Auditory & Vestibular Research

Research Article

Newborn Hearing Screening at a Single Tertiary Care Hospital in the United Arab Emirates

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Highlights

- A larger data based newborn hearing screening in the United Arab Emirates
- Incidence of hearing loss in babies with two known risk factors for hearing loss
- Audiological management based on type and laterality of hearing loss

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ABSTRACT

Background and Aim: The United Arab Emirates has been successfully identifying and rehabilitating children having congenital hearing loss. A dearth of published data regarding the newborn hearing screening programs in the country demands the current study. The study aimed to find incidence of hearing loss and impact of known risk factors for hearing loss in a cohort of newborn babies in a single tertiary hospital in the United Arab Emirates.

Methods: A retrospective analysis of hearing screening from January 2010 to December 2019 on a total of 37661 newborn babies were conducted using a screening protocol in auditory brainstem responses.

Results: We report an overall incidence of 0.16% for congenital hearing loss in the current study population. Babies with prolonged stay in Newborn Intensive Care Unit (NICU) had an incidence of 0.87% and in babies with positive family history of hearing loss, it was as high as 2.2%. Chi square analysis revealed the significance of these risk factors ($p<0.001$). 72% (44.61) received hearing rehabilitation by being fitted with cochlear implants and hearing aids except in few having other comorbidities.

Conclusion: The newborn screening program has run a successful journey since the beginning in the country and the current study is an example. A majority of children identified has received early audiological rehabilitation helping the country in promoting inclusive education and better quality of life for them. Further studies may be implicated to see the outcome of early rehabilitation initiated in the identified population.

Keywords: Hearing loss; newborn screening; newborn intensive care unit; family history; risk factors

Introduction

Congenital hearing loss is considered the most common sensory impairment [1] with an incidence of 1 to 3 per 1000 newborn babies [2-4]. As occurrence of hearing loss is more than twice the other congenital conditions screened at birth [5], newborn hearing screening has gained its importance worldwide [2]. A successful newborn hearing program determines the subsequent outcomes in children with hearing loss. Knowing the magnitude of any disability guides a country in improving the current standards of practise.

Most of the developed countries have newborn hearing screening which enables and promotes early detection and intervention fostering normal speech and language development with long lasting positive impact on the individual's quality of life [6]. The rationale for earlier identification and rehabilitation of hearing loss depends on child's critical period for development of optimal speech and language [6]. Improvements have been identified in language, cognition and social outcomes in children who were identified and intervened for hearing loss at a lower age [7].

The Joint Committee on Infant Hearing from the American Academy of Paediatrics provided guidelines regarding universal newborn hearing screening owing to the impact of early identification of hearing loss on child's overall development of speech, language, communication and cognitive skills [8, 9]. Traditionally two stage screening have been followed including an Otoacoustic Emissions (OAE) and/or Automated Auditory Brainstem Responses (AABR). So that infants who fail in the first stage of screening undergoes a referral for detailed diagnostic assessment, ideally before the age of 3 months.

Universal Newborn Hearing Screening (UNHS) is advocated rather than screening only those babies with high risk factors as almost 19 to 42% of profound hearing impairment gets missed on risk based screening [10]. Hospital based screening programs aim to achieve higher screening rate of 90% or above meeting Joint Committee on Infant Hearing (JCIH) recommendations. After the hospital discharge, a low lost to follow up would decide the success of the program.

The United Arab Emirates has been successful in newborn hearing program built on these international guidelines and standards. A few research data reported from the country reveals an incidence of hearing loss ranging from 0.18% [11] to 0.4% [12]. There is a need to foster the research conducted in these areas due to the rise in technological advancements that help to bridge the gap between a normal hearing peer with one having hearing loss. The newborn hearing screening program encompasses not just the hearing screening at birth but on regular follow up and maintenance of database to track these children who fail the test till they enter the mainstream. An efficient team work of audiologists, paediatricians and nurses is highly recommended in achieving the goals of a newborn hearing screening program [8]. Though the children pass the screening at birth, JCIH, 2007 lists some major risk factors for hearing loss that may need monitoring on a long run.

Among the listed factors, neonatal complications requiring an NICU admission or a family history of hearing loss are foremost. A positive family history may contribute for congenital hearing loss in 1.45% [13] and admission to NICU may increase the risk up to 6.3 times compared to children with no neonatal illness [4]. There are two published researches about the incidence of hearing loss in the country. Ur Rehman and others [11] reports a lower incidence of 0.18% while a more recent study [12] reports a higher incidence of 4.9 per 1000. This disparity calls for a study to investigate the incidence in a larger population to avoid any sampling bias. Also, there has been no published research showing evidence for hearing loss in newborn associated with a family history in the country and the current study probes this relation in the study population. Hence the current study aims to investigate the newborn hearing screening program running in a tertiary care hospital in the country which would reflect the country's efforts in improving quality of life in these children identified with hearing loss. The aims of the study will be discussed under the following headings.

To find the incidence of hearing loss in newborn babies born during 10 years span at a tertiary healthcare facility

To find incidence of hearing loss in babies with NICU admission

To find incidence of hearing loss in babies with family history of hearing loss

To see if incidence of hearing loss is associated with NICU admissions or family history of hearing loss.

Methods

This retrospective study was conducted in Tawam hospital, a tertiary care hospital in eastern region of Emirate of Abudhabi in the United Arab Emirates. The hospital has total 503 bed capacity with over 50 NICU beds and is one of the largest hospitals in the country. It runs a project named Tawam Infant Hearing Assessment Program (TIHAP) intending to screen all babies born in the hospital and those in neonatal intensive care unit since 2008. The current study analysed the newborn hearing screening for a period of 10 years from January 2010 to December 2019. The program aims to diagnose the babies as early as 3 months so as to start aural rehabilitation before six months of age abiding the JCIH guidelines for Universal newborn hearing screening.

Diagnostic ABR from Integrity V500 System was used for testing hearing in newborns by the audiologists. The test was performed at the bedside in the presence of the mother where possible, preferably at quiet state before discharge from the hospital. Verbal explanation was given to the mother regarding the procedure and the results. Recording parameters are shown in Table 1.

Hearing test protocol involves a click ABR done at two intensity levels of 60 dB nHL and 30 dB nHL. The infant passes the test if an identifiable ABR peak V is obtained at both the levels. In contrast, if peaks could not be identified at one or both levels, then baby fails the test. Babies who fail the test underwent a detailed diagnostic ABR and OAE test at the outpatient clinic after a month.

Daily statistics of newborn hearing screening have been maintained in an Excel sheet since the beginning of the hearing screening program. This database allows to track babies who passed or failed the initial testing and how the follow up was carried out in babies who failed the test. It also records if babies stayed in NICU for more than five days and also if they have a family history of hearing loss. Medical records of children with confirmed hearing loss were gone through to evaluate the process of hearing management. In the current study, this database of TIHAP was analysed from the year 2010 till 2019 to obtain incidence of hearing loss in overall test population and also among those having risk factors mainly NICU admission of more than five days and family history of hearing loss. Chi square test was used to check for the significance of these risk factors in causing hearing loss in the test population.

Results

A total of 37661 babies were screened for hearing during a span of 10 years in the hospital. It included 3430 (9.1%) babies with an NICU admission and 642 (1.7%) babies with a family history of hearing loss. The relatively higher rate of NICU administration could be because the hospital is the only government hospital in the city and also have a high bed capacity over 50 in the NICU. 99.2% of babies (37361) passed the test in the 1st screening. Figure 1 shows the trend of the hearing screening program across ten years with a passing rate concurrent with the total number of babies who underwent screening. A total of 300 babies (0.79%) failed the initial screening and were referred for a diagnostic ABR and OAE testing after a month. Out of 300 babies, only 203 (67.6%) came back for follow up. Among the babies who came for follow up, 134 babies were diagnosed having hearing within normal limits and their parents were advised to come back for evaluation only if they notice any delay in speech and language development. 69 babies (23%) out of 300 were found to be having either unilateral or bilateral hearing loss or auditory maturation delay and they underwent further diagnostic evaluations to confirm hearing loss and start amplification at the earliest. Upon further evaluations of these 69 babies, eight children eventually developed normal hearing and they were regarded as babies with auditory maturation delay. Hence a total of 61 babies were diagnosed with permanent hearing loss and this accounted to 0.16% of the whole population of newborn babies tested.

Figure 1 shows the protocol of newborn hearing screening followed at the hospital. The data was analysed with SPSS, version 20 (Chicago, IL, USA) to get the incidence of hearing loss in newborn babies tested at the hospital for a span of 10 years. Chi square analysis was done to see if NICU admission and family history have significant association to causing hearing loss. The data was also analysed to see the number of babies who received hearing aids or cochlear implants as treatment. The number of babies identified with hearing loss was further classified based on hearing loss type and laterality and to better identify them in terms of the audiological management they received. Figure 2 shows the total number of babies identified with permanent hearing loss and their audiological intervention.

Incidence of hearing loss in newborn babies

In the present study, the incidence of hearing loss was found to be 0.16%. Incidence of hearing loss among NICU babies were 0.87%. In babies with positive fami-

ly history of hearing loss, incidence was as high as 2.2%. Table 2 shows the incidence of hearing loss in the test population.

History of newborn intensive care unit admission and hearing loss

Figure 3 shows the distribution of babies with hearing loss in terms of risk factors under study.

Among 61 babies with hearing loss, 30 had history of NICU admission. Thus, out of 3430 babies tested from NICU, 0.87 %, (95% CI: 0.73%–1.05%) was detected with permanent hearing loss. This rate was significantly higher ($p<0.001$) when compared to a rate of 0.09% (95% CI: 0.75%–0.11%) in babies discharged from the well-baby nursery. Table 3 shows how the incidence of hearing loss differs if they had a history of an NICU admission or not. Among 30 babies with hearing loss, 26 babies had bilateral hearing loss and 4 babies had unilateral hearing loss. 12 babies had associated problems like developmental delay, or other syndromic disorders. 3 babies with NICU admission also had a positive family history of hearing loss.

Family history and hearing loss

14 babies identified with permanent hearing loss also had a family history of hearing loss. This accounts to 2.2% (95% CI: 1.6%–2.7%) of 642 babies who had a family history reported at the time of birth. This rate was significantly higher ($p<0.001$) when compared to babies born without a family history of hearing loss, i.e. 0.13%, (95% CI: 0.11%–0.14%). Table 4 shows incidence of hearing loss among newborn babies with and without a family history of hearing loss. All those 14 babies had bilateral hearing loss, among which seven got bilateral cochlear implants and seven had bilateral hearing aids. Three babies among these had prolonged stay in NICU.

Type or degree of hearing loss

Among 61 babies with permanent hearing loss, sensory neural hearing loss was diagnosed in 52 babies. 41 among these had severe to profound degree of hearing loss. Two babies had unilateral conductive hearing loss due to atresia, seven had mixed hearing loss which included two babies with bilateral atresia. One baby was identified with an inconclusive diagnosis of Auditory Neuropathy. This baby failed the initial test in both ears and was followed up till five months of age as she demonstrated an ABR till 50 dB nHL with poor morphology but otoacoustic emissions were present. The child was then lost to follow up.

Amplification or cochlear implantation

All babies with confirmed permanent hearing loss were given follow up within one month to repeat the ABR testing and hearing aid trial was done at a minimum age of three to five months. Twenty-five babies received hearing aids among which only one baby had unilateral hearing loss and she later discontinued the use of hearing aid reporting limited benefit. Cochlear implantation was done in a total of 17 babies among which 15 had bilateral implants and two had bimodal stimulation. 1 child with bilateral atresia had bilateral bone conduction (BC) hearing aids and another child with unilateral atresia received a BAHA (Bone Anchored Hearing Aid). Figure 4 shows the audiological management in terms of amplification devices received in babies with hearing loss.

Lost to follow up

Ninety-seven babies were lost to follow up after the initial screening. Among these, nine babies could be traced through their medical files and found deceased. Fourteen showed no delay in speech and language in the medical file. Remaining 74 babies could not be traced as they did not follow up in the same hospital for any specialty.

No hearing rehabilitation

Six babies with unilateral sensorineural hearing loss and two with unilateral atresia did not receive any rehabilitation. Six babies with other comorbidities and two after confirmation of mild sensorineural hearing loss did not follow up further.

Discussion

The current study focused on finding incidence of hearing loss among the newborn babies across a 10 years' time span and also finds the incidence among babies with risk factors like NICU admissions or family history of hearing loss. The data was drawn based on successful newborn hearing screening program running in a tertiary care hospital in the Eastern region of the United Arab Emirates that has coverage rate of 98%. The incidence of hearing loss in newborn babies was found to be 0.16% and it is similar to the one reported earlier from the same hospital (0.18%) in 2012 [11]. Incidence reported in few Middle East countries also follows similar trends as in Saudi Arabia (0.18%) [14] and Oman (0.12%) [15]. Similarity in figures could be attributed to the consan-

Table 1. Recording parameters of auditory brainstem responses test for newborn hearing screening

Electrode montage	Inverting electrode (-) on test ear (M1 or M2) Non inverting electrode (+) on upper forehead (Fz) Ground electrode on non-test ear (M1 or M2)
Polarity	Rarefaction
Stimulus type	Click
Filter	30 Hz to 1500 Hz
Repetition rate	37.7/s
Minimum no. of clicks	1000
Stimulus intensity levels	60 dB nHL and 30 dB nHL

M1; left mastoid, M2; right mastoid, Fz; midline frontal

Table 2. Incidence of hearing loss in the newborn babies grouped based on risk factors

Test population	Incidence of hearing loss
Overall	0.16%
Admission to NICU	0.87%
Family history of hearing loss	2.2%

NICU; newborn intensive care unit

Table 3. Incidence of hearing loss in newborn babies with and without admission to the newborn intensive care unit

Babies and history of NICU admission	Incidence of hearing loss
NICU admission	0.87%
Without NICU admission	0.09%
Significance based on Chi square test	p<0.001

NICU; newborn intensive care unit

guineous marriages that are prevalent in these regions. A recent study in the UAE [12] reported a high incidence of 0.4% which may be attributed to the smaller sample of the study population. Department of Health in the Abu Dhabi, DOH [16] is the authority that mandates the universal hearing screening in the emirate and has prescribed guidelines for follow up of babies in well baby nursery and NICU admissions.

US Joint committee on infant hearing position statement [17] states three major risk factors associated with permanent hearing loss mainly history of NICU admission, family history of hearing loss, and craniofacial abnormalities.

The literature supports a high prevalence of hearing loss due to risk factors like hyperbilirubinemia, hypoxia, use of antibiotics or other craniofacial anomalies that

Table 4. Incidence of hearing loss in newborn babies with and without family history of hearing loss

Babies and family history of hearing loss	Incidence of hearing loss
Positive family history	2.2%
No family history	0.13%
Significance based on Chi square test	p<0.001

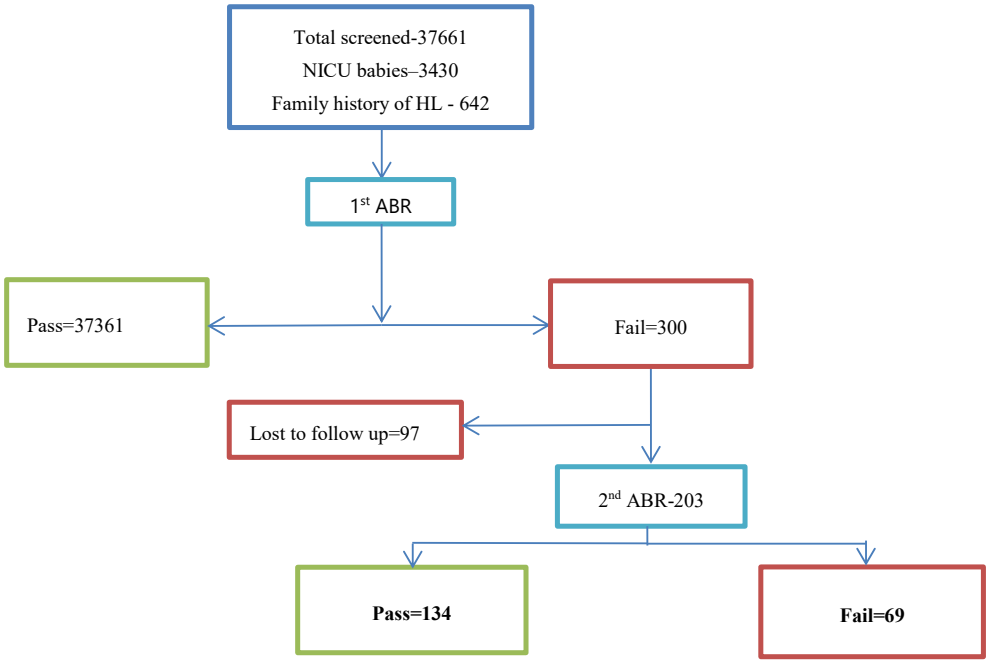

Figure 1. Newborn hearing screening protocol. The figure describes the process of screening the total population and categorises them based on the test results to finally arrive at babies identified with confirmed hearing loss. NICU; newborn intensive care unit, HL; hearing loss, ABR; auditory brainstem response

lead to an NICU admission in a newborn baby [18]. In the present study, the rate of hearing loss reported in babies with NICU admission seems to be almost eight times higher when compared to babies in well baby nursery. The reason could be attributed to the large NICU sample in the study as this is one of the largest hospital in the city that caters to NICU population. Among the babies with confirmed hearing loss, 63.3% had a preterm birth with gestational age varying between 23 to 31 weeks. Other conditions leading to NICU admissions in these babies included syndromes or genetic malformations, hyperbilirubinemia and asphyxia. The incidence of hearing loss among babies with NICU admission was 0.8% in the current study which is lesser than the previously reported data in the same hospital (1.7%) [11]. This could be attributed to the larger time frame for the

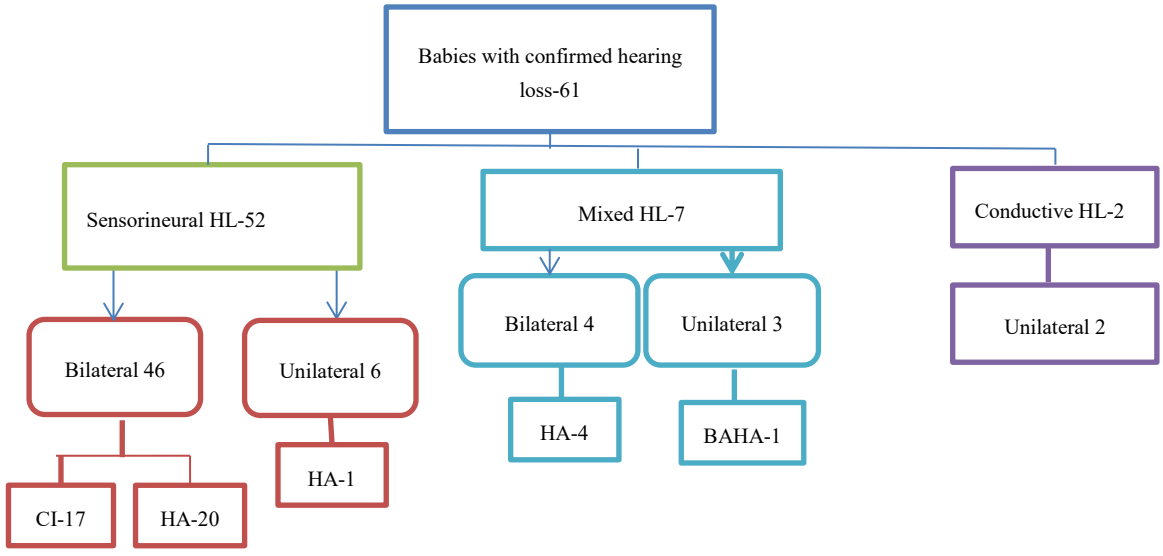

Figure 2. Babies identified with hearing loss after follow up testing. The figure describes the type of hearing loss and the audiological rehabilitation received by the children identified with hearing loss. HL; hearing loss, CI; babies who received cochlear implants, HA; babies who received hearing aids, BAHA; bone anchored hearing aid

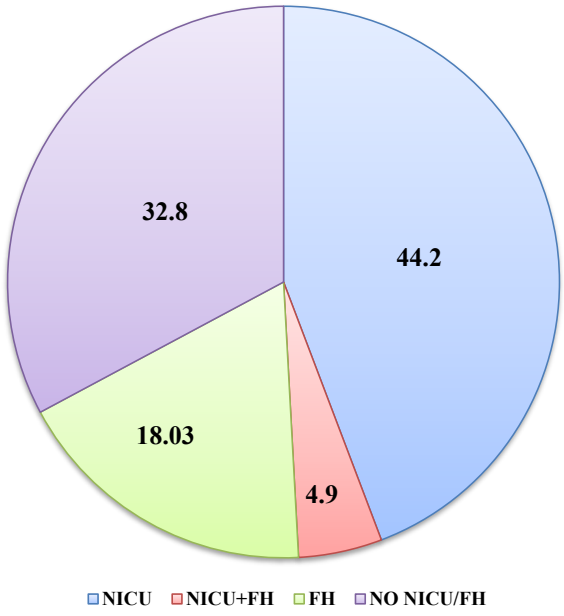

Figure 3. Percentage of babies having confirmed hearing loss in terms of two risk factors under study. NICU; babies who had an NICU admission; NICU+FH; babies who had both an NICU admission and a family history of hearing loss, FH; babies having a family history of hearing loss; NO NICU/FH; babies who did not have an NICU admission or a family history of hearing loss

current study, the larger sample or even medical technological advancements.

Regardless, whether the babies passed or failed the hearing screening, JCIH, [8, 9] recommends a mandatory follow up of babies with NICU admission. The hospital protocol allows for a follow up of every baby discharged from NICU at the age of six months and one year of age. But approximately 30% of babies have not turned up for this follow up. The high prevalence of hearing loss in NICU babies developing a hearing loss at a later age warrants tackling these deficits in follow up visits. 0.4% of babies with hearing loss in this population also had comorbidities which makes follow up and rehabilitation even more challenging. [8, 9].

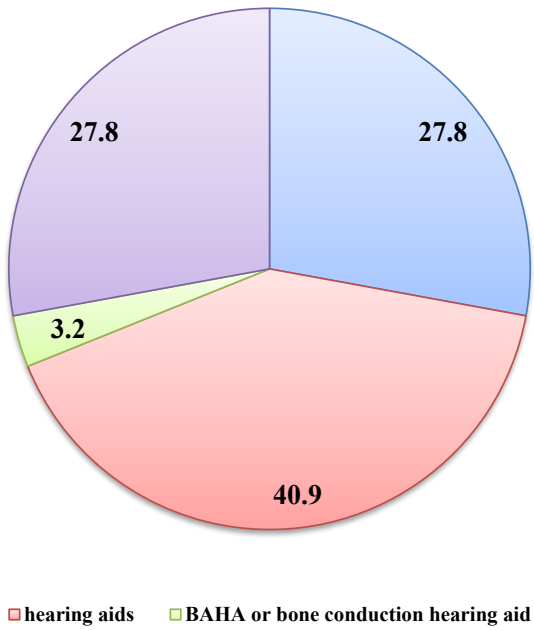

Figure 4. Percentage of babies with hearing loss in terms of audiological rehabilitation. BAHA; bone anchored hearing aid

Family history of hearing loss is yet another major risk factor for congenital hearing loss that accounts to a rate as high as 2.2%. In a population without a family history of hearing loss, the incidence was only 0.13%. This demands extreme caution when a baby has positive family history as it increases the risk of hearing loss by almost 16 times. This high prevalence was also reported in literature [19, 20] and consanguineous marriages may have a direct correlation in increasing this rate [21-23]. Regular follow up of these babies after six months at least until the age of speech and language development should be monitored even though they pass a hearing screening at birth.

In spite of all the technological advancements in the field, the study points to a need for increasing awareness among the general population regarding importance of follow up after failing an initial newborn hearing screening. The lost to follow up across studies vary between 0.03 to 18% [24]. Although not that high, 0.23% of babies were lost to follow up. An appointment given at the time of discharge from the hospital and counselling by the pediatrician on the importance of hearing screening and identification are found to be helpful in improving the follow up in our hospital. For the convenience of parents, hearing evaluation was scheduled on the same day of immunisations or general well baby check-ups. This 0.23% still needs to be tackled by causing increased awareness among the general public and health care providers especially paediatricians and otolaryngologists. A recent study by Zaitoun et al. [25] done in Jordan also indicate a strong need for increasing awareness among ENT practitioners regarding audiological interventions for children with hearing deficits in the country. Another study points to a need of maintaining a good database and an observant supervision to booster the follow ups [26].

Among those children diagnosed with hearing loss, 82 % of babies had sensory neural hearing loss who received either hearing aids or cochlear implants. It was noted that in some children, though the hearing aid was given as early as five months, most of them did not use them consistently until an age of three to four years. Also, a majority of those children who underwent CI did not use the hearing aids at least until five years of age. Lack of parent education on potential link between consistent hearing devices usage and their developmental outcomes might lead to auditory deprivation and further reduced performance [27-29]. Lack of follow up of babies fitted with hearing aids becomes a major challenge. It is important to monitor the use and benefit of the hearing aids so as not to prolong the auditory deprivation and delay the implantation as the critical period for language development expires with delay in implantation. [30, 31]

Hence a regular follow up protocol must be framed for babies fitted with hearing aids and consistent three month follow ups may be provided for these babies after hearing aid fitting at least until the hearing aid use is established. Once hearing aid use is established, six months follow up may be sufficient. This will help in evaluating the cochlear implant candidacy at the earliest.

The study had few limitations such as the data for analysis was really vast that babies who were lost to follow up could not be accessed to identify their status of hearing. The reasons for NICU admissions could not be collected due to the same reason. The age at which audiological management started and how it helped the children also could not be tracked in the current study.

Conclusion

The study portrays the success path of a newborn hearing screening program in our hospital. It emphasises on the importance of surveillance and maintenance of the newborn hearing database to ultimately help in mainstreaming the children identified with hearing loss. Future studies may be conducted in the country to investigate if there is huge disparity between the ages of identification, hearing aid fitting and or cochlear implantation, which in turn evaluates the success of the hearing rehabilitation following an early identification.

Ethical Considerations

Compliance with ethical guidelines

This study has been approved by the Tawam Human Research Ethics Committee (MF2058-2021-816).

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Authors' contributions

AMS: Study design and supervision, interpretation of the results, and critical revision of the manuscript; MER: Study design, acquisition of data, and drafting the manuscript, interpretation of the results and critical revision of the manuscript, statistical analysis.

Conflict of interest

The authors declare that they have no conflicts of interest.

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