Outcomes of Universal Neonatal Hearing Screening Program in a Tertiary Care Hospital in Lahore

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Abstract

Objective: This study was carried out to assess the outcomes of a universal neonatal hearing screening program in a tertiary care hospital in Lahore, Punjab, Pakistan.

Methods: This cross-sectional study was performed at the pediatric medicine and audiology department of Ittefaq Hospital, Lahore from July 1, 2020, to June 30, 2021. An otoscopic examination of the ear canal and tympanic membrane of 91 infants was performed. DPOAEs were used to screen. It was performed by audiologists after at least 24 hours of birth. A signal-to-noise ratio of more than six decibels in 3 out of 4 frequencies tested was documented as pass. Infants who failed the DPOAE were considered referred and underwent BERA to confirm the diagnosis. Valid response at the stimulus level of 30 dB normalized hearing level was taken as pass while no valid response was considered as having hearing impairment.

Results: Of 91 high-risk infants tested for hearing impairment, 54(59.34%) were males whereas 37(40.66%) were females. The mean age of the infants was 1.2±0.54 months. 19(20.88%) were diagnosed as having hearing impairment. 5(8.7%) of the full-term neonates had hearing impairment while 5(50%) of the preterm neonates exhibited hearing impairment. Hearing impairment was also reported among infants having a history of neonatal jaundice (26.67%), fetal distress (40%), birth asphyxia (50%), convulsions (100%), and craniofacial abnormalities (100%).

Conclusion: Identification of the neonatal risk factors associated with hearing loss is crucial, and the neonatal hearing screening program is a useful method in the early detection and management of congenital hearing loss in all neonates, thereby avoiding any hindrance in speech, language, and cognitive development. Thus, the findings of this study appreciate the importance of countrywide implementation of universal hearing screening programs in newborns.

Keywords: Neonate, hearing screening, hearing impairment, early identification, Otoacoustic emission, outcomes.

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Introduction

Hearing is a vital sense for humans, crucial for speech, language, and cognitive development and hearing impairment is one of the most frequent congenital abnormalities among neonates, accounting for approximately1-3 per 1000 cases worldwide[1]. According to the World Health Organization, approximately 0.5 to 5 out of every 1000 newborn babies have sensorineural hearing loss or profound hearing loss that is either congenital or happens in the initial stages of childhood[2]. Presently, 34 million individuals below the age of 15 years are regarded as having unilateral or bilateral hearing impairment, with a higher prevalence in low and middle-income countries (2.4%)[3]. The frequency of neonatal hearing impairment is 13 per 1000 live births in Pakistan juxtaposed to 4 per 1000 live births all around the globe[4]. The likelihood is more pronounced in high-risk neonates and increases with increasing age[5].

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Hearing loss is categorized as one of the notable health hazards as it can lead to lifelong impairments including loss of life[6]. Children with hearing loss fall behind the children of their respective age groups in education, literacy, and social development. Therefore, prompt diagnosis and management are anticipated and should be given before the age of 6 months to have improved outcomes in terms of timely speech, language, and cognitive development and better quality of life. Thereby, WHO guidelines mandated the universal neonatal hearing screening for every newborn within the 1st month of life to have an early detection of any kind of hearing disability[7]. In the year 2000, guidelines by the Joint Committee on Infant Hearing (JCIH) introduced the 1-3-6 plan. It recommended that diagnosis should be confirmed by the age of 3 months and management in terms of hearing aids or cochlear implants should be initiated by the age of 6 months[8]. This plan was later modified to a 1-2-3 plan in 2019 proposing that the screening should be conducted within 1st month, diagnosis should be made by 2nd month, and rehabilitation should be started by 3rd month[7].

There are several techniques used for the screening of hearing problems. One such technique is the use of Distortion Product Otoacoustic Emissions (DPOAEs). It is usually followed by Brainstem Evoked Response Audiometry (BERA) to confirm the findings[3,9]. Both methods are non-invasive, easy and quick to perform. DPOAE assesses sound waves produced in the inner ear as a result of the clicks or tone bursts emitted and recorded through small microphones kept in the external ear canal of the child. Although it is faster and simpler to execute than BERA, it may be influenced by debris in the external or middle ear, leading to a referral rate of 5 to 20%, especially when screening is performed within the first 24 hours after the birth of the child. On the other hand, BERA assesses the electroencephalographic waves as a result of clicks by the electrodes placed on the scalp of the infant. BERA is done in a quiet environment on a sleeping infant and is not impacted by middle or external ear fluid or debris[10].

According to WHO, incapability to hear at a threshold of 20 decibels is termed as hearing impairment, and hearing loss is loss of more than 35 decibels in the healthier ear[11]. These non-invasive tests have substantially improved the diagnosis of hearing loss during early infancy[7]. If the neonates fail these screening tests, further diagnostic tests are recommended to confirm the diagnosis and provide early intervention[8]. The infants with hearing impairment are managed with hearing aids and cochlear implants[12].

The recent enactment of hearing screening programs in various countries has endorsed the early diagnosis of hearing impairment among newborns. However, Pakistan has a huge population with no universal neonatal hearing screening program and delayed detection of hearing loss. This program is set back for several reasons in Pakistan. These include lack of awareness, financial constrictions, pitiable health infrastructure, lack of tracking systems, load on tertiary care, lack of local research, and scarcity of epidemiological data [11]. This might also be the result of Pakistan's healthcare delivery system still being focused on curative rather than preventative measures[12].

So, the rationale of this study was to estimate the frequency of hearing impairment in infants as a result of the hearing screening program in a tertiary care hospital and to assess the predisposing factors of hearing impairment. This study will offer new insights and data specific to neonates in the Lahore region, which has not been published previously, and provide updated findings on the outcomes of neonatal hearing screening programs in the Lahore region. It also will highlight the importance of a universal neonatal hearing screening program and appreciate its facility in local settings to promote early detection and intervention.

Methodology

This study was a c ross-sectional study. It was carried out at the pediatric medicine and audiology department of Ittefaq Hospital, Lahore, and Punjab, Pakistan. It was accomplished twelve months after the approval of the synopsis (July 1,

2020, to June 30, 2021). Sample size was estimated using a 95% confidence level, 5% margin of error, and prevalence of hearing impairment as 6.3% [13], in high-risk newborns. It came out to be 91. A convenient sampling technique was used to gather data. All high-risk infants aged 1 day to 3 months of either gender,including full-term and preterm babies and having one or more risk factors for hearing loss such as the history of fetal distress, birth asphyxia, convulsions, craniofacial abnormalities, and severe neonatal jaundice, were included. The study excluded: children born with external ear deformities such as microtia, anotia, cryptotia, or meatal atresia, children without any risk factor for hearing loss, and children whose parents/guardians refused to take part in the neonatal hearing screening program.

A total of 91 infants meeting the selection criteria were included in the study after obtaining approval from the committee and informed consent from the parents/guardians of the infants. Once enrolled in the study, an anonymous individual documentation code was given to each participant, and demographic details such as age, gender, and risk factors profile for hearing loss were noted in a predesigned questionnaire. An otoscopic assessment was performed for the bilateral ear canal and tympanic membranes examination of the high-risk infants. Unilateral or bilateral hearing screening was performed using the non-invasive method of distortion product otoacoustic emissions (DPOAEs). It was performed by the audiologists during natural sleep after at least 24 hours of birth in a sound-treated room where there was no external noise. Interacoustics Titan model was used in our settings and frequency-specific pure tone stimuli were provided to each ear using the probe. DPOAE was conducted at the frequency band of 1-6 kHz, stimulus intensity L1 of 65 decibels and L2 of 55 decibels, F2 to F1 ratio of 1.2:1, and signal to noise ratio of at least 6 decibels with a reproducibility score of e” 70%. A signal-to-noise ratio of more than six decibels in 3 out of 4 frequencies tested was documented as pass. Infants who passed the DPOAE test were not followed up. However, infants who failed the DPOAE were considered as referred and given an appointment for further evaluation. Brainstem evoked response audiometry (BERA) was then performed by the team of audiologists to confirm the diagnosis. The click stimulus was used at the rate of 11.1 clicks per second, at 0.5 kHz, and a filter of 30 to 3000Hz was used. Valid response at the stimulus level of 30 dB normalized hearing level was taken as pass while no valid response was considered as having hearing impairment.

Data entry and analysis were performed using SPSS Version 24. Descriptive statistics were used to demonstrate the frequency and percentage of the hearing impairment as well as the antepartum, intrapartum, and postpartum risk factors of hearing impairment among high-risk infants. Mean and standard deviation were used for quantitative variables such as age.

Results

This study consisted of a total of 91 infants. Of these 91 high-risk infants tested for hearing impairment, 19(20.88%) were diagnosed as having hearing impairment. Among these, 54(59.34%) were males whereas 37(40.66%) were females. The mean age of the infants at the time of screening was 1.2±0.54 months. The demographic characteristics are presented in Table 1.

Table 1. Demographic details of high-risk infants (N=91)

		N	%
Age* (months)		1.2±0.54	
Gender	**Male**	54	59.34
	Female	37	40.66

N = Number of study participants; % = percentage of study participants; * = mean ± standard deviation was given.

The antepartum, intrapartum, and postpartum risk factor profile is shown in Table 2. There were 52(91.23%) pass cases in the full-term group, and 5 (50.0%) pass cases in the pre-term group. 5(8.77%) of the full-term neonates had hearing impairment while 5(50%) of the preterm neonates exhibited hearing impairment and were referred for further evaluation. Hearing impairment was also reported among infants having a history of neonatal jaundice (26.67%), fetal distress (40%), birth asphyxia (50%), convulsions (100%), and craniofacial abnormalities (100%).

Table 2. Antepartum, intrapartum, and postpartum risk factors of hearing impairment in infants

Factors		Total cases	Pass cases N (%)	Refer cases N (%)
Antepartum and intrapartum factors	Full-term birth	57	52 (91.23)	5 (8.77)
	Pre-term birth	10	5 (50.0)	5 (50.0)
	Fetal distress	5	2 (40.0)	3 (60.0)
	Birth asphyxia	2	1 (50.0)	1 (50.0)
	Craniofacial abnormalities	1	1 (100.0)	0 (0.0)
Postpartum factors	Neonatal jaundice	15	4(26.67)	11 (73.33)
	Convulsions	1	1 (100.0)	0 (0.0)

N = Number of study participants; % = percentage of study participants

Discussion

Hearing disability is one of the most prevalent congenital sensory abnormalities worldwide[14], accounting for approximately 1-3 per 1000 neonates[15]. A higher prevalence of hearing loss is found in children with age 0 to 4 years (0.60%) and 5 to 9 years (0.280%)[10]. Early detection and intervention are mandatory for the timely development of speech, language, and cognition[16]. The implementation of a universal neonatal hearing screening program has made a paradigm shift in the early detection and management of congenital hearing impairment in newborns and infants[17]. However, despite tremendous improvements in screening tools, this practice is not common in developing countries like Pakistan. In Pakistan, there is no universal neonatal hearing screening program, mostly due to a lack of awareness, poor health infrastructure, ove-rload on the tertiary healthcare system, inadequate resources, lack of referrals, and poor follow-ups[18]. So, this study was performed to assess the outcomes of a universal neonatal hearing screening program in a tertiary care hospital in Lahore, Pakistan.

A few techniques are usually used for hearing screening in neonates and infants. One of them is Otoacoustic Emission (OAE) and the other is BERA[19]. OAE is centered on the recording of functional sound made by the outer hair cells of the cochlea whereas BERA is a recording of the electrical event from the brainstem as a reaction to a sound stimulus[20]. A systematic review consisting of 82 studies reported that the majority of the studies (47) used a two-stage protocol, including OAE and BER, A, for hearing screening among newborns and infants[3]. In a study by Ganesan et al., it was reported that the overall referral rate for DPOAE was 8.6%, among which 20% of infants had high-risk profiles. The BERA reported an overall referral rate of 8.4%, among which 20% of the participants were high-risk infants[19].

A study documented that there is no difference in the efficiency of transiently evoked otoacoustic emissions (TEOAEs), DPOAEs, and BERA[21]. However, another study suggested that BERA gave more accurate results with fewer false positives and a lesser referral rate[22]. In another study, Kalambe et al. reported that the male-to-female ratio was 1.32:1, close to the findings of the current study where the male-to-female ratio was 1.45:1. They concluded that compared to BERA, OAE had a higher specificity (93.3%) and positive predictive value (97.2%). On the other hand, sensitivity (67.7%) and negative predictive value (45.6%) were comparatively low[23]. In a descriptive study, Rajpoot et al. described that 45.5% of neonates had a high-risk profile. Hearing loss was identified in 3.5% of these cases. Premature birth, birth asphyxia, and neonatal jaundice were the notable risk factors.

In the current study 19(20.88%) infants had hearing impairment confirmed by DPOAE along with BERA. 5 (8.7%) of the full-term neonates had hearing impairment while 5(50%) of the preterm neonates exhibited hearing impairment. Hearing impairment was also reported among infants having a history of neonatal jaundice (26%), fetal distress (40%), birth asphyxia (50%), convulsions (100%), and craniofacial abnormalities (100%). One study reported that DPOAE, followed by BERA, is a very useful method for the timely detection of congenital hearing impairment[24]. Another study conducted in South Africa documented a high refer rate on DPOAE screening (47%)[25]. Venugopal et al. documented that BERA was a highly sensitive method in screening for hearing loss[26].

In another Indian study, it was reported that 7 out of 1000 infants had hearing impairment. In the no-risk population, the incidence was 2.9 per 1000, while in a high-risk group, it was 41.38 per 1000 infants, with a $p < 0.0001$ 10. A study conducted on the Chinese population revealed that 6.8% of infants failed the primary screening test, whereas only 0.04% of these infants were diagnosed with hearing loss after secondary screening. Hearing loss was more evident in infants with a history of severe neonatal jaundice (OR = 3.56, 95% CI 1.01-12.56), preterm birth (OR = 2.09, 95% CI 1.37-3.19), and respiratory failure (OR = 1.97, 95% CI 1.18-3.26)[27]. All these findings are consistent with the findings of the current study. So, this study supports the nationwide implementation of the hearing screening program in neonates to enable accurate diagnosis and prompt intervention.

However, there are also a few limitations of this study. Firstly, this study followed the cross-sectional study design. No cases were followed up. So, there is no evidence for further evaluation and intervention in the referred cases. Secondly, this study was conducted in a tertiary care hospital in an advanced city in Pakistan where diagnostic and management facilities are way better than other private and public sector hospitals of relatively smaller cities and towns. This limits the generalizability of the current findings. The present study may be taken as a pilot study providing in-depth insights into the advantages of the early hearing screening program and potential techniques to improve future studies. Further studies should be conducted on a larger scale to indicate the importance of the implementation of universal neonatal hearing screening programs across the country.

Conclusion

Identification of the neonatal risk factors associated with hearing loss is crucial, and the neonatal hearing screening program is a useful method in the early detection and management of congenital hearing loss in all neonates, thereby avoiding any hindrance in speech, language, and cognitive development. Thus, the findings of this study appreciate the importance of countrywide implementation of universal hearing screening programs in newborns. Various evidence-based parameters and detection criteria of neonatal hearing screening programs need to be developed before planning and implementing any hearing screening program in public settings. In addition, awareness should be raised among healthcare practitioners and the general public to ensure the successful implementation of this universal program.

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