TRAINING OF NURSES IN EAR EXAMINATION AND HEARING SCREENING IN THE SCHOOL SETTING

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Abstract. The objectives of this study were to determine the agreement between the ear examination findings of the otorhinolaryngologist (trainer) and the elementary school nurse (trainee) after training with the use of a penlight and to determine the mean sound pressure level (SPL) produced by school nurses as a standard parameter for hearing screening using a 512 tuning fork after training on tuning fork testing by the otorhinolaryngologist. Training workshops in ear examination using a penlight and hearing screening using a 512 tuning fork were conducted for school nurses. Data for assessment of ear examination skills and production of SPL were collected by questionnaire and observation of performance. Kappa statistics were used to assess agreement between trainees' and trainer's responses. Mean and standard deviation were determined for the assessment of the SPL produced. Results showed an excellent agreement between the school nurses' and otorhinolaryngologist's observations on ear examination. These included observations of the ear canal, visualization of the tympanic membrane and identification of unusual findings such as wax and discharge. The majority of nurses responded positively in terms of the ease and confidence in performance of the procedure. Regarding tuning fork testing, the nurses were able to produce significant SPL. The mean SPL produced by the nurses using a 512 tuning fork was 56.316 dB.

INTRODUCTION

The Philippines Department of Education (DepEd) has a program called "Education for All (EFA) 2015". One of its goals is the provision of early childhood preventive health and nutrition services. In line with this, the Health and Nutrition Center conducted a series of *Training of School Nurses in Preventive Health Care in the School Setting* from October 2004 to the present. The Philippine National Ear Institute (PNEI) of the National Institutes of Health (NIH) has been an active participant in this program in its quest to fulfill its vision of "No Filipino should be deprived of a functional sense of hearing and balance."

School nurses are one of the most important personnel in the delivery of basic health and nutrition services. In the Philippines at present, there is an existing ratio of 1 nurse to 3,000-5,000 students (Philippine Department of Education, 2005). This makes the school nurse a significant front line person in screening and detection of many childhood conditions, including diseases of the ear and hearing impairment.

Hearing loss in children is a serious handicap because if undetected and untreated, it can lead to delay in speech and language development, social and emotional problems, and academic failure. The causes of hearing loss in children can be classified into congenital and acquired. Worldwide, including in the Philippines, the most common cause of hearing loss is infectious causes (Northern, 1991).

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Several studies among schoolchildren showed 8-30% had some degree of hearing loss (Perez, 1987). A study by Perez concluded otitis media is the leading cause of hearing impairment in Filipino children, followed by impacted cerumen (Perez, 1987). A local unpublished survey of grade 1 pupils in a rural public school showed that 40% had hearing loss due mainly to impacted cerumen and otitis media (Penaflor *et al*, 2001).

Despite the significant prevalence of hearing impairment, there has been no adopted hearing screening test for schoolchildren in the Philippines. This may be attributed to the unavailability of equipment, personnel, or ideal audiologic settings as recommended standards by developed countries. The PNEI has begun to study the feasibility of using the 512 tuning fork as a tool for mass hearing screening used by paramedical personnel and teachers in the school setting for Filipino schoolchildren. Efforts began about 3 years ago and resulted in a study (Penaflor *et al*, 2001). Striking the tines of a 512 tuning fork against the hypothenar area of the opposite hand and placing it 3-6 inches away from the external auditory canal of the test ear is precise enough to detect low frequency hearing loss commonly found in children.

As part of continuing training and research in the use of a 512 tuning fork for hearing screening in schoolchildren, the PNEI participated in a DepEd program and formulated a training course, which was conducted to provide the school nurse with basic knowledge and simple, but effective skills, to screen for common ear diseases and possible hearing impairment in patients. This program proposed the use of a penlight and a tuning fork because these are cost-effective, easily available, easy to use, handy, light, easily maintained and durable. If this training, as the initial part of a multiphase study, proves to be effective, then the school nurses will play a vital part in hearing screening in the school setting utilizing and maximizing the limited resources available in a developing country such as the Philippines.

To assess the efficiency of the training program, research was conducted as an initial phase of the study in preparation for actual conduction in the school setting. The objectives of the study were to determine, after training with the use of a penlight, the agreement between the ear examination findings of an otorhinolaryngologist (trainer) and a school nurse (trainee) and to determine the mean sound pressure level produced by the school nurses using a 512 tuning fork as trained by an otorhinolaryngologist.

MATERIALS AND METHODS

The Ear Study Group of the PNEI conducted a series of four training workshops for the public elementary school nurses in line with the program's objectives (Table 1).

Each workshop started with a plenary session, which consisted of a lecture on basic ear anatomy and the physiology of hearing, related common conditions, diagnostic examinations, management and prevention.

This was followed by a demonstration of ear examination with the use of a penlight and screening for hearing using a 512 Hz tuning fork. The position of the patient and the manipulation of the pinna to maximize visualization were taught. The nurses were taught what to look for, such as external abnormalities, the canal, the contents of the canal, the eardrum and its appearance.

A demonstration of the tuning fork test as a screening modality followed. The nurses were taught how to hold the tuning fork and how to strike it to produce the sound pressure level desired. For standardization, specific instructions on body position and arm position of the examiner, the position of the examinee and the distance of the tuning fork when presented to the test ear were dis-

Table 1
Conducted workshops.

Workshop	Venue	Date	Regions	No. of participants	No. of study participants
I	Baguio	Oct 22-25, 2004	I,II,III,CAR	350	26
II	Baguio	Nov 23-27, 2004	IV, NCR	265	26
III	Zamboanga	Feb 25 -27, 2005	IX	107	25
IV	Iloilo	Apr 1-3, 2005	VI	123	20
		Total		845	97

cussed. Observations and recordings of the responses were also taught. Then, the participants were divided randomly into several small groups for the workshop proper which included further training on ear examination using a penlight and hearing screening using a tuning fork through strategies of small group discussion, demonstrations and return demonstrations with a partner, further practice with a partner and feedback.

At each workshop conducted, data were collected from the groups by means of a questionnaire and observation of performance to assess agreement between the trainer and the trainee in regard to the ear examination. In these study groups, the nurses were monitored in regard to the amount of sound they could produce with a tuning fork using the method taught them. The sound level produced by striking the tuning fork was measured by sound meter 3 times for each nurse. The mean sound pressure level (SPL) produced by each nurse was determined. There was one trainer for all the sessions to minimize variability.

Data collected from each workshop were treated independently for the most part in terms of statistical analysis to account for the factors that would inherently vary for each workshop. In the assessment of the agreement between the trainer's and the trainees' ear examination findings, Kappa statistic was used. In assessment of the SPL, the mean and standard deviations were determined, both independently for each workshop and for all the workshops combined.

Table 2
Assessing the ear examination: responses to "Did you see anything inside the ear?"

Nurse	Examiner		Total
	(-)	(+)	
Workshop I			
(-)	10	2	12
(+)	0	13	13
Total	10	15	25
Workshop II			
(-)	15	2	17
(+)	0	9	9
Total	15	11	26
Workshop III			
(-)	17	0	17
(+)	0	7	7
Total	17	7	24
Workshop IV			
(-)	15	0	15
(+)	0	5	5
Total	15	5	20

Workshop I: X2, p = 0.0000, Kappa statistic = 0.9999; Workshop II: X2, p = 0.000, Kappa statistic = 0.9989; Workshop III: X2, p = 0.0000, Kappa statistic = 0.9959; Workshop IV: X2, p = 0.0000, Kappa statistic = 0.9873

RESULTS

The first part of the results addressed assessment of the ear examination and the second part, tuning fork testing. Responses of the trainer and the trainees to the questionnaire that addressed the ear examination findings are shown in Tables 2, 3 and 4 and include the Kappa values that indicate the

Table 3
Assessing the ear examination: responses to “Did you see the eardrum or the tympanic membrane?”.

Nurse	Examiner		Total
	(-)	(+)	
Workshop I			
(-)	2	0	2
(+)	0	24	24
Total	2	24	26
Workshop II			
(-)	3	2	5
(+)	3	18	21
Total	6	20	26
Workshop III			
(-)	5	3	8
(+)	0	16	16
Total	5	19	24
Workshop IV			
(-)	0	1	1
(+)	0	18	18
Total	0	19	19

Workshop I: X2, p = 0.0000, Kappa statistic = 1.000; Workshop II: X2, p =0.029, Kappa statistic = 1.000; Workshop III: X2, p = 0.0000, Kappa statistic = 1.000; Workshop IV: X2, p = (-), Kappa statistic = 1.000

Table 4
Assessing the ear examination: responses to the question “Did you see anything abnormal in the ear, outside or inside?”.

Nurse	Examiner		Total
	(-)	(+)	
Workshop I			
(-)	21	0	21
(+)	0	3	3
Total	21	3	24
Workshop II			
(-)	21	3	24
(+)	0	2	2
Total	21	5	26
Workshop III			
(-)	22	0	22
(+)	0	1	1
Total	22	1	23
Workshop IV			
(-)	18	0	18
(+)	0	0	0
Total	18	0	18

Workshop I: X2, p = 0.000, Kappa statistic = 0.9584; Workshop II: X2, p = 0.0003, Kappa statistic = 0.9698; Workshop III: X2, p = 0.0000, Kappa statistic = 1.000; Workshop IV: X2, p = (-), Kappa statistic = (-)

Table 5
Statistical agreement between trainer and trainees regarding content of the ear canal and tympnic membrane characteristics.

Ear finding	Kappa value				p-value			
	I	II	III	IV	I	II	III	IV
Ear wax	0.9992	0.9928	0.9357	0.9772	<0.003	<0.012	<0.143	<0.067
Ear discharge	CNT	CNT	CNT	CNT	1.000	CNT	CNT	CNT
Tympanic membrane	1.000	0.9999	0.9998	0.9999	CNT	<0.118	<0.133	CNT

agreement between the responses for each workshop and each question. The questions were: Did you see anything inside the ear? Did you see the eardrum or the tympanic membrane? Did you see anything abnormal in the ear, outside or inside?

For those who responded positively to observing content in the ear canal and visualizing the tympanic membrane, statistical agreement between the trainer’s and the trainees’ observations were computed (Table 5).

Two questions addressed the perceptions

Table 6
Frequency distribution of the trainees' response to the question: "Is the ear examination easy or difficult to perform?".

Findings	Workshop I		Workshop II		Workshop III		Workshop IV	
	Freq	%	Freq	%	Freq	%	Freq	%
Easy	26/26	100	25/26	96	24/25	96	20/20	100
Difficult	-	-	0/26	0	1/25	4	-	-
Total	26	100	25/26	96	25	100	20	100

Table 7
Frequency distribution of trainees' response to the question: Are you capable of performing the ear examination on children?

Findings	Workshop I		Workshop II		Workshop III		Workshop IV	
	Freq	%	Freq	%	Freq	%	Freq	%
Yes	26/26	100	25/26	96	24/24	100	20/20	100
No	-	-	0/26	0	-	-	-	-
Not sure	-	-	0/26	0	-	-	-	-
Total	26	100	-	-	24	100	20	100

Table 8
Mean SPL produced by the nurses after training with the 512 tuning fork and standard deviations per workshop.

Mean	Workshop I		Workshop II		Workshop III		Workshop IV	
SPL (dB)	Mean SPL	SD	Mean SPL	SD	Mean SPL	SD	Mean SPL	SD
	44.6	11.27	48.68	4.92	60.974	4.765	71.01	2.23

Table 9
Overall mean SPL produced by nurses after training with the 512 tuning fork and standard deviations for all workshops combined.

Overall mean SPL (dB)	Standard deviation			
	Workshop I	Workshop II	Workshop III	Workshop IV
56.316	11.716	7.636	4.658	14.694

of the school nurses in regard to the task of performing ear examinations on children as instructed. Tables 6 and 7 show the responses, frequencies and percentages.

For Tuning Fork Testing, the mean SPL produced by the nurses after training are presented in Table 8. The mean SPL per workshop and combined are presented in Table 9.

DISCUSSION

The research aspect of the program aimed to assess the success of the training of the school nurses by the otorhinolaryngologist with regards to ear examination using a penlight in detecting signs of common ear conditions that account for hearing loss in schoolchildren and to determine the SPL produced by the nurses as a standard parameter for hearing screening using a 512 tuning fork.

The questions in the survey that aimed at assessing success of transfer of ear examination skills are found in Tables 2, 3 and 4.

The question "Did you see anything inside the ear canal?" aimed to assess the school nurse's capacity to visualize the ear canal and realize if there were any contents. The significance of this question lies in the fact that most ear conditions that require attention in the Philippines are infectious or due to cerumen. Thus, it is very helpful if the school nurse can screen for discharge, wax, foreign matter, fungus clumps and other external auditory canal contents that may warrant referral to a physician.

The question "Did you see the eardrum/ tympanic membrane?" aimed to assess the school nurse's ability to visualize the tympanic membrane. For those who were able to see it, there were further qualifying questions assessing their skill in identifying normal and abnormal findings in regard to the eardrum. The main point was to assess their ability to visualize it using a penlight instead of an otoscope.

The question "Is there anything unusual in the ear, outside or inside the canal?" aimed to assess the school nurses' ability to differentiate normal from abnormal findings of the pinna and peri-auricular area and the external ear canal up to the tympanic membrane. This was used to evaluate whether the nurse could identify a condition that warranted referral to a physician, such as infection or impacted wax. Thus, the school nurse must be adept at noticing findings that would signal a possible ear problem, such as redness, swelling, discharge, wax, foul smell and post-auricular abscess /wounds.

The data were analyzed for inter-observer agreement and the Kappa statistic results showed excellent agreement between the trainer's and the trainees' observations on ear examination.

To assess the possible success of hearing screening by the school nurse using the tuning fork, the study's initial aim was to determine the mean sound pressure level that can be produced by the school nurses when they perform the technique as taught to them. This is important to minimize the variability in testing so that it will be standardized and thus more accurate. The results showed an overall mean of 56.316 dB. The standard deviation ranged from 4.658-14.694. Given that hearing loss may be classified as moderate for 40-60 dB and severe for 60-80 dB hearing thresholds, then the tuning fork test as taught to Filipino school nurses may be useful in detecting moderate to severe hearing loss in schoolchildren which warrant referral to a physician.

All the nurses surveyed responded positively in terms of the ease with which they found the procedures and their confidence in performing them on children in their schools.

One of the limitations of the study was the variability encountered which is inherent in the methodology of conducting separate workshops. Statistical analysis treated the groups separately to minimize variability. Another limitation was the performance of the ear examinations was done on adults instead of the pediatric population and so the performance and results may vary significantly when done on children. Furthermore, the data was obtained with the trainee examining only one adult, albeit repeatedly, before recording the

results. Also, most of the subjects had normal ear findings so that the trainees had limited actual exposure to abnormal conditions.

In conclusion, school nurses may be effectively trained in ear examination using a penlight. With this method, they can detect ear wax and discharge; 2 signs of the most important ear conditions in Filipino schoolchildren: impacted cerumen and otitis media. They were also able to produce significant sound pressure levels with the use of a 512 tuning fork. This ability may be used to conduct hearing tests in the school setting. Mean sound pressure levels produced indicate possible standardization of the technique. However, there is much to be done. It is proposed that the following be conducted as part of the continuing development of the research and hearing screening program.

Under the supervision of the PNEI, school nurses should conduct ear examination and hearing screening in actual patients. Their findings should be checked by trainers. Then, the children should undergo screening audiometry and tympanometry as a means of validating the results of hearing screening. If it is concluded the transfer of skills has been successful, then this particular program formulated by the PNEI may be proposed for national mass hearing screening for schoolchildren in the school setting.

REFERENCES

Northern JL, Downs MP. Hearing and hearing loss in children. In: Butler JP, ed. Hearing in children. 4th ed. Philadelphia, PN: Lippincott Williams and Wilkins, 1991: 1-31.

Penaflor NA, Hilario O, Abes GT. Accuracy of 512 hertz air conduction test for hearing screening. *Phil J Oto Head Neck Surg* 2001; 16: 25-33.

Perez AB. Incidence of hearing loss among students. *Phil J Oto Head Neck Surg* 1987a: 578-9.

Perez AB. Causes of deafness in children. *Phil J O Head Neck Surg* 1987b: 603-6.

Philippine Department of Education. Handbook on Training of school nurses. Manila: Department of Education, 2005.