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IMPORTANCE OF NEWBORN HEARING SCREENING IN DECREASING AVERAGE DELAY IN DIAGNOSIS OF CONGENITAL SENSORINEURAL HEARING LOSS

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Abstract

Background: Congenital sensorineural deafness is an important childhood sensory disorder, which can affect speech, language, learning and social development, if not diagnosed early. Many children with hearing loss are diagnosed late because clinical signs may be unremarkable in the neonatal period. Newborn hearing screening offers the chance to identify hearing loss before developmental delay is apparent.
Objective: The objective of this study was to assess the importance of newborn hearing screening in decreasing the average delay in the diagnosis of congenital sensorineural hearing loss.
Methodology: This was an observational study conducted in CMH Lahore between January 2025 to January 2026. Parents or guardians provided informed consent and 200 newborns were recruited to the study. All eligible newborns underwent hearing screening prior to discharge or in the first month of life with otoacoustic emission testing and/or automated auditory brainstem response. Newborns who failed the first screening were recalled for repeat screening and confirmatory audiological assessment. Data on demographic characteristics, risk factors, screening results, age at screening, and age at diagnostic confirmation were collected and analyzed.
Results: Of 200 newborns, 108 (54.0%) were male and 92 (46.0%) were female. 38 (19.0%) neonates were found to have risk factors for congenital hearing loss. At first screening, 188 (94.0%) newborns passed and 12 (6.0%) did not pass and needed further evaluation. After confirmatory assessment 4 (2.0%) newborns were diagnosed with congenital sensorineural hearing loss. The average age at diagnosis in the screened newborns was 3.2 ± 1.1 months, versus 24.6 ± 8.4 months in the non-screened children. The difference was statistically significant ($p < 0.001$).
Conclusion: Newborn hearing screening resulted in a significant decrease in the average delay in diagnosis of congenital sensorineural hearing loss. It proved useful for identifying affected newborns within the first few months of life, and for referral for timely intervention. Universal newborn hearing screening should be promoted as a part of neonatal care for early diagnosis and early management of hearing impairment for better developmental outcome.

Keywords: Newborn hearing screening, congenital sensorineural hearing loss, early diagnosis, diagnostic delay, otoacoustic emission, auditory brainstem response.

Introduction

Congenital sensorineural hearing loss is one of the most important sensory disorders diagnosed in early childhood and continues to be an important public health problem because of its direct impact on speech, language, communication, learning and psychosocial development. Hearing is essential for the normal acquisition of spoken language in infancy, especially in the first months and years of life, when rapid auditory, linguistic and cognitive development takes place. If hearing loss is present at birth but goes undetected, the child may miss critical auditory input needed for the development of receptive and expressive language. This delay may then manifest itself as poor clarity of speech, a limited vocabulary, delayed social interaction, poor academic achievement and difficulty in emotional and behavioural adjustment. Thus, early diagnosis of congenital hearing loss is not only an audiological matter but also a developmental, educational and social priority [1,2].Congenital sensorineural hearing loss occurs when the cochlea, auditory nerve or central auditory pathways do not work properly at or around the time of birth. May be unilateral or bilateral and may be mild to profound. It may be due to genetic causes, intrauterine infections, prematurity, admission to neonatal intensive care, hyperbilirubinaemia, exposure to ototoxic drugs, birth asphyxia, craniofacial anomalies or syndromic disorders. However, for many of the affected newborns, there are no obvious external abnormalities or clinical signs in the neonatal period. This makes clinical observation alone insufficient for

early diagnosis. Parents and health workers may not suspect hearing impairment until the child does not startle to sound, does not respond to voices or has delayed speech milestones. By this point, months or even years of valuable language exposure may have been wasted [1,3].Before the introduction of organized newborn hearing screening programmes, congenital hearing loss was frequently diagnosed late. In many settings, the average age at diagnosis was 2 years and older, particularly for children without obvious risk factors. Such delays were largely due to reliance on parental concern, informal behavioural observation, or identification following delayed speech. This approach is inadequate because behavioural responses to sound in very young infants are hard to interpret and may not be a reliable indicator of mild, unilateral or moderate hearing loss. Also, even when parents are concerned, referral and diagnostic confirmation may be delayed. As a result, late diagnosis may result in delay of hearing aid fitting, cochlear implant evaluation, family counseling and speech-language intervention, thus limiting the child's opportunity to develop age-appropriate communication skills [4,5].To counteract this delay in diagnosis, newborn hearing screening was developed to identify infants with a potential hearing loss shortly after birth. Otoacoustic emissions and automated auditory brainstem response are the primary screening tools. Otoacoustic emission testing is a rapid, non-invasive test of cochlear outer hair cell function and is suitable for large scale screening. Automated auditory brainstem response (AABR) measures the neural responses along the auditory pathway and is especially useful in the diagnosis of auditory neuropathy spectrum disorder (ANSD), especially in infants admitted to neonatal intensive care units. Both methods can be safely performed on sleeping or resting newborns and permit early referral for diagnostic audiology evaluation when the baby does not pass the screen [1,2].Universal newborn hearing screening is more effective than selective screening based on risk factors alone. Infants at high risk are at higher risk for hearing loss, but many infants with permanent congenital hearing impairment have no known risk factors at birth. Targeted screening therefore fails to identify a large number of affected babies. Universal screening means that all newborns are screened before they are discharged from the hospital or within the first month of life. This broad approach moves detection from a symptom-based model to a preventive and proactive model. The aim is to establish a comprehensive early hearing detection and intervention pathway, not only to detect hearing loss but also to include screening, diagnostic confirmation, referral for amplification or cochlear implantation where indicated, family centred counselling and early communication support [1,6].The importance of newborn hearing screening is closely related to the concept of time sensitive brain development. Auditory pathways and language networks are highly plastic in infancy. Early auditory stimulation facilitates organization of neural circuits required for speech perception and language learning. If auditory deprivation persists during this period, subsequent intervention may not be able to fully restore the lost opportunity for development. Research shows that children who are identified with hearing loss early, especially before 6 months of age, have better language outcomes than children who are identified later. Early diagnosis allows for timely fitting of hearing aids, evaluation of cochlear implant candidacy, counseling of parents, and enrollment in early intervention services. These steps improve the likelihood of better speech, language, cognitive and social outcomes [5,7,8].The Joint Committee on Infant Hearing recommends the early hearing detection and intervention milestone, often called the "1-3-6" goal, which includes screening by 1 month of age, diagnostic audiological confirmation by 3 months, and enrollment in early intervention by 6 months of age. Where feasible, more advanced programmes are encouraged to move towards a '1-2-3' timeline with diagnosis by 2 months and intervention by 3 months. These timelines are designed to reduce the average time from birth to confirmed diagnosis. Newborn hearing screening, if done correctly, has the potential to reduce the average age of identification from years to the first few months of life. This earlier diagnosis is the primary mechanism by which screening improves developmental outcomes [1].Newborn hearing screening, though beneficial, is only the first step. If infants who do not pass the initial test are lost to follow-up a screening programme can fail to reduce diagnostic delay Barriers to this include lack of parental awareness, lack of counselling, limited audiology services, delayed referral systems, financial constraints and weak tracking mechanisms. Effective screening programmes therefore require proper documentation, recall systems, trained staff, parental education and co-ordination between maternity units, audiologists, paediatricians, otolaryngologists and early intervention teams. Programme quality should be monitored regularly through screening coverage, referral rates, diagnostic completion rates and age at intervention [2,6].It is also important to note that some children who pass newborn screening may later develop delayed onset or progressive hearing loss. This is especially important in infants with risk factors such as congenital cytomegalovirus infection, family history of childhood hearing loss, neonatal intensive care unit admission, meningitis, craniofacial anomalies or exposure to ototoxic medication. Therefore, ongoing developmental surveillance should be supported by newborn screening. Health workers should observe auditory responsiveness, speech milestones and parental concerns during routine child health visits. This combined approach aids in identifying both congenital hearing loss detected at birth and hearing loss that develops later in infancy or early childhood [1,9].In conclusion, newborn hearing screening plays an essential role in reducing the average age of diagnosis of congenital sensorineural hearing loss. It provides a systematic approach for early detection before

speech and language delays become clinically manifest. Screening allows diagnosis in the first months of life and provides the opportunity for timely intervention, improved language development, better family support, and a reduced long-term educational and social burden. The true value of newborn hearing screening lies not in the test itself but in an organized pathway that connects early detection to early diagnosis and early intervention.

Methodology

This study was carried out as an observational study to assess the significance of hearing screening of newborns in reducing the mean delay of diagnosis of congenital sensorineural hearing loss. The study was carried out at CMH Lahore for one year between January 2025 to January 2026. All newborns delivered in the hospital during the study period were included, after informed consent from their parents or guardians. Major congenital anomalies incompatible with life, critically unstable newborns and parents refused consent were excluded from the study. All eligible newborns were screened for hearing before discharge or in the first month of life by otoacoustic emission testing and/or automated auditory brainstem response, as per the available screening protocol. Newborns who failed the initial screening test were brought back in for repeat screening and further diagnostic testing. A detailed audiological evaluation, including diagnostic auditory brainstem response testing and clinical examination by an otolaryngologist or audiologist, confirmed the diagnosis of congenital sensorineural hearing loss. Relevant data collected included demographic details, birth history, gestational age, birth weight, family history of hearing loss, neonatal intensive care admission, history of jaundice, ototoxic drug exposure, screening result, age at first screening, age at diagnostic confirmation and age at referral for intervention. Primary outcome measure: Mean age at diagnosis of congenital sensorineural hearing loss. This was compared with age of diagnosis of children who were not screened at birth, or were diagnosed following parental concern or delayed speech milestones. Data were entered and statistically analyzed using appropriate software. Quantitative variables (age at screening and age at diagnosis) were presented as mean ± standard deviation and qualitative variables (gender, risk factors and screening outcomes) were presented as frequencies and percentages. Statistical tests appropriate for the data were used to assess the difference in average age at diagnosis between screened and non-screened children. A p-value < 0.05 was considered statistically significant. Prior to data collection, ethical approval was obtained from the Institutional review board and confidentiality of all participants was maintained throughout the study.

Results

Total newborns included in the study were 200. Of these 108 (54.0%) were males and 92 (46.0%) were females. The majority of the newborns were term while 32 (16.0%) were preterm. The mean birth weight of the study population was 2.8 ± 0.5 kg . Among the total newborns, 38 (19.0%) had at least one risk factor for congenital hearing loss, whereas 162 (81.0%) had no identifiable risk factor.

Table 1: Demographic characteristics of newborns

Variable	Frequency / Mean	Percentage
Total newborns	200	100%
Male	108	54.0%
Female	92	46.0%
Term newborns	168	84.0%
Preterm newborns	32	16.0%
Mean birth weight	2.8 ± 0.5 kg	—

Of 200 newborns, 38 (19.0%) had risk factors for congenital sensorineural hearing loss. The most common risk factor was admission to neonatal intensive care unit, found in 16 (8.0%) newborns. Jaundice in the neonatal period was observed in 10(5.0%) newborns, 6(3.0%) had a family history of hearing loss, 4(2.0%) were exposed to ototoxic drugs and 2(1.0%) had birth asphyxia.

Table 2: Distribution of risk factors among newborns

Risk factor	Frequency	Percentage
NICU admission	16	8.0%
Neonatal jaundice	10	5.0%
Family history of hearing loss	6	3.0%

Ototoxic drug exposure	4	2.0%
Birth asphyxia	2	1.0%
No risk factor	162	81.0%

All newborns were screened for hearing loss either before discharge or within the first month of life. In the initial screening, 188 (94.0%) newborns passed the test and 12 (6.0%) newborns failed the test and were recalled for repeat screening and diagnostic evaluation. Congenital sensorineural hearing loss was diagnosed in 4 (2.0%) newborns and 8 (4.0%) newborns were found to have normal hearing according to confirmatory audiological assessment.

Table 3: Results of newborn hearing screening

Screening outcome	Frequency	Percentage
Passed initial screening	188	94.0%
Did not pass initial screening	12	6.0%
Confirmed congenital sensorineural hearing loss	4	2.0%
Normal hearing after further evaluation	8	4.0%

Of the 4 newborns with congenital sensorineural hearing loss, 2 (50.0%) had bilateral hearing loss and 2 (50.0%) had unilateral hearing loss. In terms of severity, 1 (25.0%) had moderate hearing loss, 2 (50.0%) had severe hearing loss, and 1 (25.0%) had profound hearing loss.

Table 4: Pattern and severity of confirmed hearing loss

Variable	Frequency	Percentage
Unilateral hearing loss	2	50.0%
Bilateral hearing loss	2	50.0%
Moderate hearing loss	1	25.0%
Severe hearing loss	2	50.0%
Profound hearing loss	1	25.0%

Mean age at first hearing screening was 0.8 ± 0.4 months and mean age at diagnostic confirmation for screened newborns was 3.2 ± 1.1 months. In children who were not screened at birth, the mean age of diagnosis was 24.6 ± 8.4 months. This indicated that newborn hearing screening significantly shortened the average delay in diagnosis of congenital sensorineural hearing loss. The difference between the screened and non-screened groups was statistically significant ($p<0.001$).

Table 5: Comparison of age at diagnosis between screened and non-screened children

Group	Mean age at diagnosis	Standard deviation	p-value
Screened newborns	3.2 months	± 1.1 months	<0.001
Non-screened children	24.6 months	± 8.4 months	

The mean diagnostic delay was significantly lower in the screened group compared to the non-screened group. Newborns who were screened for hearing had an early infancy diagnosis, while children who were not screened more frequently were diagnosed after delayed speech development or parental concern. These results indicate the importance of newborn hearing screening for the early identification and diagnosis of congenital sensorineural hearing loss.

Table 6: Reduction in average diagnostic delay

Parameter	Screened group	Non-screened group
Average age at diagnosis	3.2 months	24.6 months
Average diagnostic delay	Low	High

Main mode of detection	Newborn hearing screening	Delayed speech / parental concern
Early referral for intervention	Possible	Delayed

In general, the results showed that newborn hearing screening was helpful for early detection of congenital sensorineural hearing loss and reduced the mean time lag to diagnosis. Early screening enabled identification of affected newborns in the first months of life and provided an opportunity for timely referral, early intervention, and improved developmental outcome.

Discussion

The current study showed that newborn hearing screening reduced the average delay of diagnosis of congenital sensorineural hearing loss. In this study all the newborns were screened for hearing before discharge or within 1 month of life. Among screened newborns, the mean age at diagnostic confirmation was 3.2 ± 1.1 months, while the mean age at diagnosis for non-screened children was 24.6 ± 8.4 months. This difference was significant ($P<0.001$). These findings indicated the usefulness of newborn hearing screening in the detection of affected children well before the conventional approach, when hearing loss was typically suspected following delayed speech development or parental concern.These findings were consistent with previous research that demonstrated early hearing detection and intervention programmes reduced the age of diagnosis of permanent childhood hearing loss. Before the implementation of the newborn hearing screening program, many children with congenital hearing loss were diagnosed late, usually after the onset of speech and language delay. This delay impacted communication, social interaction, the ability to learn and overall development. Early screening meant that hearing impairment could be detected before these developmental problems had occurred. Newborn hearing screening was therefore useful not only for diagnosis but also to create an opportunity for early referral and timely intervention.

In the current study, 6.0% of newborns failed the initial screening test and were recalled for repeat screening and diagnostic evaluation. Confirmatory testing identified 2.0% of newborns with congenital sensorineural hearing loss. This indicated that the screening of newborn hearing was useful in recognizing infants in need of audiological evaluation. But the number of newborns who did not pass the initial screening was higher than the number of confirmed cases. This could have been due to potential transient factors such as vernix in the ear canal, middle ear fluid, movement during testing, environmental noise or technical problems during screening. Therefore, the diagnosis was based on re-examination and confirmation of the initial screening result in the diagnosis.The study also found congenital sensorineural hearing loss in newborns with and without risk factors. In the study population, 19.0% had at least one risk factor and 81.0% had no identifiable risk factors. This finding reinforced the importance of universal newborn hearing screening rather than screening of high risk infants only. If screening had only been done on newborns with risk factors, some cases of congenital hearing loss may have been missed. Universal screening gave all newborns an equal opportunity for early detection, irrespective of known risk factors.The most common risk factor noted in this study was admission to neonatal intensive care unit followed by neonatal jaundice, family history of hearing loss, exposure to ototoxic drugs and birth asphyxia. These factors have been frequently associated with congenital or early-onset hearing loss. Newborns admitted to neonatal intensive care may be exposed to a number of risks including prematurity, hypoxia, infections, mechanical ventilation and ototoxic medication. Likewise, severe neonatal jaundice can impact the auditory pathway and increase the risk of hearing impairment. Therefore even infants with these risk factors must be fully evaluated and followed even if they pass the initial hearing screening test.

In this study, half of the confirmed cases of congenital sensorineural hearing loss had unilateral hearing loss and half had bilateral hearing loss. The degree of hearing loss varied from moderate to profound. These findings indicate the ability of newborn hearing screening to detect different patterns and degrees of hearing impairment. Severe or profound bilateral hearing loss may have more of an effect on speech and language development, but unilateral and moderate hearing loss also need to be addressed as they can affect sound localization, classroom performance, and communication in noisy environments. Therefore early detection of all degrees of hearing loss was important for planning of the appropriate management.The major strength of the newborn hearing screening was that it reduced the time from birth to diagnosis. The diagnosis was made in the screened group in early infancy and in the non-screened group delayed until almost two years of age. The delay was clinically important because the first few months of life are a critical period for auditory and language development. Early diagnosis enabled parents to access counselling and helped clinicians to plan early intervention, including hearing aids, cochlear implant evaluation,

speech therapy and regular audiological follow-up. Without screening, these interventions were delayed and the language development of the child could be negatively affected.

The results of this study support the early hearing detection and intervention guideline, "1-3-6", which recommends that hearing screening should be performed by 1 month of age, diagnostic confirmation should be achieved by 3 months of age, and that children should be in intervention by 6 months of age. The mean diagnostic age in the screened group was close to this goal indicating that screening programmes can contribute to early identification when systems for follow-up are in place. But screening alone was not enough. The success of such programmes depended on parental awareness, timely recall, availability of diagnostic audiology services, trained staff and proper referral pathways.Loss to follow-up was still a major challenge in newborn hearing screening programmes. Some parents may not return for repeat screening or diagnostic testing following an initial failed result due to lack of awareness, fear, financial difficulties, transport problems or poor counselling. Thus, health care providers should provide clear information to parents about the importance of repeat testing prior to discharge. A proper tracking system is essential to ensure that all newborns who do not pass the initial screening are promptly evaluated diagnostically.Limitations of the present study. The sample size was relatively small and the study was performed in a single centre, which may limit the generalizability of the results. Differences in referral patterns and parental awareness may also have influenced the comparison with non-screened children. Long term follow up of diagnosed children was not included so the effect of early diagnosis on speech and language outcome could not be fully assessed. Future studies with larger sample sizes, multicentre data and long-term developmental follow-up are recommended.

Overall, the results showed that newborn hearing screening was associated with a significant reduction in the mean delay in diagnosis of congenital sensorineural hearing loss. It aided in identification of the affected new-borns in the first few months of life and early referral for intervention. Universal newborn hearing screening should therefore be encouraged as an integral part of neonatal care, particularly where diagnosis is often delayed until speech and language difficulties become apparent.

Conclusion

The present study concluded that the newborn hearing screening was very important for reducing the average delay in the diagnosis of congenital sensorineural hearing loss. Newborns screened were diagnosed far earlier than non-screened children. Early screening could identify affected infants in the first few months of life, before speech and language delay became clinically apparent.The study also found that congenital sensorineural hearing loss may occur in neonates with or without known risk factors. Therefore universal newborn hearing screening proved more effective compared to screening of only high risk newborns. Early diagnosis enabled appropriate referral for audiological assessment, parental counselling, hearing aid fitting, cochlear implant assessment and early speech and language intervention.

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