Original Article

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An Early Hearing Detection and Intervention Program in Songklanagarind Hospital

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Abstract:

Objective: To compare the results of the universal newborn hearing screening program in Songklanagarind Hospital with the Joint Committee of Infant Hearing (JCIH) recommendations in regards to early hearing detection and intervention.

Material and Methods: We retrospectively reviewed the Early Hearing Detection and Intervention (EHDI) program results between January 2017 and June 2017. Furthermore, we calculated and compared the percentages of hearing screening, diagnostic evaluation, and rehabilitation at 1, 3, and 6 months of age.

Results: A total of 1,579 (93.1%) newborns were screened for otoacoustic emissions (OAEs). One hundred and eight (6.8%) newborns showed abnormal OAE in the first phase, and 11 (0.7%) newborns failed the OAE retest before discharge and within 1 month of age. Ten newborns (90.9%) had a hearing loss diagnosis confirmed due to a complete audiologic evaluation before 3 months of age, and 100.0% of newborns with abnormal hearing were enrolled for intervention within 6 months of age. Among the 4 newborns with abnormal hearing, 3 of them had conductive hearing loss, and one had profound sensorineural hearing loss, receiving an intervention via cochlear implant. Following intervention, all newborns with hearing loss had improved their hearing ability, speech and language development.

Conclusion: The universal newborn hearing-screening program is the first step in identifying a child with hearing problems, which leads into early intervention. The key to achieve best outcomes for the newborns is to ensure family support and the involvement of an interdisciplinary team.

Keywords: ABR, early detection, early intervention, hearing, infant, neonatal screening, OAE

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Introduction

Newborn hearing loss is a critical problem as it negatively affects child development, especially in the first three years of life, in areas such as language acquisition, learning, speech, cognitive development, occupational performance, and psychosocial well-being.[1,2] Moderate to profound bilateral hearing loss prevalence appears to occur in 1–3 per 1,000 newborns and can increase 10–50 times in high-risk groups.[2–6] In the past, delays in diagnosing hearing loss were common until the 2nd year of age; however, nowadays, new hearing screening technologies are available, such as otoacoustic emission (OAE) and auditory brainstem evoked response (ABR) tests, which can detect the newborns hearing status at birth.

In 1969, the Joint Committee of Infant Hearing (JCIH) was established, aiming to improve congenital hearing loss identification. The JCIH focused on screening only high-risk neonates, which was later, in 1994, extended to all newborns.[6–8] From then on, they have recommended screening all newborns prior to discharge, thus leading to the development of the universal newborn hearing screening (UNHS) program, which can identify infants with congenital hearing loss, needing early intervention enrollment, as soon as possible.

In 2007, the JCIH recommended the '1-3-6' rule in regards to monitoring hearing screening detection and intervention programs. In order to guarantee good results, quality indicators were used, serving as benchmarks, aiming that all newborns undergo hearing screening before they are discharged, no later than one month of age, in at least 95.0% of infants; with a referral rate under 4.0% and a follow-up rate that is more than 95.0% of those who failed initial screening in regards to their hearing. Moreover, that a minimum of 90.0% of newborns who were referred due to their hearing screening, should be diagnosed via audiologic evaluation at no later than 3 months of age. Furthermore, that 95.0% of infants with hearing loss should be enrolled in early intervention and rehabilitation services as soon as possible, specifically when they are at least 6 months old.[2,7–10]

In 2008, our hospital started hearing screenings only in regards to high-risk infants due to shortages of staff, materials, and finances. However, 50.0% of present congenital hearing loss was identified in 'well-infant' neonates in the low-risk group.[1,6,9] Therefore, in 2017, we have begun performing the universal newborn hearing screening as recommended by the JCIH.

In Thailand, UNHS and EHDI have not been mandated, and thus many reports have only focused on the high-risk group or the universal newborn hearing screening program, with only a few studies showing results in regards to the diagnosis and interventions.[11–14] Furthermore, the efficacy of the UNHS program in each facility depends on the coverage percentage, time to referral for diagnostic tests, intervention, and follow-up.[8]

This study, therefore, shows the results of the UNHS program and the achievement of hearing loss diagnosis and early intervention in Songklanagarind Hospital.

Material and Methods

This was a retrospective cohort study performed in Songklanagarind Hospital, which was approved by the Human Research Ethics Committee (REC. 60-293-13-4) and follows the guidelines of the Helsinki Declaration.

The inclusion criterion was neonates who were born between January 2017 and June 2017.

The exclusion criteria were neonates with defective auricles that could not be tested using otoacoustic emission (OAE) and neonates who died or who had not completed all stages of the study due to Newborn Intensive Care Unit (NICU) admission for more than 1 month due to severe illness.[5]

This study defined hearing loss as moderate to profound bilateral hearing loss, which means that the hearing level is at more than 40 dBHL.[3,6,8,15,16]

All infants who failed the hearing screening test were referred for a complete diagnostic audiologic evaluation by an audiologist and otologist, within 3 months of age.

All infants were screened for hearing loss using the transient evoked otoacoustic emission (TEOAE) test performed by nurses in the postpartum ward prior to hospital discharge. If the 1st OAE results indicate a 'refer' in regards to both ears, we arrange for the infant to undergo a second TEOAE test, as an outpatient, by an audiologist at the audiologic unit in the outpatient department of 'Otorhinolaryngology Head and Neck Surgery', within 1 month of age. If the 2nd results were still indicating a 'refer' for both ears, their hearing status was detected by using tympanometry and diagnostic auditory brainstem evoked response (ABR) testing, wherein all infants under 3 months of age were tested using ABR under natural sleep. The flowchart in Figure 1 further describes in detail the steps of the universal newborn hearing screening program in Songklanagarind Hospital. Finally, we conducted an intervention for newborns with hearing loss within 6 months of age, as recommended by the JCIH. In order to evaluate the outcome of the intervention, the participants underwent behavioral hearing evaluations such as the Visual Reinforcement Audiometry (VRA) or Conditioned Play Audiometry (CPA) tests.

Hearing screening equipment

-TEOAEs was elicited using a click stimulus via a transducer in the external ear canal, wherein the sound response from the outer hair cells was recorded using a microphone. TEOAE response revealed normal outer hair cell function in the inner ear. The equipment used for TEOAE screening was a Sentiero TEOAE/ABR (Screening/Diagnostic, PATH MEDICAL GmbH, Germany). The stimulus was a nonlinear click stimulus, with a stimulus level of 60-85 dB peSPL, and frequencies of 1-4 kHz. The pass criteria were stimulus stability >80.0%, artifact <20.0%, signal-to-noise ratio of at least 6 dB.[5]

-Middle ear tympanometry was performed using a 1,000 Hz probe tone, which was conducted through the middle ear analyzer-impedance audiometer (AT235h, Interacoustics).

-Diagnostic ABR recording used an ICS medical CHARTR diagnostic system (MCU103 90, Schaumburg, IL, USA), using click stimulus at intensities of 75 and 35 dB nHL and stimulus rate during 11.1-55.1 clicks/second was applied to determine the wave V which estimated the hearing threshold.[8,15] If the wave V could not be identified at 75 and 35 dBnHL, the stimulus would emerge at another intensity, in regards to determining the level of hearing loss.

All data were collected from a computerized hospital database, and the results of this study are presented using descriptive statistics.

We calculated the coverage percentage of hearing screening within 1 month of age, referral rate, diagnostic evaluation within 3 months of age, intervention within 6 months of age, and hearing loss prevalence in regards to the initial newborn hearing screening in Songklanagarind Hospital.

Results

A total of 1,696 newborns were born in Songklanagarind Hospital during the study period. and 1,579 newborns were included in this study, comprising 800 (50.7%) males and 779 (49.3%) females.

Results showed that 93.1% of newborns were screened for OAE within 1 month of age, with a referral rate of 6.8%. Newborns with a bilateral 'refer' result from their TEOAE had this confirmed with diagnostic audiologic evaluation before 3 months of age in 90.9% of the cases, with 34 (31.4%) newborns lost during follow-up. Additionally, 100.0% of newborns with abnormal hearing were enrolled for intervention, as shown in Figure 1.

Our study also showed the results of diagnostic audiologic evaluation, bilateral referral rate, and loss to follow-up rates, as further described in Table 1. Of the 108

mothers in the study, 34 (31.4%) of them did not return with their infants to take the 2nd OAE test and did not ensure that the infants attended to their complete audiologic evaluation appointments. This was due to a number of factors such as: mothers believing that their child could hear well, and believing that there was no problem as their infants generally responded to sound very well, maternal health problems, transportation problems, lack of time, infants' health problems, and long-distance travel issues.

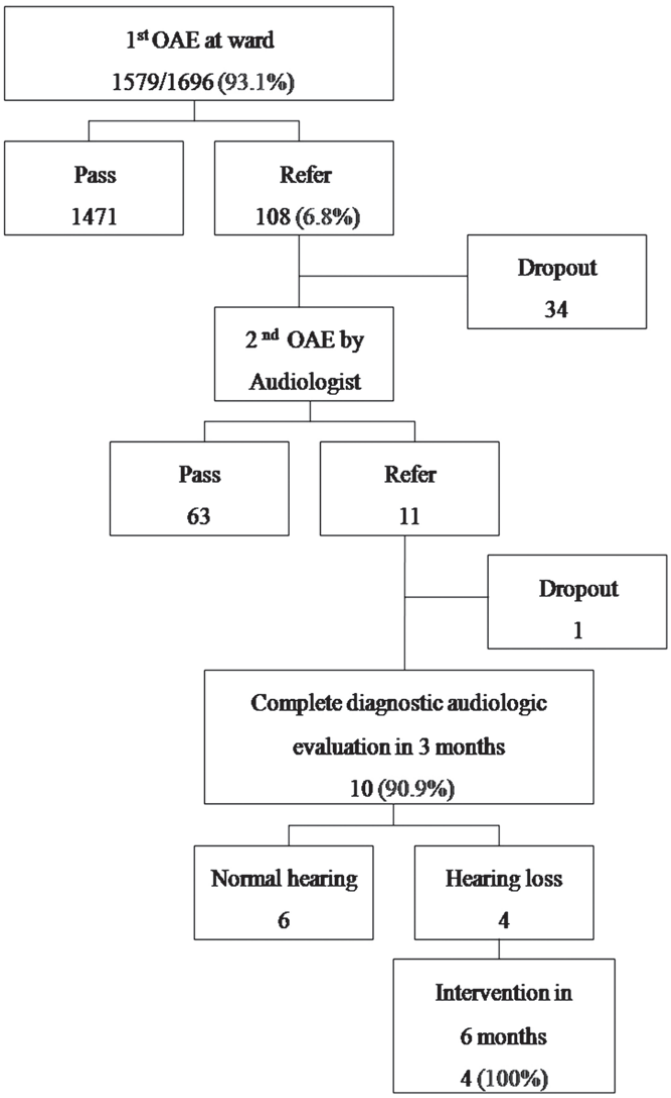

Figure 1 Diagram illustrating the results of early hearing detection and intervention in Songklanagarind Hospital

The newborn hearing loss prevalence in Songklanagarind Hospital was 2.5 per 1,000 infants. Moreover, results showed that only 50.0% of high-risk infants had congenital hearing loss, whereas the remaining 50.0% were identified in regards to 'well-infant' neonates.

More specifically, among the 4 newborns with abnormal hearing, 3 had conductive hearing loss, and one had sensorineural hearing loss (Table 2).

All infants could receive the intervention as soon as possible within 6 months of age, which meets the target of the JCIH indicator, as shown in Table 3.

Table 1 The results of bilateral referral rates for OAE retesting, diagnostic testing and non-attendance to follow-up appointments rates

	Bilateral referral rate (n)	%	Loss to follow-up rate (n)	%
Retest with 2nd OAE	108/1579	6.8	34/108	31.4
Diagnostic with ABR	11/74	14.8	1/11	9.1

OAE=otoacoustic emissions, ABR=auditory brainstem evoked response

Table 2 The prevalence of newborn hearing loss in Songklanagarind Hospital

Type of hearing loss	Frequency (per 1,000) n=1579
Conductive hearing loss	3 (1.9)
Sensorineural hearing loss	1 (0.6)

Table 3 The characteristics of infants with hearing loss and their intervention results

Type of HL	Risk factor	Intervention	Hearing level (decibel)	
			Pre-intervention	Post-intervention
1. CHL	Cleft palate Hypothyroid NICU with Ototoxic drug	Myringotomy with tube insertion	50	30
2. CHL	No risk	Watchful waiting	60	30
3. CHL	Cleft palate	Myringotomy with tube insertion	60	20
4. SNHL	No risk	Hearing aids, CI	100	50

HL=hearing loss, CHL=conductive hearing loss, SNHL=sensorineural hearing loss, CI=cochlear implant, NICU=newborn intensive care unit

Discussion

Before 1994, the JCIH initially focused on hearing screening only in regards to high-risk infants.[6,7] Unfortunately, hearing screening in regards to the high risk group could only be identified in 50.0% of congenital hearing loss cases, meaning that the remaining 50.0% were identified in the low-risk group.[17] Therefore, the JCIH consensus recommended performing the UNHS in regards to all infants.[6]

Similarly, to a previous study, our study showed that 50.0% of congenital hearing loss came from high-risk infants, and that the remaining 50.0% was identified in regards to 'well-infant' neonates.[17]

In 2000, EDHI programs were established in the United States public health system. From that point onwards, they have had a new consensus on early hearing detection and intervention, instead of the UNHS program.[7]

The UNHS in our hospital had a success indicator of 93.1%, which did not meet the JCIH's recommended indicator (95.0%). Due to a number of problems, such as: an insufficient number of wards for mothers, a lack of personnel for the screening of hearing, poor levels of reporting in the computer system, and some infants requiring NICU admission; a number of infants did not have a hearing screening within 30 days prior to discharge. Other problems which contributed to decreased testing also included the parents refusing this test due to the system of reimbursement in place and the equipment's frequent breakdowns due to its multiple users.

The referral rate was 6.8%, which was higher than that of the JCIH's recommended indicator (4.0%) as this program had just started in our hospital. The health personnel in each obstetric ward and private ward, such as nurses and nurse aids, required training on the screening test with OAE; however, the referral rate decreased in the following months, indicating that there was a learning curve in regards to this procedure. Kemp et al. reported that the higher the age, the lower the failure rate. Thus, we advised our nurses to perform hearing screenings at around 24 or 48 hours after birth in order to resolve the problem of fluid in the middle ear.[3] In fact, many studies have also reported a decrease in referral rates by ensuring an at least two-or three-stage screening with OAE or AABR prior to ABR diagnosis.[5,7,8,16]

The most common causes of failed newborn hearing screenings were the presence of sensorineural hearing loss and conductive hearing loss, accounting for 58.0% and 21.0%, respectively. However, the remaining 21.0% of those who failed UNHS was indicated as having normal hearing.[11,18] In some studies, conductive hearing loss from otitis media with effusion was shown as a common finding in 15.0–65.0% of infants with a failed hearing screening.[3,5,8,18,19] In this study, the most common cause of hearing loss was conductive hearing loss (75.0%), in which middle ear effusion may have been caused by a foreign body related inflammatory reaction to either reflux amniotic fluid, persistent middle ear mesenchyme, or blood products.[5,11] In 'well-infant' neonates, most middle ear effusions are resolved with just observation, and some studies have also shown the resolution of middle ear fluid by 4.8 months of age; however, this has been found to persist in high-risk infants, such as those with cleft palate or a craniofacial anomaly affecting eustachian tube function.[9] Additionally, middle ear fluid is difficult to diagnose in infants below 6 months of age due to their small, narrow ear canals and the limitations of conventional tympanometry in connection to young infants.

Currently, there is no established protocol to guide the management of neonatal otitis media with effusion. More specifically, its management options include watchful waiting, usually for 3 months with shorter surveillance periods (4–6 weeks), or surgical treatment via myringotomy with tube insertion if the effusion persists after 3–6 months, and an additional intraoperative ABR, after surgical treatment, to

rule out any sensorineural hearing loss conditions.[20–23] In the present study, we managed middle ear effusions in newborns via watchful waiting for a period of 5–6 months. Nevertheless, if this did not resolve by itself, then we performed a myringotomy with tube insertion. As per previous studies, most cases of persistent middle ear fluid were associated with cleft palate presence, affecting eustachian tube function. Effusions in these cases were spontaneously resolved in 65.3% of infants, with 17.0% of them requiring tube insertion.[14,20,22]

Although our hospital can accomplish UNHS with some indicators, such as diagnostic evaluation within 3 months of age (90.0%) and intervention within 6 months of age (95.0%), the problem with the UNHS program implementation was the non-attendance rates in connection to the follow up appointments. This was identified as the cause for this program's failure due to the screening being performed without diagnostic evaluations and interventions. Some studies have reported follow-up re-test appointment non-attendance to be at around 17.6–50.4% and in regards to diagnosis at 16.0–100.0%.[2,7,14,18,24] Furthermore, many studies have shown that the significant determining factors for UNHS retesting non-compliance were: forgetting the appointment, lack of information about the test, a belief that their child could hear well, ignorance on the importance of retesting, transportation problems, or limited access to audiologic services.[4,5,15] To address concerns regarding retesting information, postpartum ward nurses must come into play, as they are the best suited health professionals for the role of explaining the importance of re-testing, prior to the mothers' discharge. Moreover, it was found, that the follow-up appointment non-attendance rate was at 9.1% when the diagnostic evaluation was performed using ABR. Overall, increasing follow-up rate for diagnostic evaluation remains the main challenge of the UNHS program, and resolving this could improve its short-term cost effectiveness.[3]

In developed countries, UNHS program implementation is widespread, whereas in developing countries, problems in its implementation occur due to government policies, a lack of financial assistance, expensive screening equipment, shortage of personnel, a lack of pediatric audiologists to conduct diagnostic evaluations, inadequate third-party reimbursements, opposition by the hospital administration, a lack of knowledge on follow-up retesting among health providers, and a lack of systematization in the collection of data in order to follow up newborns with hearing loss.[7–9,14] Therefore, it is very challenging to set this program up not only in regards to performing hearing screening programs, but also in connection to doing diagnostic audiologic evaluations, early intervention services, and operating data management systems.

Conclusion

The UNHS program is a help in regards to the early diagnosis of infants with hearing loss and can be used in connection to planning early intervention programs before the golden period of language development. In addition to hearing screening, diagnostic and interventional steps are very important for the development of children with hearing loss. In Thailand, due to shortages in connection to the 3 M's (manpower, money, and materials), in conjunction with a national shortage of audiologists and a lack of collection and follow up related operational systems; there are challenges in ensuring that the diagnostic and interventional steps of the UNHS program are properly implemented. Furthermore, ensuring that these issues are resolved is key to the program's success.

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Conflict of interest

None

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