ประสิทธิผลของโปรแกรมการสอนผ่านอุปกรณ์มือถือแบบพกพา ต่อความรู้และการปฏิบัติของพยาบาล ในการดูดเสมหะทางท่อช่วยหายใจ โรงพยาบาลศูนย์เว้ ประเทศเวียดนาม: การศึกษานำร่อง*

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บทคัดย่อ

การทดลองแบบสุ่มและมีกลุ่มควบคุมนี้มีวัตถุประสงค์เพื่อประเมินประสิทธิผลของโปรแกรมการเรียนรู้ผ่านอุปกรณ์มือถือแบบพกพาต่อความรู้และการปฏิบัติของพยาบาลในการดูดเสมหะทางท่อช่วยหายใจ โดยสุ่มกลุ่มตัวอย่างที่เป็นพยาบาลปฏิบัติงานอยู่ในหออภิบาล 3 แห่ง ในโรงพยาบาลศูนย์เว้ ประเทศเวียดนาม จำนวน 30 คน และสุ่มแบ่งกลุ่มตัวอย่างออกเป็นกลุ่มทดลองและกลุ่มควบคุม โดยกลุ่มทดลองได้รับการสอนผ่านโปรแกรมที่ผู้วิจัยสร้างขึ้นตามแนวปฏิบัติการดูดเสมหะของโรงพยาบาลศูนย์เว้ นำเสนอเนื้อหาผ่านตัวอักษร ภาพ และวิดีโออุปกรณ์มือถือแบบพกพา ใช้เวลาประมาณ 30 นาที ส่วนกลุ่มควบคุมได้รับการสอนตามปกติของโรงพยาบาล ใช้เวลาในการทดลอง 1 เดือน และวัดผลก่อน-หลังการทดลอง เครื่องมือที่ใช้เก็บข้อมูล ได้แก่ แบบประเมินความรู้ในการดูดเสหะจำนวน 15 ข้อ และแบบตรวจสอบการปฏิบัติการดูดเสมหะจำนวน 16 หัวข้อ (21 ขั้นตอน) วิเคราะห์ข้อมูลด้วยสถิติเชิงบรรยาย ได้แก่ ความถี่ ร้อยละ ค่าเฉลี่ย ส่วนเบี่ยงเบนมาตรฐาน chi-square test, fisher's exact test และ independent t-test ผลการวิจัยพบว่า หลังการทดลองกลุ่มทดลองมีค่าเฉลี่ยคะแนนความรู้และปฏิบัติสูงกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ ($p<0.001$) และกลุ่มทดลองมีค่าคะแนนเฉลี่ยความรู้ และปฏิบัติหลังการทดลองสูงกว่าก่อนทดลองอย่างมีนัยสำคัญทางสถิติที่ ($p<0.001$) ซึ่งแสดงให้เห็นว่าโปรแกรมการเรียนรู้ผ่านอุปกรณ์มือถือแบบพกพานี้สามารถช่วยพัฒนาความรู้และการปฏิบัติการดูดเสมหะทางท่อช่วยหายใจของพยาบาลได้ และเห็นควรที่จะนำโปรแกรมนี้ไปใช้จริงในหออภิบาลเพื่อเพิ่มประสิทธิภาพในการดูแลผู้ป่วยที่ใส่ท่อช่วยหายใจให้ดียิ่งขึ้น

คำสำคัญ: การเรียนรู้ผ่านอุปกรณ์มือถือแบบพกพา ความรู้ การปฏิบัติ การดูดเสมหะทางท่อช่วยหายใจ

วันที่รับบทความ 16 มิถุนายน 2563 วันที่แก้ไขบทความเสร็จ 16 กุมภาพันธ์ 2564 วันที่ตอบรับบทความ 22 กุมภาพันธ์ 2564

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Effectiveness of a mobile-device-based teaching program on knowledge and practice of endotracheal suctioning among nurses in Hue Central Hospital, Viet Nam: A pilot study*

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Abstract

This randomized controlled trail (RCT) study aimed to evaluate the effectiveness of a mobile-device-based teaching program on knowledge and practice of endotracheal suctioning (ETS) among nurses. The researcher randomly selected 30 nurses working in three intensive care units (ICUs) of Hue Central Hospital, Viet Nam. The participants were randomly divided into experimental group or control group. The experimental group received a 30-minute teaching program via a smartphone, which was developed by the researcher following the hospital protocol. It was presented in terms of words, pictures, and video. The control group received the common teaching provided by the hospital. The outcome variables were evaluated on the posttest, comparing with the pretest as a baseline. The study instruments for evaluation consisted of a knowledge questionnaire (15 items) and an observation checklist for practice (16 items/21 steps). Data were collected within one month and analyzed through descriptive statistics (frequency, percentage, mean, and standard deviation); Chi-square test; Fisher's exact test; and independent t-test. The results showed that after the intervention, the experimental group had the mean scores of knowledge and practice higher than those in the control group, with a significant level ($p<0.001$). Also, the experimental group had the mean scores of knowledge and practice after the intervention higher than those before the intervention, with a significant level ($p<0.001$). The results of this study indicate that the program can improve nurses' knowledge and practice regarding ETS. Therefore, it should be used in ICUs to improve the quality of care in intubated patients.

keywords: mobile-device teaching; knowledge; practice; endotracheal suctioning

Received 16 June 2020 Revised 16 February 2021 Accepted 22 February 2021

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Introduction

Endotracheal suctioning (ETS) is a common procedure performed by nurses in intensive care units (ICUs) to remove accumulated secretion from the endotracheal tube, upper and lower airways, of mechanically ventilated patients. The purpose of ETS is to establish and maintain gas exchange, adequate oxygenation, and alveolar ventilation.[1] ETS consists of two methods, including opened suctioning and closed suctioning.[2] No matter what type of ETS is used, it is potentially harmful procedure, especially when performed inappropriately or incorrectly.[3] Therefore, it is important that those carrying out such a procedure are aware of the potential risks and practice in a manner that ensures effectiveness and patient safety.

Previous studies indicated that nurses may not have adequate knowledge and proper practice of ETS.[4] Lack of knowledge regarding complications and side effects of ETS can lead to the decrease in dynamic lung compliance and functional residual capacity, atelectasis, hypoxia/hypoxaemia, tissue trauma to the tracheal, bronchoconstriction, increased ventilator-associated pneumonia, hypertension, hypotension, cardiac dysrhythmias, changes in cerebral blood flow and increased intracranial pressure, and increased microbial colonization of lower airway in endotracheal patients.[1]

Hue Central Hospital, one of the national general hospitals, is located in the Center of Vietnam. It has provided care to intubated patients by following the hospital protocol[5] which is approved by the Vietnamese Ministry of Health. However, when practicing, some nurses didn't follow the protocol. Based on my preliminary study with ten nurses working in ICUs of this hospital, the results showed that some of them had inadequate knowledge and practice skills regarding ETS. This could cause the patients to develop complications and to spend more time in the hospital.

From the literature review, practice-based education program can improve knowledge and skills in EST among ICU nurses.[4,6] Moreover, such a teaching and learning activity using computers, mobiles, and other technology devices has become an inevitable part of the 21st century. Mobile-learning content that can be viewed anytime and anywhere enables interactive learning and promotes achievement and satisfaction in clinical education, clinical practice, and patient safety.[7] Based on the above information, we developed a mobile-device-based teaching program to improve knowledge and practice regarding ETS among ICU nurses working at Hue Central Hospital.

Purpose of the study

To evaluate the effectiveness of a mobile-device-based teaching program on knowledge and practice regarding ETS among ICU nurses working at Hue Central Hospital, Viet Nam.

Research hypothesis

1. In the experimental group, the mean score of knowledge in the posttest will be higher than that in the pretest.

2. The mean posttest score of knowledge in the experimental group will be higher than that in the control group.

3. In the experimental group, the mean score of practice in the posttest will be higher than that in the pretest.

4. The mean posttest score of practice in the experimental group will be higher than that in the control group.

Material and methods

A randomized control trial was a design used in this study. The experimental group received a mobile-device-based teaching program while the control group received common knowledge provided by the hospital. The outcome variables consisting of knowledge and practice were evaluated before and after the experiment and compared between control and experimental groups.

The study population was nurses working in ICUs and providing direct care to the patients with the endotracheal tube in Hue Center Hospital, Viet Nam. The researcher used a random sampling method to select 30 participants from three ICUs. The inclusion criteria consisted of 1) possessing a smartphone, 2) being able to access the internet, 3) being able to read and write in the Vietnamese language, and 4) being willing to participate in this study. Nurses recently appointing in ICU (within 24-48 hours) and on vacation or absent from work were excluded. A pair matching method was used to control the confounding factors among the participants in the control and experimental groups, including educational level and duration of work experiences in ICU. Finally, the paired participants were randomly assigned to the control and experiment groups.

The research instruments consisted of: 1) an education program called a mobile-device-based teaching program, 2) questionnaires including a demographic data form and a knowledge questionnaire, and 3) an observation checklist.

A mobile-device-based teaching program was developed by the researcher to provide knowledge to the experimental group via a smartphone. The program was designed to cover both knowledge and practical aspects in ETS. The content presented in terms of words, pictures, and videos was based on the hospital protocol5 which covered five parts, including equipment preparation, nurse preparation, patient preparation, ETS, and medical records. The duration of the program was about 30 minutes.

A demographic data form consisted of age, gender, education level, and duration of work experiences in ICU.

A knowledge questionnaire regarding ETS was original in English version.6 After getting permission from the author, the researcher adjusted some items to the update standard guideline.[8] The questionnaire consisted of 15 items, and each item had four multiple choices. The correct response to each item was rated one score; on the other, the wrong response was rated no score. Therefore, the total score of this questionnaire was 15.

An observation checklist for practice was developed by the researcher and two master's degree nurses following the hospital protocol.5 It consisted of two parts (closed suction system and open suction system), and each part had 16 items (21 steps). The correct practice on each step was rated one score whereas the wrong practice was rated no score. The total score of this checklist was 21.

All instruments had both English and Vietnamese versions. The researcher used a forward and backward translation method,[9] which required two translators who were influent in both languages. The education program was evaluated by five

experts for its content validity, and the item objective congruence index (IOC) was 0.85. The knowledge questionnaire and the observation checklist for practice were determined by three experts, and the content validity was 1.00 for each of them. To obtain the reliabilities of the two latter instruments, the researcher tested them with 30 nurses who had the same characteristics as the study subjects. The reliabilities of the knowledge questionnaire and the observation checklist evaluated by the Kuder-Richardson Formula 20 (KR-20 were 0.89 and 0.79, respectively.

Procedure:

After receiving approval from the Khon Kaen University Ethics Committee for Human Research (IRB00008614), the researcher met the hospital director and the head nurse of each unit to explain the study and ask for permission to collect the data. The head nurses provided the researcher a list of nurses who met the study inclusion criteria by code numbers. The researcher selected nurses through a random sampling method and used pair matching and random sampling methods to divide them into control and experimental groups. The selected nurses were asked by the head nurses to permit the researcher to contact them. After they accepted, the researcher called them up and made an appointment to meet with them. They were free to choose the date, time, and place that provided them convenience and confidentiality.

On the date of appointment, the researcher explained the study purpose, study procedure, human protection, and subject right to them. After they decided to participate in the study, the researcher asked them to sign a consent form. The participants in the control and experimental groups were approached by the research assistants to collect the data through the demographic data form, the knowledge questionnaire, and the observation checklist for practice. There were two research assistants in this study and they were trained by the researcher on how to use the knowledge questionnaire and the observation checklist before performing data collection. Also, to prevent bias and to have high reliability on observations, they were blinded to the participants' groups and were asked to have an observation from the same participant at the same time by using the same tool (the observation checklist for practice). Then, the researcher determined the inter-rater-reliability (IRR). If the level of agreement is between 0.8-1.0, it means that two research assistants have high reliability on their observations.

For data collection, each participant in both groups took 3-5 minutes to fill up the demographic data form, 15 minutes to answer the knowledge questionnaire, and research assistants took 15 minutes each time to observe the participant's practice through the checklist. The participants were observed on their practice at least one time for pretest and posttest. The control group completed the pretest in the first week, and the posttest in the second week while the experimental group completed the pretest in the first week, received the education program in the third week, and completed the posttest in the fourth week. Therefore, the data of posttest were obtained from the control group before the researcher started the intervention in the experimental group to prevent the contamination of information between two groups. Moreover, after receiving knowledge of ETS, the participants in

the experimental group were asked to perform their practice with the real patients following the instruction in the mobile device. During that time, the researcher used the observation checklist to determine their practice until they could perform it correctly.

Data analysis

Data were analyzed with the Statistical Package for Social Science (SPSS version 20).

As this pilot study had a small sample size (n=30), the researcher used the Shapiro Wilk to test a normal distribution. The data showed a significant level of $p>0.05$; therefore, the normal distribution was presented. The descriptive statistics, including frequency, percentage, mean, and standard deviation were used to analyze the demographic data. The independent t-test and Chi-square test were used to compare the demographic variables between the control and experimental groups. Paired t-test was applied to determine the mean differences within group before and after the intervention while the independent t-test was used to analyze the mean differences between groups before and after the intervention. A p value of <0.05 was considered for the statistics significance in all analyses.

Results

The response rate was 100%. In the control group, the mean age of the participants was 34.33 years (±5.64). Most of them were female (86.7%), had a bachelor's degree or were in a 4-year program (53.3%), and had an average of 10.27 years (±5.65) of work experiences in ICU. In the experimental group, the mean age of the participants was 36.60 years (±7.75). Most of them were female (73.3%), had a bachelor's degree or were in a 4-year program (53.3%), and had an average of 10.80 years (±6.41) of work experiences in ICU. There were no statically significant differences in demographic variables between the control and experimental groups (See table 1)

Table 1 Frequency, percentage, mean, and standard deviation of demographic characteristics of the participants in control and experimental groups (n=30)

Variables	Control group (n=15)		Experimental group (n=15)		P value*
	n	%	n	%	
Age (mean ± SD)	34.33 ± 5.64	36.60 ± 7.75	0.368 [a]		
Gender					
- Male	2	13.3	4	26.7	0.651[b]
- Female	13	86.7	11	73.3	
Education level					1.000[b]
- 2-year program	4	26.7	5	33.4	
- 3-year program	3	20.0	2	13.3	
- 4-year program	8	53.3	8	53.3	
Duration of work experiences in ICU (mean ± SD)	10.27 ± 5.65		10.80 ± 6.41		0.811[a]

a: Independent t-test, b: Chi-square test

*p<0.05

At baseline, there was no statistically significant difference in overall knowledge regarding ETS between the control and experimental groups (p=0.822), comparing the mean scores of 6.46±2.80 and 6.27±1.95, respectively. After the intervention, the knowledge of each item and overall in the experimental group increased. Moreover, the experimental group had overall knowledge higher than the control group, comparing the mean scores of 13.20±1.37 and 6.73±2.28, respectively (p<0.001). The experimental group also had overall knowledge after the intervention higher than those before the intervention, comparing the mean scores of 13.20±1.37 and 6.27±1.95, respectively (p<0.001) (See table 2)

Table 2 Knowledge scores regarding ETS in the control and experiment groups (n=30)

Items	Before intervention		P value	After intervention		P value*	P value**
	Control group (n=15)	Experiment group (n=15)		Control group (n=15)	Experiment group (n=15)		
1. How often does a nurse do ETS?	10 (66.7)	12 (80.0)	0.682[b]	11 (73.3)	15 (100.0)	0.100[b]	0.250[a]
2. Which is the best method of ETS?	8 (53.3)	7 (46.7)	0.715[a]	9 (60.0)	15 (100.0)	0.017[b***]	0.008[a***]
3. What is the length of the catheter that should be inserted?	4 (26.7)	3 (20.0)	1.000[b]	4 (26.7)	13 (86.7)	0.001[a***]	0.006[a***]
4. What is true about ETS?	7 (46.7)	10 (66.7)	0.269[a]	8 (53.3)	15 (100.0)	0.006[b***]	0.063[a]
5. What is the time limitation of ETS?	14 (93.3)	11 (73.3)	0.330[b]	14 (93.3)	15 (100.0)	1.000[b]	0.125[a]
6. What is an appropriate patient's position for ETS?	5 (33.3)	5 (33.3)	1.000[a]	4 (26.7)	13 (86.7)	0.001[a***]	0.008[a***]
7. During ETS, how many degrees should the catheter be rotated?	8 (53.3)	5 (33.3)	0.269[a]	8 (53.3)	14 (93.3)	0.035[a***]	0.004[a**]
8. Which method is used to determine successful ETS?	2 (13.3)	0 (0.0)	0.483[b]	3 (20.0)	13 (86.7)	<0.001[a***]	<0.001[a***]
9. Which nerve can be stimulated during ETS?	6 (40.0)	5 (33.3)	0.705[a]	2 (13.3)	11 (73.3)	0.001[a***]	0.070[a]
10. What is a complication due to carina irritation?	2 (13.3)	3 (20.0)	1.000[b]	3 (20.0)	11 (73.3)	0.003[a***]	0.021[a***]
11. What is the recommended suction pressure in adult patients?	11 (73.3)	9 (60.0)	0.439[a]	11 (73.3)	14 (93.3)	0.330[b]	0.063[a]

Table 2 Knowledge scores regarding ETS in the control and experiment groups (n=30) (Cont.)

Items	Before intervention		P value	After intervention		P value*	P value**
	Control group (n=15)	Experiment group (n=15)		Control group (n=15)	Experiment group (n=15)		
12. What is an appropriate size of the catheter when doing ETS to a patient with 8mm ET tube?	2 (13.3)	2 (13.3)	1.000[b]	6 (40.0)	10 (66.7)	0.143[a]	0.008[a***]
13. How often should the catheter be changed?	3 (20.0)	6 (40.0)	0.427[a]	2 (13.3)	11 (73.3)	0.001[a***]	0.125[a]
14. What is a complication due to the absence of hyperventilation prior to ETS?	12 (80.0)	11 (73.3)	1.000[b]	11 (73.3)	15 (100.0)	0.100[b]	0.125[a]
15. Why shouldn't normal saline be instilled in the endotracheal tube?	3 (20.0)	5 (33.3)	0.682[b]	5 (33.3)	13 (86.7)	0.003[a***]	0.008[a***]
Overall knowledge score	6.46 ± 2.80	6.27 ± 1.95	0.822[c]	6.73 ± 2.28	13.20 ± 1.37	<0.001[c***]	<0.001[c***]

a: Chi-square test, b: Fisher's exact test, c: independent t-test

* Comparison of after-intervention scores between the control and experiment groups

**Comparison between pre- and post-intervention scores in the experiment group

***p<0.05

Before the intervention, there was no statistically significant difference in overall practice regarding ETS between the control and experimental groups (p=0.077), comparing the mean scores of 11.73±1.30 and 10.93±0.96, respectively. After the intervention, the experimental group had overall practice higher than the control group, comparing the mean scores of 11.93±1.22 and 19.00±1.07, respectively (p<0.001). The experimental group also had overall practice after the intervention higher than those before the intervention, comparing the mean scores of 19.00±1.07 and 10.93±0.96, respectively (p<0.001) (See table 3)

Table 3 Practice scores regarding EST in the control and experiment groups (n=30)

Steps	Before intervention		P value	After intervention		P value*	P value**
	Control group (n=15)	Experiment group (n=15)		Control group (n=15)	Experiment group (n=15)		
1. Perform hand hygiene	12 (80.0)	11 (73.3)	1.000[b]	11 (73.3)	15 (100.0)	0.100[b]	0.125[a]
2. Assess the patient's condition	12 (80.0)	11 (73.3)	1.000[b]	11 (73.3)	15 (100.0)	0.100[b]	0.125[a]
3. Assess the need for suctioning	2 (13.3)	1 (6.7)	1.000[b]	5 (33.3)	13 (86.7)	0.003[a***]	<0.001[a***]
4. Explain the procedure to the patient	3 (20.0)	4 (26.7)	1.000[b]	5 (33.3)	11 (73.3)	0.028[a***]	0.016[a***]
5. Assemble and check the equipment	14 (93.3)	13 (86.7)	1.000[b]	14 (93.3)	15 (100.0)	1.000[b]	0.500[a]
6. Adjust the patient's position	8 (53.3)	7 (46.7)	0.715[a]	7 (46.7)	14 (93.3)	0.014[b***]	0.016[a***]
7. Wear a mask and wash hands	14 (93.3)	15 (100.0)	1.000[b]	13 (86.7)	15 (100.0)	0.483b	-
8. Hyper-oxygenate with 100% oxygen for 30-60 seconds prior to suctioning	4 (26.7)	2 (13.3)	0.651[b]	5 (33.3)	15 (100.0)	<0.001[a***]	<0.001[a***]
9. Turn on the vacuum regulator and adjust the pressure to the desired level (80-120 mmHg)	15 (100.0)	15 (100.0)	-	13 (86.7)	15 (100.0)	0.483[b]	-
10. Attach the catheter to the suction unit	15(100.0)	15 (100.0)	-	14 (93.3)	15 (100.0)	1.000[b]	-
11. Clean the patient's mouth and nose	6 (40.0)	4 (26.7)	0.439[a]	6 (40.0)	11 (73.3)	0.065[a]	0.016[a***]
Perform suctioning	2.07±0.46	2.00±0.38	0.667[c]	2.07 ± 0.59	5.00 ± 1.00	<0.001[c***]	<0.001[c***]
12. Reassess through chest auscultation	1 (6.7)	1 (6.7)	1.000[b]	2 (13.3)	12 (80.0)	<0.001[a***]	0.001[a***]
13. Turn off the vacuum regulator	15 (100.0)	13 (86.7)	0.483[b]	15 (100.0)	15 (100.0)	-	0.500[a]
14. After suctioning, discard the equipment according to the instruction and wash hands	14 (93.3)	9 (60.0)	0.080[b]	14 (93.3)	15 (100.0)	1.000[b]	0.031[a***]
15. Document the suction procedure	10 (66.7)	13 (86.7)	0.390[b]	13 (86.7)	14 (93.3)	1.000[b]	1.000[a]
Overall practice score	11.73±1.39	10.93±0.96	0.077[c]	11.93±1.22	19.00±1.07	<0.001[c***]	<0.001[c***]

a: Chi-square test, b: Fisher's exact test, c: independent t-test

* Comparison of after-intervention scores between the control and experiment groups

**Comparison between pre- and post-intervention scores in the experiment group

***p<0.05

Discussion

New tools and approaches are vital for the improvement of nurse knowledge and practice. One area of nursing practice that is of concern is the ETS for intubated patients.[10] Also, it demonstrated that mobile-based-learning methods could enhance the knowledge and skills of nursing students.[11] As we used a mobile-device-based learning intervention for ETS among ICU nurses working in Hue Central Hospital, Viet Nam, our findings indicated that it could improve nurse knowledge and practice effectively.

In this study, the results showed that the demographic variables, such as age, gender, duration of working experiences in ICU, and education level were not significantly different between the control and experimental groups. It means that participants in both groups were matched and had homogeneity. As demonstrated in Table 2, overall knowledge scores before and after the intervention in the experimental group showed a statistically significant difference ($p < 0.001$), with the pretest score of 6.27 ± 1.94 and the posttest score of 13.20 ± 1.37. Moreover, after the intervention, the experimental group had an overall knowledge score higher than the control group, comparing the mean scores of 13.20 ± 1.37 and 6.73 ± 2.28, respectively ($p<0.001$).

It revealed that most nurses acknowledged some items of knowledge regarding ETS before receiving the intervention, including frequency of performing ETS, time limitation of ETS, and importance of hyper-oxygenation before ETS. However, after the intervention, the knowledge score significantly increased in many items, including the best method of ETS ($p=0.008$), the length of catheter insertion ($p=0.006$), an appropriate patient's position for ETS ($p=0.008$), the rotation of the catheter ($p=0.004$), the determination of successful suctioning method ($p<0.001$), the complication due to carina irritation ($p=0.021$), an appropriate size of the catheter ($p=0.008$), and no instillation of normal saline in the endotracheal tube ($p=0.008$).

The improvement of knowledge in the experimental group may be derived from the content regarding ETS, the methods used to present the content (words, pictures, and video), and the training of how to use the protocol based on the teaching program. Also, the participants can view the content on the mobile phone as much as they want. Since they always carry the phone, it allows them to learn at any place and at any time. The results of this study are corresponding with previous studies,[12,13,14,15] and support hypotheses 1 and 2.

Similarly, overall practice scores before and after the intervention in the experimental group were significantly different ($p<0.001$), with the pre-test score of 10.93 ± 0.96 and the post-test score of 19.00 ± 1.07. Moreover, after the intervention, the experimental group had an overall practice score higher than the control group, comparing the mean scores of 19.00 ± 1.07 and 11.93 ± 1.22, respectively ($p<0.001$). Also, there were improvements in many steps of ETS performance of the experimental group, such as assessing the need for suctioning ($p<0.001$), explaining the procedure to the patient ($p=0.016$), adjusting the patient's position ($p=0.016$), hyper-oxygenating with 100% oxygen for 30-60 seconds prior to suction ($p<0.001$), cleaning the patient's mouth and nose ($p=0.061$), performing suctioning ($p<0.001$), reassessing through chest auscultation ($p=0.001$), and discarding equipment according to the instruction and washing hands ($p=0.031$).

As the participants in the experimental group received knowledge regarding ETS prior to their practice, they may have better understanding about the procedure. Moreover, the demonstration of ETS step by step following the mobile-device teaching program could help them improve their practice. There is an association between nurses' practice and training course.6 The results of this study were in the line with previous studies[12,13,14,15,] and hypotheses 3 and 4 were accepted.

Conclusion

This study identified that nurses working in ICUs of Hue Central Hospital had a lack of knowledge and practice regarding ETS, and didn't follow the hospital protocol. These may jeopardize patient safety and the quality of nursing care. As the mobile-device-based teaching program has positive influences to improve nurses' knowledge and skills, we recommend using it in ICUs, cooperating with training. However, the content should always be updated to new knowledge of EST. Nurses' knowledge and practice should be periodically evaluated to maintain the quality of care. Further studies should consider for more subjects as it can be a limitation of this study.

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