Original Article

In Universal Newborn Hearing Screening: Knowledge of Thai Healthcare Personals

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Objective: The present study aimed to evaluate the knowledge of Thai healthcare personals involved in newborn hearing screening program (NHSP) training program.

Materials and Methods: A cross-sectional design, 200 medical staffs who involved newborn in HRH Maha Chakri Sirindhorn Medical center (MSMC) as well as in public health area 4 (Sara Buri) attended the best practice in NHSP training program. Participants completed pre-post surveys of their NHSP training.

Results: The mean epidemiology and causes of hearing loss score of post training was statistically significant higher than that pre-training by 0.48 scores (95% CI = 0.19 to 0.76). Moreover, the overall knowledge score of post training was significantly higher than that pre-training by 0.99 scores (95% CI = 0.26 to 1.72). Nevertheless, the overall percentage score of knowledge for all participants was 19.0% of the participants which was categorized as having good knowledge level.

Conclusion: The overall knowledge score of post training was higher than that pre-training, Nevertheless, the most participants had overall percentage scores of knowledge as having poor knowledge level. Therefore, the finding suggests that there is also a need for continuous educational initiatives for the healthcare personals on intensively proper NHSP training workshop.

Keywords: Knowledge, Healthcare Personals, Newborn Hearing Screening Program

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Hearing loss is a common neonatal congenital condition screened at birth in the world[1-4], and 1.3 per 1000 infants were born with permanent hearing loss in Thailand[5]. The several previous studies have shown that undetected hearing loss in infants can negatively affect speech, language, social development, and educational achievement[6,7]. However, these negative effects can be prevented through newborn hearing screening program (NHSP) to early identify hearing loss. Therefore, all infants should be screened for hearing impairment, preferably prior to hospital discharge[8] and early appropriate intervention should be performed no later than six months of age[9]. To date, NHSP has been widely implemented in developing countries including Thailand, where has been implemented only in super tertiary, tertiary, and some secondary healthcare services. A successful NHSP requires the active participation of several healthcare professionals who play roles to educate, advocate and promote NHSP to the families. Unfortunately, the overall knowledge of NHSP was limited within some healthcare professionals. They had insufficient knowledge especially in causes of hearing loss, techniques for hearing evaluation, treatment and rehabilitation of hearing loss[10-14]. Since, the HRH MSMC together with the public health area 4 (Sara Buri) have created NHSP training in order to give NHSP education, together with the importance and implementation among healthcare professionals. Therefore, the aims of the present study were to evaluate the knowledge of Thai healthcare personals involved in NHSP training.

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Materials and Methods

Study design and participants

A descriptive, cross-sectional study was employed in the present study. Oto-rhino-laryngologist, neonatologists, pediatricians, obstetricians, residents, midwives, audiologists, medical students, and other medical staffs who involved newborns in MSMC as well as public health area 4 (Sara Buri) who implemented NHSP were invited to take part in the best practice in NHSP training program. Approvals for the study were obtained from the Ethic Committee of Faculty of Medicine, Srinakharinwirot University Bangkok, Thailand (SWUEC- 029/58X).

Study instrument

A structured questionnaire with 40 items was created by the (Figure 1). There were 4 items assessing

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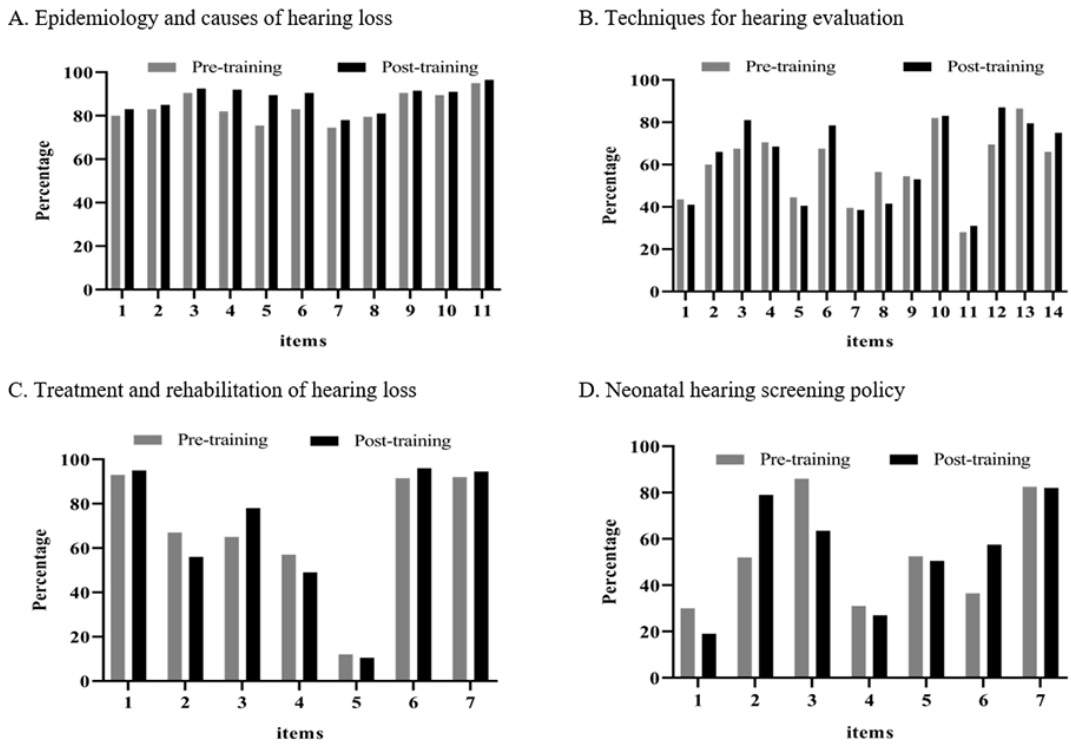

Figure 1. Descriptive proportion for each item in the knowledge items at pre-and post-trainings.

knowledge about NHSP as epidemiology and causes of hearing loss, techniques for hearing evaluation, treatment and rehabilitation of hearing loss, and neonatal hearing screening policy. Within the domain of knowledge, items were measured in the form of dichotomous (yes/no questions). The results showed a KR-20 value of 0.79, indicating a high level of internal consistency therefore no modification to the questionnaire was necessary. The questionnaire required 25 to 30 minutes to complete. The questionnaire was explained and provided in Thai language however the participants could ask for clarification on any question if required. Moreover, Baseline characteristics of the participants including age, gender, position, and department were also included in questionnaire.

Data collection

In order to obtain information concerning the effectiveness of NHSP short course training program, participants were asked to complete three subjective measures: a baseline characteristic survey with 4 questions, a pre-post-survey with the same 40 questions. These were all presented in the same hard-copy format. The participants were explained about the aim of the study and a written consent was taken prior to administer the questionnaire. The pre-survey measured their knowledge of NHSP according to their previous levels of trainings. Each correct answer was scored 1 mark; while 0 was given for each wrong or unsure response, therefore the maximum obtainable correct score was 40. The total knowledge score was categorized into two levels by poor (<80%) and good (≥80%) evaluation.

Data analysis

For baseline characteristics, all categorical variables were reported as numbers and percentages as well as mean and standard deviations were used to describe for continuous variables. Mean difference and their 95% confidence intervals (95% CIs) were estimated using paired t-test. All analyses were performed using SPSS version 19.0 (Chicago, USA). The *p*-value less than 0.05 were considered as statistically significant.

Results

Baseline characteristic

A total of 200 participants responded to the questionnaires. There were 123 medical students, 37 midwives/nurses, 15 residents, and 9 medical staffs. Of the participants, 105 (52.5%) worked in Department of Otolaryngology, 55 (27.5%) in Pediatrics Department, and 40 (20.0%) in obstetrics and gynecology. Participants' baseline characteristics are summarized in Table 1. The category age of the participants were 20 to 30 years (70.0%) as well as several participants were female (62.0%).

Knowledge of NHSP

Of the 200 participants, within the domain of knowledge at post-training, the participants correctly

answered each epidemiology and causes of hearing loss items (Table 5). According to techniques for hearing evaluation, the majority of participants did not know that an otoacoustic emission (OAE) was reverberated during the measurement in the middle ear (item 1). Hypnotic or soporific drugs, commonly known as sleeping pills could effect to interpret ABR results (item 5). The ABR audiometry should be evaluated in children at age under 18 years (item 7). Actually, the ABR audiometry is an objective measure to detect hearing sensitivity using pure tone 500 to 2,000 Hz (item 8) and the normal noise levels are 25 to 40 dB (item 9). To confirm the results, prior to evaluation using ABR audiometry, which should be used hypnotic or soporific drugs in all children (item 11), half of the participants (53.0%) knew that the normal noise levels were 25 to 40 dB as well as 63.0% knew that the ABR audiometry had 2 methods, namely ABR and TEUAE. Regarding the domains of treatment and rehabilitation of hearing loss items, only 56.0% knew that the children with congenital hearing loss should be provided for hearing aids, less than a half of the participants (49.0%) correctly answered that the cochlear implantation should be operated prior 15 years of age. Moreover, only 10.5% knew that if the children came with negatively affected speech, we must stimulate speech development instead of hearing loss screen. Nearly 19.0% incorrectly answered that an OAE provided only newborn hearing screening. Nevertheless, 63.5% of the participants knew that if the authors found the negative results with OAE, we should use ABR technique within 2 months. A half of participants (50.5%) knew that if the results of OAE were positive, we should confirm the results by using ABR audiometry, and only 27.0% understood that the early neonatal hearing screening was the best practice. Although a half (50.5%) of the participants knew that if we found the normal hearing screening in negatively affected speech, it would indicate no hearing problems, and 79.0% of them knew an OAE should be screened in newborn at age older than 1 day.

The mean of epidemiology and causes of hearing loss score of post training was higher than that pre-training by 0.48 scores (p-value = 0.001) (Table 2). Meanwhile, the mean knowledge scores of techniques for hearing evaluation, knowledge scores of treatment and rehabilitation of hearing loss as well as knowledge scores of neonatal hearing screening policy were not significantly higher than pre-training. Moreover, the overall knowledge score of post training was significantly higher than that of pre-training by 0.99 scores (p-value = 0.008). In addition, the subgroup-specific analyses showed the mean knowledge score of epidemiology and causes of hearing loss, techniques for hearing evaluation, treatment and rehabilitation of hearing loss, and overall knowledge scores were higher than pre-training in medical staffs by 1.33 (95% CI 0.74 to 3.40), 1.03 (95% CI 1.34 to 2.01), 1.02 (95% CI 1.34 to 2.00), and 1.87 (95% CI 1.02 to 3.69), respectively (Table 3). Meanwhile, the mean knowledge score of epidemiology and causes of hearing loss, and overall knowledge scores for residents, medical students, and midwives/nurses were higher than pre-training by 0.49 (95% CI 0.11 to 0.87); 0.54 (95% CI 0.28 to 0.68); (0.35; 95% CI 0.18 to 0.88), and 1.54 (95% CI 0.55 to 2.52); 1.67 (95% CI 0.42 to 3.35); (0.73; 95% CI 0.48 to 1.94), respectively. Interestingly, the mean scores of neonatal hearing screening policy domain for all groups were not increased after training.

Table 1. Baseline characteristics

Characteristics	Number	Percentage
Gender		
Male	76	38.0
Female	124	62.0
Age (years)		
20 to 30	141	70.5
31 to 40	35	17.5
41 to 50	17	8.5
50 or older	7	3.5
Department/OPD		
Eye Ear Nose Throat (ENT) department	105	52.5
Pediatrics department	55	27.8
Obstetrics and gynecology	40	19.8
Position		
Medical students	123	61.5
Midwives/nurses	37	18.5
Residents	15	7.5
Medical staffs	9	4.5
Nurse aide/nursing assistant	9	4.5
Nursing staffs	6	3.0
Audiologists	1	0.5

Table 2. Mean differences and their 95% confidence intervals

Knowledge items	Pre-training		Post-training		Mean diff.	95% CI
	Mean	SD	Mean	SD		
Epidemiology and causes of hearing loss	9.23	2.11	9.71	1.68	0.48	0.19 to 0.76
Techniques for hearing evaluation	8.36	6.05	8.64	2.20	0.28	-0.08 to 0.64
Treatment and rehabilitation of hearing loss	4.78	1.27	4.79	1.10	0.02	-0.18 to 0.21
Neonatal hearing screening policy	3.70	1.36	3.79	1.40	0.08	-0.13 to 0.29
Overall knowledge scores	26.76	5.51	27.75	4.37	0.99	0.26 to 1.72

The mean difference was statistically significant (p-value <0.05), using paired t-test

Table 3. Mean differences and their 95% confidence intervals of subgroup analysis

Knowledge items	Medical student (n = 123)	Midwives/nurses (n = 37)	Resident (n = 15)	Medical staffs (n = 9)
Epidemiology and causes of hearing loss	0.49 (0.11 to 0.87)	0.35 (0.18 to 0.88)	0.54 (0.28 to 0.68)	1.33 (0.74 to 3.40)
Techniques for hearing evaluation	0.58 (-0.06 to 1.09)	-0.49 (-1.05 to 0.08)	0.73 (-0.28 to 1.74)	1.03 (1.34 to 2.01)
Treatment and rehabilitation of hearing loss	0.18 (-0.09 to 0.44)	-0.43 (-0.20 to 0.84)	0.27 (-0.31 to 0.84)	1.02 (1.34 to 2.00)
Neonatal hearing screening policy	0.12 (-0.16 to 0.40)	-0.19 (-0.55 to 0.18)	0.07 (-0.70 to 0.83)	-0.22 (-1.59 to 1.15)
Overall knowledge scores	1.54 (0.55 to 2.52)	0.73 (0.48 to 1.94)	1.67 (0.42 to 3.35)	1.87 (1.02 to 3.69)

The mean difference was statistically significant (*p*-value <0.05), using paired t-test

However, the total knowledge score was categorized into two levels by poor and good evaluation, the overall percentage score of knowledge for all participants was 69.38±10.93 scores, and 19.0% and 81.0% of the participants were categorized as having good and poor knowledge levels, respectively. Meanwhile, a half of medical staffs (55.6%) had good knowledge levels in universal newborn hearing screening (Table 4).

Discussion

Knowledge on NHSP training was studied to document the knowledge of Thai healthcare personals, namely medical staffs, residents, medical students, midwives/nurses, nurse aide/nursing assistant, nursing staffs, and audiologists. The mean of epidemiology and causes of hearing loss score of post training was significantly higher than that of pre-training by 0.48 scores but was not significantly higher than the mean knowledge scores of techniques for hearing evaluation, treatment and rehabilitation of hearing loss as well as the knowledge scores of neonatal hearing screening policy**.** Moreover, the overall knowledge score of post training was significantly higher than that of pre-training by 0.99 scores. Nevertheless, the overall percentage score of knowledge was 69.38±10.93. The survey results also revealed that the overall knowledge levels were poor (81.0%) in all healthcare personals involved in the NHSP training. However, about a half of medical staffs (55.6%) had good knowledge levels in NHSP training as well as the results of subgroup-specific analyses showed that the mean knowledge score of epidemiology and causes of hearing loss, techniques for hearing evaluation, treatment and rehabilitation of hearing loss, and overall knowledge scores were higher than pre-training in only medical staffs. Probably, the medical staffs had been exposed to audiology curriculum, particularly on the diagnosis and management of children with hearing loss more than others healthcare personals.

The deficiencies in healthcare personals' knowledge about techniques for hearing evaluation, treatment and rehabilitation of hearing loss as well as the knowledge scores of neonatal hearing screening policy are concerned because it could directly affect quality and threshold detection for NHSP, effectiveness of treatment and rehabilitation of hearing loss, which importantly result in parents' reluctance or non-compliance towards the NHSP program as well as formulate policies geared toward primary ear and hearing care. Meanwhile, the residents, medical students, and midwives/ nurses showed only a modest increase in knowledge of epidemiology and causes of hearing loss, and overall knowledge scores. It could be concluded that many resident, medical student, and midwives/ nurses did not have basic knowledge about NHSP, particularly the techniques for hearing evaluation, treatment and rehabilitation of hearing loss. Interestingly, we found that the mean scores of neonatal hearing screening policy domain for all groups were not increased after training. Several factors may explain this result. Firstly, the lack of awareness may be attributed to newly implemented program and their working experience in which

Table 4. Percentage distribution of knowledge at pre-post training according to personals category

Professional Category	Knowledge Scores (%)		Knowledge levels	
	Mean	SD	Poor	Good
Participants (n = 200)	69.38	10.93	162 (81.0)	38 (19.0)
Medical student (n = 123)	66.71	11.77	107 (87.0)	16 (13.0)
Midwives/nurses (n = 37)	71.35	6.84	31 (83.8)	6 (16.2)
Resident (n = 15)	77.00	6.96	8 (53.3)	7 (46.7)
Medical staffs (n = 9)	78.33	7.29	4 (44.4)	5 (55.6)

most participants (123/200) in the present study were medical students, and only 62 participants worked in hospitals. It was demonstrated that the residents, medical students, and midwives/nurses could be less knowledgeable, less confident and less engaged after training, leading to an under-estimation of the proper effect. For the next design phase, the pre and post-questionnaire administration should be two or four weeks, and have implemented measures to prevent recall bias. Secondly, the educational intervention is an intensive and interactive one day session designed to develop the knowledge scores, to gain knowledge which is necessary to practice frequently with different scenarios. This is difficult to do in a teaching module where many topics have to be explained in a short period of time. It may be worthwhile to reconsider the time allocated to each step of the NHSP in the teaching module. However, the similar findings from the previous study, the overall knowledge of NHSP was poor in pediatricians, ENTs and neonatal intensive care unit (NICU) nurses involved in the NHSP [11,12,14]. The most participants knew the risk factors for the detection of neonatal hearing impairment, how to perform procedures, and recognized the importance of diagnosis of hearing loss and the need to refer suspected cases, but most did not know the techniques used to assess hearing in newborns[10]. Further, several of the participants stated that they received initial training several years prior to complete the training included in this project. However, they had never received continuing education concerning NHSP even though this is included within their scope of practice, which is not an acceptable standard for healthcare personals. Hence, it is imperative that these personals are adequately trained as well as they need continuous educational evolve development (intensively NHSP training program). Moreover, retraining should be completed on a scheduled basis for the healthcare personals in Thailand.

The present study has some limitations. Firstly, we could not control for a potential Hawthorne effect in before-after designs. Furthermore, the participants knew if the test was evaluated and administrated before or after the intervention, then they could also have biased results. Secondly, the authors did not follow measuring the knowledge after post-training as well as investigate the attitudes of healthcare personals involved in NHSP. Moreover, it's also possible that the sample size was not fully representative of the national population of healthcare personals involved in NHSP, for instance, the participate might have a greater interest in and more favorable attitudes in NHSP than others who did not participate. Nevertheless, the results of present study obtained contribute valuable information for planning alteration to improve the quality of care for NHSP in Thailand.

Conclusion

The overall knowledge score of post-training was higher than that pre-training, Nevertheless, the knowledge scores of techniques for hearing evaluation, treatment and rehabilitation of hearing loss, especially neonatal hearing screening policy of post-training were low among medical student, resident, and midwives/nurse. As well as the overall percentage score of knowledge, which was categorized as having good knowledge levels for all participants, was low. The findings of the study suggest the intensive and interactive NHSP workshop should only be concerned about a gain in knowledge of techniques for hearing evaluation, treatment and rehabilitation of hearing loss, and neonatal hearing screening policy than other domain, but also on how this gain is transferred to behavioral or attitude change for the healthcare personals, especially medical student, resident, and the midwives/nurse.

What is already known on this topic?

Adequately training healthcare personals to complete hearing screening is necessary to provide important information to familiars or parents to assist them in appropriate and timely follow-up as well as a better understanding of NHSP serves to healthcare personals in initiating the appropriate treatment for children identified as congenital hearing loss.

What this study adds?

A future training for healthcare personals should be expanded to cover more in-depth topics that may not be addressed by general training, including attitude in NHSP. Moreover, a future study including allied health personals would be beneficial as well as a hands-on module.

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Table 5. Questionnaire used in the study

Knowledge items
Epidemiology and causes of hearing loss
1) The incidence of newborn hearing loss were 2 to 4 per 1,000 infants
2) The one common risk factor associated with hearing loss in infants is used antiseptic drugs
3) Had family history of congenital hearing loss
4) Infectious Disease in Pregnancy, namely CMV, Rubella, Toxoplasmosis, and Herpes
5) Had craniofacial anomalies
6) Had a pinna and ear canal anomalies
7) Had a hyperbilirubinemia
8) Had a persistent pulmonary hypertension of newborn (PPHN), requiring the use of extracorporeal membrane oxygenation
9) Postnatal infections associated with congenital hearing loss, including bacterial meningitis
10) Diagnosis with Neurofibromatosis, Osteopetrosis, and Usher syndrome.
11) Had a neurodegenerative disorders such as Hunter syndrome, sensory motor neuropathies (Charcot-Marie-Tooth syndrome)
Techniques for hearing evaluation
1) An otoacoustic emission (OAE) are reverberation which measure in the middle ear
2) An OAE is a screening test as well as diagnostic test
3) The ABR audiometry is a neurologic test of auditory brainstem function in response to auditory
4) Auditory Brainstem Response Audiometry has 2 methods, namely ABR and TEUAE
5) Hypnotic or soporific drugs, commonly known as sleeping pills can effect to interpreted ABR results
6) The objective of audiometry was to confirm hearing loss in newborn
7) The ABR audiometry should be evaluate in children at aged under 18 years
8) The ABR audiometry is an objective measure for detect hearing sensitivity using pure tone 500 Hz to 2,000 Hz
9) The normal noise levels is 25 to 40 dB
10) A tympanogram is a graphic representation of the function of Eardrum as well as middle ear
11) To confirm the results, prior evaluate using ABR audiometry, which should be used hypnotic or soporific drugs in all children
12) The ABR is an auditory evoked potential extracted from ongoing electrical activity in the brain and recorded via electrodes placed on the scalp
13) The ABR can evaluate in both infants and adults
14) Newborn Hearing Screening must evaluate at 28 days of age
Treatment and rehabilitation of hearing loss
1) Early diagnosis and treatment prior 6 months can positively affect speech, language, and social development included educational achievement
2) The children with congenital hearing loss should be provide used hearing aids
3) Cochlear implantation improve upon children with severe hearing loss
4) Cochlear implantation should be surgery prior 15 years of age
5) If the children comes on with negatively affect speech, we must stimulate speech development not be hearing loss screening
6) Hearing, speech, language or developmental delay
7) Recurrent or persistent otitis media with effusion for at least 3 months
Neonatal hearing screening policy
1) Otoacoustic Emissions: provide only Newborn Hearing Screening
2) An OAE should be screen in newborn at aged older 1 day
3) If our found the negative results with OAE, we should be used Audio Brainstem Response (ABR) technique within 2 months
4) Early neonatal hearing screening is the best practice
5) If the results of OAE is positive, we should be was to confirm the results using ABR audiometry
6) If we found that the normal hearing screening in negatively affect speech, it's meant no hearing problems
7) Recommend risk children evaluate every 6 to 24 months of age

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Author's contributions

JS wrote the proposal to apply a grant, designed the study, screened and examined all the recruited subjects, researched data, and wrote and reviewed the manuscript. KK Analyzed data and performed the statistical analysis and wrote the manuscript. Both of JS and KK are the guarantor of this work and, as such, had full access to all the data in the study and take responsibility for the integrity of the data and

the accuracy of the data analysis.

Potential conflicts of interest

The authors declare no conflict of interest.

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