Alport, Pierre Robin, Usher, Waardenburg syndromes, and trisomy 21). In approximately 25% of childhood hearing loss, a non-genetic cause is identified. Hearing loss is thought to be secondary to an injury to the developing auditory system in the intrapartum or perinatal period. This injury may result from infection, hypoxia, ischemia, metabolic disease, ototoxic drugs, and hyperbilirubinemia. The etiology of neonatal hearing loss may remain unknown in as many as 30% to 40% of children.[3, 13]

Meyer showed a familial hearing loss, sepsis, meningitis, and craniofacial malformations were identified to be independent significant risk factors for neonatal hearing disorders. He also showed prematurity, 32 weeks, and weight at birth, 1500 gm, did not significantly increase the risk for neonatal hearing disorders.[14]

Recent advances in the area of hearing screening have facilitated the availability of more sensitive and easy-to-use screening tools that can effectively and reliably test hearing soon after birth.[15,16] At present, the choice of device for newborn hearing screening is either transient evoked otoacoustic emission (TEOAE) or Auditory brain stem response (ABR) and sometimes a combination of the two. A threshold of 35 dB has been established as a cut-off for an abnormal screen. A threshold above 35 dB is regarded as refer, and a threshold below 35 dB is regarded as a pass. Automated ABR is used for screening, and Diagnostic ABR is used for the diagnosis of sensorineural hearing loss. Diagnostic ABR is the gold standard for diagnosing sensorineural hearing loss.[3, 17]

Aims and objectives

To identify risk factors associated with newborn hearing impairment in the study group.

Materials and Methods

A prospective observational study was conducted in the neonatal intensive care unit (NICU), department of neonatology, BSMMU, Dhaka, and department of otolaryngology- head and neck surgery, BSMMU, Dhaka over a period of 24 months between January 2014 to January 2016. Newborn admitted to the NICU during the study period was the study population. After taking written consent from the parents/guardians, there was a face-to-face interview with the mother or

caregivers to take a thorough history of these newborns. Gestational age was determined by maternal record (Maternal recall of LMP or available ultrasonography reports) and by the New Ballard Scoring system. Weight was measured by an electronic weighing scale (SALTER Model-914 UK) which was accurate to ±5g and was calibrated before each measurement. Weight was taken with accuracy by keeping the baby undressed and before feeding by the neonatal nurse. The newborn's medical records were reviewed to identify antenatal, natal, and postnatal risk factors and recorded in a data collection form. Clinical examination was done in the search for risk factors such as outer ear anomalies, preauricular pits or tags, and syndromic features. The newborn was screened with TEOAE first, as close to discharge as possible when the newborn was deemed to be well or just before one month of age if staying longer in the NICU. Both ears were screened individually. A second screen was done with TEOAE again after one month of the first screen but prior to 3 months of postnatal age in a newborn who was referred in the first screen. Both ears were screened, even if only one ear was referred in the initial screening. A diagnostic evaluation with ABR (Diagnostic ABR) was performed in both ears prior to 3 months of postnatal age if referred in both 1st and 2nd screens. Newborn re-admitted in the NICU during the first month of life should have a hearing screen repeated as a new case. Parents were informed in an understandable manner if their newborn did not pass screening and informed about the importance of prompt follow-up. Before discharge, those parents were offered an appointment for follow-up testing. After discharge, the parents/guardians of a newborn who was referred in the previous screening were contacted by repeated phone calls, text messages, and letters to return at the scheduled time for the next test. Data were analyzed by statistical package for social sciences (SPSS) version 20.

At first, the frequency of the risk factors was assessed among 402 valid records. All risk factors were then analyzed with a Chi-square test to find out significant risk factors among them. These significant risk factors were then assessed with a multiple logistic regression test to see the odd ratio. P-values less than 0.05 (at 95% CI) were considered statistically significant.

Results

Four hundred ninety-three newborns admitted to NICU were eligible for the study during the study period. After excluding 67 newborns from the study, 426 newborns were enrolled in the study. Twenty-four newborns were dropped out, leaving 402 valid records for analysis. Hearing impairment was confirmed in 14 newborns (3.3%). It was unilateral in 2 newborns and bilateral in 12 newborns. It is still an underestimation considering the number of newborns (24) who were lost to follow-up.

Table 1: Association between hearing impairment and risk factors (Chi-square test):

Risk Factors	Variable	Frequency	P value
Gender	Male	241	**0.04**
	Female	161	
Gestational age	28-32 wks	122	0.13
	33-36 wks	168	
	37-42 wks	112	
Place of birth	Inborn	334	**0.00**
	Outborn	64	
Mode of delivery	NVD	103	0.31
	C/S	297	
	Assisted	2	
PROM≥ 18 hours	Yes	68	0.78
	No	334	
APGAR ≤ 6 at 5 minutes	Yes	62	**0.00**
	No	340	
Birth weight	<1500g	127	0.73
	1500-<2500g	168	
	≥2500	107	
IUGR	Yes	78	**0.00**
	No	324	
	No	324	

Table 1: shows the association between hearing impairment and risk factors by Chi-square test. P-values less than 0.05 were considered statistically significant. It shows gender, place of birth, APGAR ≤ 6 at 5 minutes, and IUGR are significant risk factors for hearing impairment.

Table 2: Association between hearing impairment and risk factors (Chi-square test):

Risk Factors	Variable	Frequency	P value
Sepsis	Yes	206	0.52
	No	196	
Meningitis	Yes	28	0.97
	No	374	
TORCH	Yes	30	**0.00**
	No	372	
Phototherapy	Yes	204	0.25
	No	198	
Exchange transfusion due to jaundice	Yes	26	0.31
	No	376	

Ototoxic drugs	Yes	241	0.30
	No	161	
NICU care >5 days	Yes	302	0.34
	No	100	
Ventilator care >5 days	Yes	60	0.39
	No	342	
Craniofacial anomalies	Yes	8	**0.00**
	No	394	
Family history of hearing loss	Yes	3	**0.04**
	No	399	

Table 2: shows the association between hearing impairment and risk factors by Chi-square test. P-values less than 0.05 were considered statistically significant. It shows TORCH, Craniofacial anomalies, and a Family history of hearing loss are significant risk factors for hearing impairment.

Table 3: Multiple logistic regression of risk factors

Risk factors	**Coefficient (**B**)**	**Standard Error**	**Significance (p-value)**	**Exp(B)**	**95% CI for Exp(B)** **Lower - Upper**
Gender	0.433	1.062	0.693	1.542	0.192-12.362
Place of birth	-1.321	0.893	0.139	0.267	0.046-1.536
APGAR ≤ 6 at 5 minutes	3.013	1.275	0.018	20.340	1.673-247.309
IUGR	2.189	0.985	0.026	8.924	1.294-61.560
TORCH	2.365	0.950	0.013	10.640	1.654-68.441
Craniofacial anomalies	-0.031	1.994	0.988	0.970	0.019-48.290
Family history of hearing loss	1.590	3.891	0.683	4.904	0.002-10069.175
Constant	-6.281	1.385	0.000	0.002	

Table 3: showed the validity of a single risk factor was further assessed by multiple logistic regression of the statistically significant risk factors performed by the Chi-square test. Multiple logistic regression shows APGAR ≤ 6 at 5 minutes (odds ratio 20.34, p-value 0.01), TORCH infection (odds ratio 10.64, p-value 0.01), IUGR odds ratio 8.92, p-value 0.02) were independent significant risk factors for hearing impairment. The strength of association was estimated by odds ratios (OR) and the corresponding 95% confidence intervals (CI).

Discussion

Unidentified hearing impairment at birth is an invisible disability that needs audiologic evaluation of neonates with risk factors for early detection and timely intervention to assist proper speech, language, and cognitive development. The risk factors associated with newborn hearing impairment vary from country to country and even within countries.[16] There has been a paucity of studies on this topic from Bangladesh. This study was done to identify the risk factors associated with newborn hearing impairment in the study place.

In a study done from January 2011 to June 2011 by Mannan MA on 168 newborns, including 116 from NICU and 52 from neonatal nursery (MCU), underwent hearing screening and found small for gestational age, birth weight <1500 gram, neonatal ototoxic medication, sepsis/meningitis, hyperbilirubinemia, TORCH infections as an independent risk factor for abnormal hearing screening result ($p<0.01$).[18] In our study, 426 valid recordings from 493 newborns admitted to the NICU, and 14 newborns were found to have a hearing impairment. APGAR $\leq$ 6 at 5 minutes (odds ratio 20.34, p-value 0.01), TORCH infection (odds ratio 10.64, p-value 0.01), IUGR (odds ratio 8.92, p-value 0.02) were independent significant risk factors for hearing impairment in our study. The difference in such associations might be due to advanced care and decreased postnatal morbidities associated with LBW or IUGR newborns in the last few years and careful monitoring of ototoxic drug doses.

Meyer et al., in a study, found - sepsis, meningitis, craniofacial malformations, and familial hearing loss as independent significant risk factors. Our study found TORCH infection in the newborn, IUGR, and APGAR score <6 at 5 minutes were associated with hearing impairment.[14] Different risk factors in our study might be due to improved perinatal handling of the neonatal population at risk for hearing disorders. The newer technology used in modern NICUs, careful implementation of new treatments, better infection control, and strict drug dose monitoring might have an impact on other risk factors of our study. Risk factors are different in these studies might be due to variations in sample size, study design, study population, and study area. Lack of antenatal screening and lack of therapeutic termination of fetuses affected by in- utero infections may explain the high association of TORCH infection as a significant risk factor in our study in contrast to developed countries. Parmar B et al. from India found TORCH infection; Low APGAR score as common risk factors for hearing impairment.[19] Our findings here closely match Parmer's findings. Additionally, we found IUGR as a risk factor for hearing impairment. The matching of findings could be due to geographical similarity.

Conclusion

APGAR $\leq$ 6 at 5 minutes, TORCH infection, and IUGR are independent significant risk factors for newborn hearing impairment. Newborns in NICU with these risk factors should have a mandatory audiological evaluation and other appropriate measures to reduce their suffering.

Conflict of interest: None declared

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