



Original Article

## Hearing Screening to Evaluate the Status of Newborn Hearing Impairment in the NICU of a Tertiary Hospital

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### Abstract

**Introduction:** One to three per 1,000 live births suffers from significant hearing impairment. However, 2 to 4 per 100 infants who survived neonatal intensive care have some degree of sensorineural hearing loss. If hearing impairment in newborns is detected earlier, early management can prevent undesirable and often irreversible damage due to late detection.

Early detection and the treatment of hearing impairment in children are essential for the development of communication skills, social skills, emotional well-being, and positive self-esteem. Unfortunately, this disability remains undetected for many newborns until it is too late to prevent undesirable and often irreversible damage. Unfortunately, not many studies were done on this topic in Bangladesh. The magnitude of the burden of hearing impairment in the study place might be identified by this study.

**The objective of the study:** Hearing screening was done to see the status of hearing impairment in newborns admitted to NICU

**Methodology:** A prospective observational study was conducted in the department of neonatology, BSMMU. Newborn admitted to the NICU during the study period was the study population. The newborn who met the inclusion criteria was screened with 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 1<sup>st</sup> screen but prior to 3 months of postnatal age if referred in 1<sup>st</sup> screen. Diagnostic ABR was done prior to 3 months of the postnatal age if referred in both the 1<sup>st</sup> and 2<sup>nd</sup> screen.

**Results:** 426 valid recordings from 493 newborns admitted to the NICU enrolled consecutively constitute the basis of this study. Fourteen newborns were found to have hearing impairment among 426 newborns (3.3%). 2 newborns had unilateral hearing loss, and their hearing losses were moderate in nature. The other 12 newborns in their 24 ears had different grades of hearing loss. It was mild hearing loss in 3 ears, moderate in 9 ears, severe in 8 ears, and profound in 4 ears.

**Conclusion:** Hearing screening showed that 3.3% of newborns in the NICU have a hearing impairment. It is still an underestimation considering the number of newborns who were lost to follow-up.

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### Introduction

One to three per 1000 live births suffers from significant hearing impairment. In the neonatal

intensive care unit, this number is up to 2-4% live birth which is a ten times increase in number.<sup>1</sup> According to WHO, newborns in the NICU, are

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10-20 times at higher risk of developing hearing loss, and hearing screening should be focused on NICU newborns if hearing screening programs are unable to screen all newborns in the community.<sup>2,3</sup> Parmar B et al. concluded if all newborns could not be screened due to infrastructural problems, then at least the high-risk newborns must be screened.<sup>4</sup>

Universal newborn hearing screening (UNHS) has been widely practiced in developed countries. Successful implementations of such newborn hearing screening in developed countries have been widely published, but little is known about hearing screening activities in developing countries.<sup>5</sup> Recently, some of the developing countries of Asia like India, Malaysia have started hospital-based screening programs and/or pilot studies in neonates to identify hearing loss shortly after birth.<sup>6</sup> Bangladesh still remains far behind in the current global trend of universal newborn hearing screening programs or hospital-based hearing screening programs. Unfortunately, little or no initiative has been taken so far, even at the tertiary care level, for the implementation of newborn hearing screening in Bangladesh. With this background, this present study was planned to demonstrate hearing status in NICU neonates by screening with Transient Evoked Otoacoustic Emissions (TEOAE) and confirming the diagnosis of hearing impairment by diagnostic Auditory Brain stem Response (ABR).

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 been known for a long time that, unidentified hearing loss, even a mild loss at birth, can negatively affect speech and language development of the baby along with academic achievement and social-emotional development.<sup>7</sup> In most of the cases, moderate-to-severe hearing loss in young children is detected after the newborn period, and the diagnosis of milder hearing loss and unilateral hearing loss is delayed until school age, long after the critical period for speech and language development had

ended.<sup>8</sup> Parental suspicion of hearing loss, usually from the age of 2 years, is currently the predominant mode of detection. This late detection diminishes the opportunities for optimal intervention for speech and language development.<sup>9</sup> Therefore, the American Academy of Pediatrics has recommended that hearing loss in infants is identified and, when possible, be treated prior to 6 months of age.

Recent advances in 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.<sup>2, 10</sup> At present, the choice of device for newborn hearing screening is either TEOAE or 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 pass.<sup>2</sup> Refer' doesn't mean hearing impairment; rather, it indicates a likelihood of hearing loss that requires a re-screening or diagnostic evaluation.

Hearing impairment detection by TEOAE, also known as cochlear echoes, is non-invasive, reproducible, sensitive to cochlear pathology, simple, easy to perform, and rapid clinical test. It is cost-effective and independent of test-subject cooperation, making it an ideal screening method for infants.<sup>8, 11, 12</sup> As it involves only a small probe in the outer ear with no sedation or placement of electrodes to do the exam, which makes it very acceptable to parents and infants.<sup>12</sup> OAE screening detects both conductive and sensorineural hearing loss. This technology has a sensitivity of 95% and a specificity of 91%.<sup>13</sup>

Diagnostic ABR is the gold standard for diagnosing sensorineural hearing loss.<sup>14</sup> ABR is costly, time-consuming and requires trained personnel. ABR needed the placement of electrodes on the forehead and on both mastoids. Newborns can be tested with ABR whilst asleep. The sensitivity of ABR in detecting hearing impairment is 98%- 100%, and specificity is 91-96%.<sup>15</sup>

There has been a paucity of studies on this topic from Bangladesh. This study was done to identify

the magnitude of the burden of hearing impairment.

### **Aims and objectives**

The hearing screening was done to see the status of hearing impairment in newborns admitted to the NICU.

### **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. Written consent was taken from the parents/guardians. Newborns who met the inclusion criteria were 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

### **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. Among 67 excluded newborns, one was referred, 26 left against medical advice, 29 died before enrollment, eight due to increased postnatal age, and three due to lack of consent.

Among 426 newborns (100%) enrolled newborns in the study, 329 newborns (77%) passed, and 97 were referred (23%) in the 1<sup>st</sup> screening with TEOAE. Only 97 newborns (23%) who were referred in the 1<sup>st</sup> screening had undergone the 2<sup>nd</sup> screening. After 2<sup>nd</sup> screening with TEOAE on 97 newborns, 54 newborns passed (13%), 19 newborns dropped out (4.4%), and 24 (5.6%) newborns have referred again. 3<sup>rd</sup> screening was planned with diagnostic ABR only on 24 newborns referred on the 2<sup>nd</sup> screening. Among these 24 newborns, five newborns passed (1.2%), five newborns dropped out (1.2%), and hearing-impaired was confirmed in 14 newborns (3.3%). It was unilateral in 2 newborns and bilateral in 12 newborns. It was still an underestimation considering the number of newborns who were lost to follow-up. Twenty-four newborns were dropped out from this study among 426 newborns. Hearing loss was graded according to WHO classification, such as 30-40 decibel hearing level as mild loss, 41-60 decibel hearing level as moderate loss, 61-80 decibel hearing level as severe loss, and 81 or more decibel hearing level as profound hearing loss.<sup>16</sup> Among 14 newborns with confirmed hearing loss, two newborns, had unilateral hearing loss, and their hearing losses were moderate in nature. Other 12 newborns in their 24 ears had different grades of hearing loss. It was mild hearing loss in 3 ears, moderate in 9 ears, severe in 8 ears, and profound in 4 ears.

### **Discussion**

Hearing impairment in newborns is an invisible disability that needs early detection and timely

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. Even if only one ear was referred in the initial screening, both ears were screened. A diagnostic evaluation with ABR (Diagnostic ABR) was performed in both ears prior to 3 months of postnatal age if referred in both the 1<sup>st</sup> and 2<sup>nd</sup> screen. 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 the 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.

intervention to assist in proper speech, language, and cognitive development. A protocol regarding newborn hearing screening is much needed for us. In Bangladesh, a prevalence rate of 0.3% for

severe hearing loss was reported in a normal school population.<sup>17</sup> But relevant data on congenital, early-onset, or acquired hearing loss are lacking. Therefore the present study focuses on the baseline need for carrying out hearing screening in neonates soon after birth and subsequent confirmation in follow-up visits.

Parental anxiety is an important consideration in any neonatal screening program. We attempted to allay anxiety as much as possible by providing an information leaflet and by a personal discussion with parents or guardians in our study. The screen was extremely well received by most of the parents.

In a study done from January 2011 to June 2011 by Mannan MA on 168 newborns, including 116 from NICU and 52 from the mother-child unit (MCU), underwent hearing screening by TEOAE before discharge from the hospital and found that 32.7% of neonates screened scored Refer in first screening; forty-seven were bilateral, and eight were unilateral. The referral rate for NICU and MCU populations was 40.5% and 15.4%, respectively.<sup>18</sup> Here, the initial referral rate was quite high in comparison with findings demonstrated in some other studies where the month-wise referral rate in a year ranged from 5.1% to 14.4%.<sup>19</sup> Mean averages of referral rates for the MCU and NICU newborns in that study were 11.98 and 11.75%, respectively.<sup>19</sup> Refer in 1<sup>st</sup> TEOAE in early postnatal days may be falsely positive due to the presence of vernix or debris in the external ear. In our study, we tried to eliminate this possibility by clearing it from the external ear canal before a test and advising follow-up screening one month later. However, the reference in 1<sup>st</sup> TEOAE was also high in our study. It was 23% (97 refer among 426 newborns screened). Our study population differed from another study because it included newborns only from NICU.

Meyer et al. found 2.3% of hearing loss in their study.<sup>20</sup> In our study, it was 3.3%. These two result matches with each other and therefore is consistent with the concept of a 10-fold increased risk for neonatal hearing disorders in high-risk groups.

Parmar B et al. started screening for hearing loss with TEOAE between 1 to 30 postnatal age. 2<sup>nd</sup> follow-up TEOAE examination was done in referred cases after 7 to 10 days. Brainstem evoked response audiometry (BERA) was done in those cases, those 'referred' on the second examination. Out of 300 newborns, 24 showed OAE 'refer' at first examination (8%), and out of these 24 'refer,' 18 were 'referred' on second TEOAE examination (6% of the total study population). Out of these 18 who underwent BERA examination, 12 showed pathological deafness, and 6 showed normal BERA examination. In this study, the incidence of hearing loss in high-risk newborns was 12 among 300, constituting 4%.<sup>4</sup> In our study, 23% were referred after 1st screen, which was quite high in comparison to Parmar B et al. findings.<sup>4</sup> Our referred case was 5.7% after 2<sup>nd</sup> screen, and we found 3.3% hearing impairment after the diagnostic test. In Parmar B et al. study, they are 6% and 4%, respectively.<sup>4</sup> Our findings here closely match with Parmar's findings. The matching of findings could be due to geographical similarity.

In auditory neuropathy/dyssynchrony, the newborn passes the TEOAE screening but gets referred to ABR. In this study, we screened the newborn with TEOAE on 1st and 2<sup>nd</sup> screens. If newborns were referred in the 2<sup>nd</sup> screen with TEOAE, only then were they evaluated with diagnostic ABR. The newborns who passed in 1<sup>st</sup> and 2<sup>nd</sup> screens with TEOAE were not followed up further. This could miss some auditory neuropathy/dyssynchrony cases.

In the study of Olusanya et al., 57 newborns among 180 SCBU (special care baby unit) newborns were referred, comprising 31.7%.<sup>21</sup> But the referral rate for diagnostic evaluation was reduced to 4.4% (8 newborns among 180). In this study, 97 newborns among 426 NICU newborns were referred, comprising 23%, and the referral rate for diagnostic evaluation was reduced to 5.7% (24 newborns among 426). This variation might be due to different geographical locations and different study populations.

Despite the fact that approximately 95% of newborn infants have their hearing screened in the United States, almost half of newborn infants who do not pass the initial screening do not have an appropriate follow-up to either confirm the presence of a hearing loss and/or initiate appropriate early intervention services (JCIH 2007).<sup>22</sup> This study also faced the same challenges. Twenty-four newborns dropped out among 426 newborns (5.6%) after initial screening.

Augustine et al., in a study done in a tertiary care hospital in Southern India, followed a protocol in which newborns admitted to NICU were screened prior to discharge from the NICU (once their general condition was stable).<sup>23</sup> This portion of the protocol has similarities with our study. In his study, 164 babies were identified as suspected of hearing loss, but of which only 58 came for follow-up and to confirm the diagnosis. The number of newborns who lost to follow-up was too high (64.6%). In our study, 24 newborns were suspected of hearing loss after 2<sup>nd</sup> screening. Five newborns were lost to follow-up among them. Here lost to follow up only 20.8%. However, ensuring follow-up of children who were referred twice proved to be the biggest hurdle in our study. A more efficient tracking and follow-up system is needed to reduce the dropout.

## Conclusion

Hearing screening showed that 3.3% of newborns in the NICU have a hearing impairment. It is still an underestimation considering the number of newborns who were lost to follow-up (24 among 426 newborns). The magnitude of this alarming situation demands our immediate attention.

**Conflict of interest:** None declared

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