

การศึกษาทบทวนของโปรแกรมการคัดกรองการได้ยินในทารกแรกเกิดทุกราย ในจังหวัดนครสวรรค์: คาดหวังผลลัพธ์ที่ดีขึ้น

Retrospective Study of Universal Neonatal Hearing Screening Program in Nakhonsawan: Anticipating Improved Outcomes

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Abstract

Introduction: Newborn hearing loss is a significant health concern that can impact speech, language, and cognitive development. The Universal Neonatal Hearing Screening (UNHS) program aims to promptly identify hearing impairments in newborns for timely interventions and improved outcomes.

Objectives: This retrospective study assessed the effectiveness of the UNHS program in Nakhonsawan, specifically regarding coverage rate, identification of high-risk newborns, referral rates, prevalence of hearing loss, and audiological risk factors.

Methods: Data were collected from November 2021 to May 2023 at all 20 participating hospitals in the UNHS program. Newborns were screened using either Transient Evoked Otoacoustic Emissions (TEOAEs) or Automatic Auditory Brainstem Response (AABR) tests. Newborns with abnormal screening results underwent further diagnostic testing using Auditory Brainstem Response (ABR) or Auditory

Steady-State Response (ASSR) tests for confirmation.

Results: A total of 2,623 newborns were screened, with a coverage rate of 66.9%. Among the screened infants, 15.0% were classified as high-risk. The two-stage screening protocol significantly reduced referral rates from 18.6% to 6.6%. The most prevalent risk factors in Nakhonsawan were ototoxic medications (80.3%), preterm labor (32.5%), and NICU stays longer than five days (21.7%).

Conclusion: The UNHS program in Nakhonsawan plays a crucial role in improving outcomes for infants with hearing loss and provides valuable information to managers and healthcare personnel involved in public health. Continuing to implement and support the UNHS program is essential to ensure the improved well-being of newborns.

Keywords: Universal newborn hearing screening, Hearing loss, TEOAEs

บทคัดย่อ

ที่มา: ปัญหาการสูญเสียการได้ยินของทารกแรกเกิดเป็นปัญหาที่สำคัญทางด้านสุขภาพที่มีผลกระทบต่อพัฒนาการ การสื่อสาร ภาษา การเรียนรู้และสติปัญญาของทารก โปรแกรมการคัดกรองการได้ยินในทารกแรกเกิดทุกราย (Universal Neonatal Hearing Screening: UNHS) มีเป้าหมายเพื่อตรวจพบปัญหาการได้ยินในทารกแรกเกิดในระยะแรก เพื่อให้มีการแก้ไขที่ทันเวลาและมีผลลัพธ์ที่ดีขึ้น

วัตถุประสงค์: การศึกษาทบทวนนี้มีวัตถุประสงค์เพื่อประเมิน ประสิทธิภาพของโปรแกรม UNHS ในจังหวัดนครสวรรค์ โดยเฉพาะเรื่องอัตราครอบคลุมการคัดกรอง การตรวจพบทารก

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แรกเกิดที่มีความเสี่ยงสูง อัตราการเกิดความผิดปกติทางการได้ยิน (Referral rate) อัตราส่วนของการสูญเสียการได้ยิน และ ปัจจัยเสี่ยงทางการได้ยิน

วิธีการศึกษา: สุ่มข้อมูลตั้งแต่พฤศจิกายน พ.ศ. 2564 ถึง พฤษภาคม พ.ศ. 2566 จากโรงพยาบาลทั้งหมด 20 แห่ง ที่ร่วมรายการ UNHS โดยทำการคัดกรองด้วยการทดสอบการวัดเสียงสะท้อนจากหูชั้นใน (Transient evoked otoacoustic emissions: TEOAEs) หรือเครื่องตรวจการได้ยินระดับก้านสมองอัตโนมัติ (Automatic auditory brain stem response: AABR) สำหรับทารกแรกเกิดที่มีผลตรวจคัดกรองผิดปกติ จะส่งตรวจวินิจฉัยเพิ่มเติมด้วยเครื่องตรวจการได้ยินระดับก้านสมอง Auditory Brainstem Response/ Auditory steady-state response (ABR/ASSR) ต่อไป

ผลการศึกษา: ทารกแรกเกิดทั้งหมด 2,623 ราย ที่ผ่านการคัดกรอง ซึ่งเป็นสัดส่วนของการครอบคลุมอยู่ที่ 66.8% ในทารกที่ผ่านการคัดกรอง 15.0% ได้รับการจัดว่าเป็นเสียงสูง แนวทางการคัดกรองแบบสองขั้นตอนแสดงการลดลงอย่างมีนัยสำคัญในอัตราส่วนการส่งต่อลดลงจาก 18.6% เป็น 6.63% ปัจจัยเสี่ยงที่พบบ่อยที่สุดในจังหวัดนครสวรรค์คือ ยา Ototoxic ซึ่งมีสัดส่วน 80.3% การคลอดก่อนกำหนด (Preterm labor) ซึ่งมีสัดส่วน 32.50% และการอยู่ในห้อง NICU นานกว่า 5 วัน ซึ่งมีสัดส่วน 21.70%

สรุป: โปรแกรม UNHS ในจังหวัดนครสวรรค์มีบทบาทสำคัญในการเพิ่มผลลัพธ์ที่ดีขึ้นสำหรับทารกที่มีการสูญเสียการได้ยิน และให้ข้อมูลที่มีคุณค่าให้แก่ผู้บริหารและบุคลากรสาธารณสุขที่เกี่ยวข้อง การรักษาความสำเร็จและการสนับสนุนต่อไปของโปรแกรม UNHS เป็นสิ่งสำคัญเพื่อให้มั่นใจในคุณภาพชีวิตของทารกแรกเกิดที่ดีขึ้น

คำสำคัญ: โปรแกรมการคัดกรองการได้ยินในทารกแรกเกิดทุกราย, การสูญเสียการได้ยิน, การทดสอบการวัดเสียงสะท้อนจากหูชั้นใน

Introduction

Universal Neonatal Hearing Screening (UNHS) programs play a crucial role in the early detection and intervention of hearing loss among newborns. These programs aim to ensure that every infant can access timely screening, diagnosis, and appropriate interventions, ultimately improving their long-term developmental outcomes. While achieving high coverage rates in UNHS programs is essential, it is equally important to evaluate the effectiveness

and implications of these programs, even in regions where coverage may be less than optimal.

Hearing loss is a common issue among newborns, with approximately 1-2 out of every 1000 children being born profoundly deaf.¹ The prevalence of permanent congenital hearing loss, exceeding 25 dB HL in the poorer ear, is estimated to be at least three infants per thousand, and this prevalence increases as children grow.² High-risk infants have an estimated hearing loss prevalence ranging from 2.5% to 10%, while infants in neonatal intensive care units (NICU) are 10 to 20 times more likely to experience significant hearing loss compared to the general population.^{3,4} It is important to note that only half of the cases of permanent congenital hearing loss occur in children with known risk factors.⁵

Hearing impairment can profoundly impact a child's ability to develop speech, language, and social skills.⁶ Late diagnosis of hearing loss can significantly affect a child's future, leading to disabilities and associated high costs.^{4,7} Early diagnosis and intervention for hearing loss before the age of 6 months have been shown to result in significantly better outcomes for speech and language development compared to untreated children.^{8,9} Without a newborn hearing screening program, moderate to severe hearing loss may go undetected until around two years of age and remain untreated until around 40 months, while mild hearing impairment may not be identified until a child reaches school age.¹⁰

UNHS programs, initiated in 1994, strive to universally detect hearing loss in children, enabling early intervention with hearing aids and cochlear implants.^{11,12} Studies have shown that UNHS is the most effective way to screen the majority of the population, avoiding undiagnosed hearing impairments in high-risk groups.¹³⁻¹⁷

The objective of this study was to assess the effectiveness of the UNHS program in Nakhonsawan, specifically regarding coverage rate, identification of high-risk newborns, referral rates, prevalence of hearing loss, and audiological risk factors.

Materials and Methods

A retrospective review was conducted on newborns in Nakhonsawan from November 2021 to May 2023, following clearance from the institutional research and ethical committee, number COA.33/2566. All 20 birth centers and private hospitals in Nakhonsawan participated in a Universal Neonatal Hearing Screening (UNHS) program. The study included all newborns expected to undergo hearing screening, including both well newborns and those with known audiological risk factors. The screening process involved the use of transient evoked otoacoustic emissions (TEOAEs) tests and automatic auditory brainstem response (AABR) audiometry. The number of screening stages and tests varied depending on the presence of audiological risk factors in the infants.

For well newborns, the TEOAEs/ AABR test was performed 2-3 days after birth by trained personnel (1st stage). If the test showed no issues in both ears (pass), the screening was considered complete. However, if the newborns failed the initial hearing test (refer), the same test was repeated at one month of age at the same birth center (2nd stage). If the newborns failed the second test as well, they were referred to the tertiary care center (Sawanpracharak Hospital) for further diagnostic ABR/ASSR testing (3rd stage) before the age of 6 months. Newborns with

refer results in the diagnostic test were then sent to the Queen Sirikit National Institute of Child Health for treatment with hearing aids or implanted prosthetic devices before the age of 3.

For high-risk newborns, the TEOAEs tests and AABR audiometry were performed as soon as possible after birth by trained personnel, considering the general conditions of the infants (1st stage). Performing AABR in all infants born with audiological risk factors was necessary to identify auditory neuropathy. If the test results were negative in both ears (pass), the screening was considered complete. However, if the newborns failed the second test, they were referred to the tertiary care center (Sawanpracharak Hospital) for further diagnostic ABR/ASSR testing (3rd stage) before the age of 6 months. Newborns with refer results in the diagnostic test were then sent to the Queen Sirikit National Institute of Child Health for treatment with hearing aids or implanted prosthetic devices before the age of 3.

For subjects in the high-risk category who passed the screening, audiological monitoring with biannual assessments was conducted until the age of 3 years. The screening protocol is depicted in Figure 1.

Data collection involved obtaining the necessary data for each care center from the HDC dashboard of the Ministry of Public Health and the data collection program.

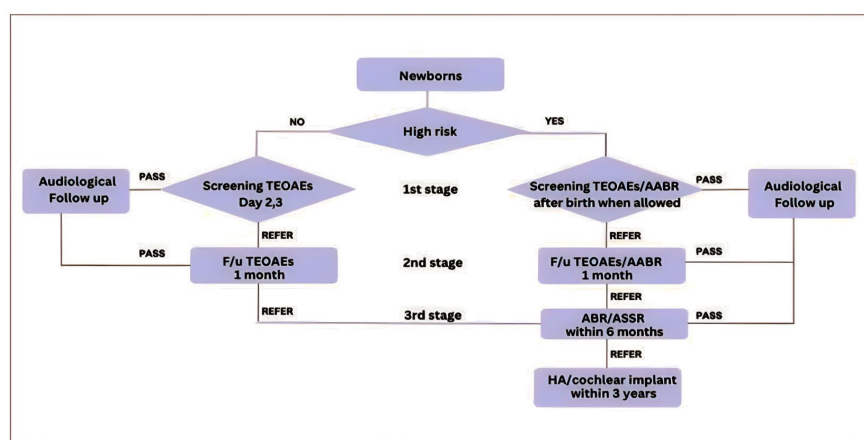


Figure 1 The screening protocol



Figure 2 Illustrates the process of newborn hearing screening at Sawanpracharak hospital,including the measurement of TEOAEs

Results

A total of 7,058 newborns were delivered in Nakhonsawan from November 2021 to May 2023. Out of these, 2,623 newborns underwent hearing screening, resulting in a screening coverage rate of 66.9%. Among the screened newborns, 1,498 (57.1%) were male, and 1,125 (42.9%) were female, resulting in a male-to-female ratio of 1.3:1. Among the screened newborns, 393 (15.0%) were classified as high risk, while 2,230 (85.0%) were considered well newborns (Table 1).

During the first stage of screening, 358 newborns (13.7%) were referred for further evaluation in the right ear, and 487 newborns (18.6%) were referred in the left ear. In the second stage, the referral rates decreased, with 151 newborns (5.8%) referred in the right ear and 174 newborns (6.6%) referred in the left ear. Unilateral hearing loss was identified in 174 newborns (6.6%), while bilateral hearing loss was found in 54 newborns (2.1%).

Among the newborns diagnosed with hearing loss, 122 (6.6%) were diagnosed within 6 months using the diagnostic test ABR/ASSR. Four newborns received fitting for hearing aids, while no newborns met the inclusion criteria for cochlear implantation.

Table 1 The key findings of the newborn hearing screening conducted in Nakhonsawan

	n (%)
Hearing screening	2,623 (66.9%)
Sex	
Male	1,498 (57.1%)
Female	1,125 (42.9%)
1st stage Refer	
Rt ear	358 (13.7%)
Lt ear	487 (18.6%)
2st stage Refer	
Rt ear	151 (5.8 %)
Lt ear	174 (6.6%)
Hearing loss	
Unilateral	174 (6.6%)
Bilateral	54 (2.1%)
Newborns	
Well	2,230 (85.0%)
High risk	393 (15.0%)
ABR/ASSR	174 (6.6%)
ABR/ASSR within 6 months	122
Fit HA(Hearing aid)	4
Cochlear implant	0

ABR: Auditory Brainstem Response, ASSR: Auditory Steady-State Response

Table 2 Second stage screening in the birth centers of Nakhonsawan form from November 2021 and May 2023 (Per)

Birth centers	Care center	Born Alive	Tested	%Tested	PASS	Refer	% Refer
Sawanpracharak	Tertiary	3,921	2,623	66.9%	2,449	174	6.6%
Krok Phra	Secondary	50	0	0	-	-	-
Chum Saeng	Secondary	192	0	0	-	-	-
Nong Bua	Secondary	183	0	0	-	-	-
Banphot Phisai	Secondary	686	0	0	-	-	-
Kao Liao	Secondary	18	0	0	-	-	-
Takhli	Secondary	563	188	33.4%	176	12	6.4%
Tha Tako	Secondary	363	0	0	-	-	-
Phaisali	Secondary	21	0	0	-	-	-
Phayuha Khiri	Secondary	19	0	0	-	-	-
Lat Yao	Secondary	1,001	0	0	-	-	-
Tak Fa	Secondary	9	0	0	-	-	-
Mae Wong	Secondary	30	0	0	-	-	-
Chum Ta Bong	Secondary	2	0	0	-	-	-
Mae Poen	Secondary	0	0	0	-	-	-
Chiraprawat	Military	N/A	N/A	-	-	-	-
Srisawan	Private	N/A	N/A	-	-	-	-
Prince	Private	N/A	N/A	-	-	-	-
Ruam Phaet	Private	N/A	N/A	-	-	-	-
Romchat	Private	N/A	N/A	-	-	-	-

N/A: Not Available

Table 3 Audiological risk factors according to the JCIH

Risk factor	Nakhonsawan	National
1. Birth weight less than 2,500 grams	30.8%	42.2%
2. Preterm labor (GA< 37 weeks)	32.5%	37.0%
3. Family history of hereditary childhood sensorineural hearing loss	0.3%	0.6%
4. NICU > 5 days	21.7%	29.1%
5. Hyperbilirubinemia at a serum level requiring exchange transfusion	1.2%	1.2%
6. Ototoxic medications, including but not limited to the aminoglycosides,used in multiple courses or in combination with loop diuretics	80.3%	60.3%
7. Severe birth asphyxia	12.2%	6.2%
8. ECMO	0.3%	0.4%
9. In utero infections (Herpes, rubella, syphilis, toxoplasmosis, cytomegalovirus, zika)	3.1%	3.4%
10. Craniofacial anomalies, including pinna, ear canal, ear pits, temporal bone	1.3%	2.0%
11. Syndromes associated with hearing loss (Alport syndrome, CHARGE syndrome, Pendred syndrome, Jervell & Lange-Nielsen, Usher syndrome, Waardenburg syndrome)	0.4%	0.2%
12. Meningitis or Encephalitis (culture positive postnatal infections associated hearing loss)	0	0.2%
13. Head trauma (Temporal bone fracture, skull base fracture) and chemotherapy	0	0.4%
14. Caregiver concern regarding hearing, speech, language, delay development	0.8%	1.1%

GA: Gestational age, NICU: Neonatal Intensive Care Unit, ECMO: Extracorporeal membrane oxygenation

At Sawanpracharak Hospital, a tertiary care center, out of 3,921 live births, 2,623 newborns were screened, representing a screening rate of 66.9%. Among these newborns, 2,449 passed the screening, while 174 (6.6%) were referred for additional evaluation.

Similarly, at Takhli Hospital, a secondary care center, out of 563 live births, 188 newborns were screened, representing a screening rate of 33.4%. Among these newborns, 176 passed the screening, while 12 (6.4%) were referred for further evaluation. Other Secondary, Military, and Private Birth Centers: no screening was conducted, and no data was available for those centers (Table 2).

In Nakhonsawan, the most prevalent risk factors were ototoxic medications (80.3%), followed by preterm labor (32.5%), and NICU stays longer than five days (21.7%). Other significant risk factors included severe birth asphyxia (12.2%), in utero infections (3.1%), and craniofacial anomalies (1.3%). It is important to note that some risk factors, such as ECMO, head trauma, and meningitis or encephalitis, were not observed in the cases analyzed in Nakhonsawan.

Nationally, the most common risk factor was low birth weight (42.2%), followed by preterm labor (37.0%) and NICU stays longer than five days (29.1%). The prevalence of ototoxic medications was slightly lower compared to Nakhonsawan (60.3%). Other notable risk factors included severe birth asphyxia (6.2%), in utero infections (3.4%), and craniofacial anomalies (2.0%). Similar to Nakhonsawan, certain risk factors like ECMO and head trauma were infrequent nationally (Table 3).

Discussion

In this retrospective study, we assessed the outcomes and implications of the UNHS program in Nakhonsawan, despite a coverage rate of 66.9%. Although the coverage rate was slightly below the desired level, we want to emphasize the positive impact and benefits the program has brought to identified newborns. Our investigation into the effectiveness of the screening protocol and

subsequent interventions highlights the potential improvements that can be achieved with a comprehensive UNHS program.

The difference in screening rates between Sawanpracharak Hospital, a tertiary care center, and Takhli Hospital, a secondary care center, can be attributed to various factors. One significant factor is the variation in their available resources. Tertiary care centers like Sawanpracharak Hospital typically have more resources, including trained staff, advanced screening equipment, and a larger workforce. This allows them to efficiently screen a higher number of newborns.

The implementation of a two-stage screening protocol, commonly used in Western countries, has proven effective in improving specificity and reducing referral rates. Our study showed a significant reduction in referral rates from 18.6% to 6.63% after the second screening, consistent with previous research.^{18,19} The first screening was performed within the first 48 hours of life or before discharge from the hospital.²⁰

Furthermore, we explored the audio-logical risk factors associated with hearing loss in Nakhonsawan and their prevalence among the screened newborns. Understanding these risk factors emphasizes the importance of targeted care and ongoing monitoring for high-risk infants, ensuring early identification and intervention. Despite the coverage challenges, our study highlights the continued importance and support needed for the implementation of the UNHS program.

Our findings demonstrate that even with a coverage rate of 66.89%, the UNHS program in Nakhonsawan successfully identifies newborns at risk of hearing loss, facilitating early detection and intervention. These findings emphasize the significance of comprehensive UNHS programs in promoting improved outcomes for infants with hearing loss. By highlighting the need for targeted care and ongoing monitoring, our study provides valuable insights for policymakers, healthcare professionals, and stakeholders involved in newborn hearing screening programs.

Conclusion

In conclusion, while acknowledging the coverage rate challenges, our study highlights the effectiveness and significance of the UNHS program in Nakhonsawan. The findings underscore the importance of early identification and intervention for newborn hearing loss and emphasize the need for continued implementation and support of the UNHS program. By sharing these insights, we aim to contribute to the ongoing efforts to improve the outcomes and well-being of newborns in Nakhonsawan and beyond.

Conflict of interest

The authors report no conflict of interest.

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