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Combining video-assisted teaching with patient simulation improves nursing students' knowledge and performance of aseptic endotracheal suctioning

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Ο συνδυασμός της εκπαίδευσης στην προσομοίωση ασθενών με τη βοήθεια βίντεο βελτιώνει τις γνώσεις και την απόδοση των φοιτητών νοσηλευτικής στην άσηπτη ενδοτραχειακή αναρρόφηση

Abstract at the end of the article

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Introduction: Nurses should develop high competence in the aseptic endotracheal suctioning technique during university to reduce the associated complications of intubated patients. Video-assisted teaching and simulation training are two learning methods that significantly improve students' knowledge, skills, and competencies. However, there is limited empirical evidence on their combined effect when teaching the aseptic endotracheal suctioning technique.

Purpose: The study aims to evaluate the effect of video-assisted teaching accompanied by simulation training on nursing students.

Material and Method: This is a single-blind, randomized pilot trial with 87 undergraduate nursing students. The students were randomly divided into two groups: a control group, n1=41, and an intervention group, n2=46. Both groups participated in the videos-assisted lecture, but only the intervention group practiced the technique on the simulator. Subsequently, both groups were assessed based on their knowledge and competency of the technique.

Results: The intervention group showed significantly greater knowledge acquisition ($p<0.001$) regarding the technique. They also performed the technique considerably better than the students in the control group (80.9% versus 49.0%, confidence interval 95%). Furthermore, the intervention group had a higher level of satisfaction with the training method (rho=0.469, $p<0.001$).

Conclusion: Combining video-assisted teaching with simulation training seems to improve knowledge acquisition and competency of nursing students when teaching the aseptic endotracheal suctioning technique. Therefore, educators could combine these methods to teach the aforementioned technique more efficiently.

Key-words: *Simulation training, Nursing education, Knowledge, Satisfaction*

Introduction

Tracheostomy is a common procedure for patients receiving mechanical ventilation, and especially within ICU departments, about 10-15% of patients are intubated.[1] The purpose of intubation is to maintain airway patency; however, it causes secretions to accumulate in the airway because coughing is inhibited and mucociliary function is diminished.[2] Nurses are required to have high competence in endotracheal suctioning to manage intubated patients and reduce the associated complications (e.g., hypoxemia, cardiac arrest, death, etc.).[2] Consequently, nurses should receive adequate training in endotracheal suctioning as soon as possible, preferably during their undergraduate studies.

Traditionally, nursing students were taught the endotracheal suctioning technique by educators during clinical practice on actual patients. As a result, students had limited opportunities to gain sufficient clinical experience with patients, which inhibited their satisfaction and self-confidence.[3] However, healthcare education, with the help of technology, is constantly growing and improving the learning experiences of students. For example, video-assisted teaching, which has gained popularity during the COVID-19 pandemic, can help students better comprehend lessons / topics by allowing them to pause, replay, and adjust the playback speed as needed.[4,5] Furthermore, when video-assisted teaching is used to teach a nursing skill, it appears to be effective in improving knowledge acquisition and satisfaction.[6] Additionally, simulation training is another popular educational method for healthcare students because it allows them to practice skills in a safe, realistic, and controlled learning environment.[7] Furthermore, several studies suggest that simulation training improves knowledge acquisition, psychomotor skills, competencies, self-confidence, student satisfaction, and motivation to learn.[8,9] However, and despite the advantages of each method, there is limited empirical evidence on the effect of combining video-assisted teaching with simulation when teaching the aseptic endotracheal suctioning technique in nursing students.

Evidently, such a study would provide useful insights to better teach the aseptic endotracheal suctioning technique and, consequently, other techniques by combining the utility of video-assisted teaching with the safe and controlled learning environment of simulation. Therefore, the present study aimed to fill this knowledge gap by examining the effect of video-assisted teaching with simulation on nursing students' knowledge acquisition and performance when teaching the aseptic endotracheal suctioning technique.

Material and Method

Design of study and Local

This single-blind, randomized pilot trial was conducted from April to May 2019 in the Nursing Department of the Hellenic Mediterranean University.

Population and Selection Criteria

All 102 second-year nursing students were informed about the purpose of the study and subsequently invited to participate. Among them, 87 agreed to participate and signed an informed consent (87/102 = 85.3%). Afterwards, these students were randomly assigned to one of two groups: intervention (n1=46) or control (n2=41) group by drawing lots. To ensure that the randomization process was unbiased and balanced, an educator/researcher was present during the draw and a computer-generated randomization list was used to create the lots. The lots were prenumbered (with 1 indicating participation in the intervention group and 2 indicating participation in the control group) and sealed in envelopes to maintain confidentiality and prevent interference. It should be noted that the aseptic endotracheal suctioning technique is taught for the first time in the second year during the subject of surgical nursing, according to the department's curriculum. Therefore, students had no prior experience with the technique. However, all students had previously participated in the simulation room and learnt other basic nursing skills.

For the simulation, we used the MegaCode Kelly by Laerdal, which is an adult life-size, full-body, life-like manikin designed for the practice of advanced, difficult, and obstructed airway scenarios.[10] We used MegaCode Kelly with the SimPad system, which allowed the auscultation and recognition of breath and abdominal sounds. SimPad also supports pre-recorded vocal sounds and live voice via a wireless microphone, as well as logging (for debriefing) and scenario functions.[10]

Study protocol

Both groups were presented with a video-assisted lecture on how to perform the aseptic endotracheal suctioning for the clearance of secretions in patients with tracheostomy; the lecture was based on a relevant guideline published by Greece's health authorities.[11] The guideline divides the aseptic endotracheal suctioning

technique into 28 simple steps, which makes it great to use as the basis for teaching the technique.[11] To elaborate, the guideline explains in steps how to use a suctioning device with a nelaton catheter in a patient with tracheostomy to clear secretions. For example: 'How to open and adjust the sterilized nelaton catheter in the suction tube; Spraying the catheter with lidocaine nasal spray; Disconnecting the patient from the ventilator and how to insert the catheter gently until a cough is stimulated, or resistance is felt, without applying suction during catheter insertion' etc.

During the video-assisted lecture, the educator/researcher introduced the technique to the students by linking it to previous knowledge (anatomy of the trachea, patients with tracheostomy needs, etc.), explained it in steps (based on the guideline), and then played the video on a projector (with speakers). The authors created this 45-minutes video for this study. The video visualizes, explains, and rationalizes each step of the guideline on the simulator with audio cues. During the video, the educator/researcher was pausing and reversing (when needed) the video to give students the time to comprehend new knowledge and answer questions. After that, the educator/researcher demonstrated the technique on the MegaCode Kelly with the SimPad and a suctioning machine, in a fully equipped simulation learning room to both groups.

Subsequently, only the intervention group practiced the technique by using the simulator. To make the experience more realistic, we adapted a breathing circuit into the tracheostomy tube; monitored all vital signs of the manikin; and connected a plastic water tank to the trachea (to better mimic suction sounds). It should be noted that the manikin could communicate with the students via the SimPad. Finally, to measure the level of acquired competence, both groups were advised to carefully read the guideline and informed that a practical evaluation would take place in the simulation room the following day.

On the day of the evaluation, both groups were examined on the basis of their knowledge acquisition and technique competency. First, for knowledge acquisition, students completed a 4-item test created by the researchers for the purpose of this study. Each correct answer was worth one point (total maximum score = four points). Second, the students performed the technique in the simulation room. A dichotomous variable was used to define the competency of each step (by successful performance or not). The total score corresponded to a wide range scale of 0-100%, where a higher score meant a higher level of competence. It should be noted that the educators/researchers rated the students' competence without knowing which group they were assigned to. Furthermore, prior to evaluation, students were asked to report the following: time spent studying the technique (in minutes) and their confidence in the ability to successfully perform the technique (on a numerical scale of 0-100%). In addition, the students were asked: a) about their perceived satisfaction with the training method and b) if they felt stressed. Both questions were evaluated based on self-reported data using a Likert scale (1=not at all; 2=slightly; 3=moderate; 4= very; 5=extremely). After that, they had to enter the simulation room to be evaluated on the performance of the technique. It should be noted that the simulation room is separated by a one-way mirror glass from the instructor's room, thus helping students avoid stressful feelings from direct observation.

Data analysis

The frequency distributions of the basic descriptive characteristics of the 87 participants were calculated, in total, for each group. Control of differences in characteristics, levels of knowledge, and skills was compared using the x^2 test and the t test. Spearman's rank correlation coefficient was used to test the relationship between the characteristics, levels of knowledge, and the 28-steps of the guideline. For all analyses, $p<0.05$ was considered statistically significant. The internal consistency of the 28-item questionnaire was calculated as 0.741 using the Kuder-Richardson 20 test, since the measurements were dichotomous variables. Statistical analysis was performed using IBM SPSS 25.0 (IBM, Armonk, NY, USA).

Ethical aspects

Study approval was obtained (Ref. No. 2521/5-3-2019) by the relevant Ethics Committee of the Nursing Department of the Hellenic Mediterranean University. Additionally, all personal data of participants were managed anonymously and confidentially. Furthermore, informed consent was obtained from all students, and they were informed that they could withdraw at any time without any consequences (although no student chose to withdraw).

Results

Demographic data and knowledge acquisition

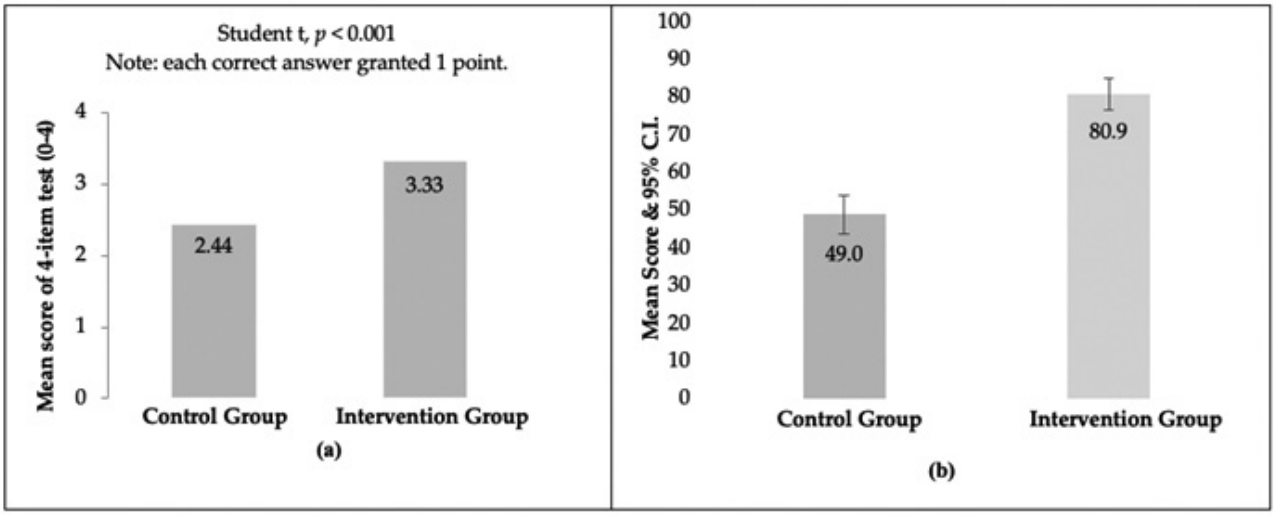

Figure 1. *Evaluation of knowledge acquisition regarding the guideline; (b) Summative assessment of competency in 28 items of the guideline.*

The mean age of the participants was 22.6 6.5 years and the majority of them (82.8%) were female. The level of theoretical knowledge of the guideline (measured with the 4-item test) was found to be significantly different between the two groups [2.4/4 vs 3.3/4 (Student t, $p < 0.001$)] [Figure 1(a)]. Students with an increased level of stress before performing the technique showed a significant decrease in knowledge acquisition (rho = 0.330, p = 0.002). Furthermore, students with an increased level of personal satisfaction with perceived training showed a significant increase in knowledge acquisition (rho = 0.396, p = 0.001) [Table 1].

The results in Table 2 describe the factors that can affect successful performance with respect to the competency gained during training. Specifically, a non-parametric control (Spearman's Rho testing), revealed that students who: a) felt more self-confident (rho=0.519, p<0.001), b) were more satisfied with the simulation-based method (rho=0.469, p<0.001), and c) had accumulated a higher knowledge acquisition (rho=0.578, p<0.001) showed a significantly higher competency in performing the technique [Table 2].

Competency

Figure 1(b) presents the summative assessment of the competency in all the 28 items of the guideline between the two groups. The intervention group had a significantly higher average competency score than the control group (49.0 versus 80.9 [*95% confidence interval*]). Additionally, the intervention group was associated with higher competency scores in 24 of the 28 items of the guideline. However, no significant differences were observed in four items. These four items were very common nursing skills, such as 'hand hygiene', 'wearing personal protective equipment - PPE' etc., that all students already knew very well how to perform [Table 2].

Discussion

The present study examined the effect of video-assisted teaching with simulation on nursing students' knowledge acquisition and performance when teaching the aseptic endotracheal suctioning technique. The main finding of the present study was that the combination of both teaching methods potentially improves knowledge acquisition and performance of the technique (increased competence) than using only video-assisted teaching. It should be emphasized that, to the best of our knowledge, this is the first study in Greece that combines these educational methods in an effort to improve the learning outcomes when teaching a new technique to nursing students.

An important finding of the present study was that simulation training, combined with video-assisted teaching, positively affects students' self-confidence and satisfaction, which also improves knowledge acquisition and competency. This is in line with the main finding of a qualitative study which found that students who gained confidence were led to improve their clinical skills after simulation training.[12] Additionally, our findings suggest

Table 1. Factors affecting knowledge acquisition and successful performance of the guideline with respect to competency

Factors	**Knowledge acquisition**	
	rho-Spearman	***p***
Stress level before performing the guideline[1]	-0.149	0.167
Personal satisfaction level from the perceived training [1]	0.330	0.002
Self-confidence in performing successfully the guideline (rate-response 0-100%)	0.396	<0.001
Factors	**Competency**	
	rho-Spearman	***p***
Self-confidence before executing the protocol (rate-response 0-100%)	0.519	<0.001
Knowledge acquisition (min =0, max=4)	0.578	<0.001
Stress levels before the evaluation [1]	-0.157	0.147
Satisfaction levels from the perceived training method[1]	0.469	<0.001
Study time (homework) before the protocol performance (min)	0.106	0.331

[1]1: not at all, 2: slightly, 3: moderate, 4: very, 5: extremely *Factors affecting the successful performance of the guideline with respect to competency*

that simulation training is an innovative and effective teaching strategy better suited to teach a practical skill in nursing students, which coincides with other studies.[13-20] Findings from a recent study show that the competency gained by students through simulation training was better than the competency gained through a case scenario that was frequently used by faculty members.[21] Furthermore, a quasi-experimental study with a pretest and post-test control group design reports that learning skills in the demonstration method were more than in the video-based method on obstetrical palpation.[22] Furthermore, the results of the present study are quite similar to those of a meta-analysis that suggests that simulation training was found to improve clinical nursing care skills and knowledge of nursing students more than other traditional teaching methods.[7] A possible explanation for these findings could be that simulation training provides students with the opportunity to practice and apply what they have learnt in a realistic and controlled environment.[15,20] This allows students to gain practical experience with new techniques, which can help reinforce their understanding and increase their confidence in their ability to perform them.[15,16] Accordingly, simulation training reduces stress levels and promotes the student's self-confidence, satisfaction, awareness, and other intellectual qualities such as critical thinking and emotional intelligence.[14,15,23-27] Moreover, simulation training can promote teamwork and satisfaction among students by making each lecture more engaging, unique, and therefore easier to remember.[15,22,28] However, and despite its advantages, simulation training has some prerequisites that make it difficult to use as a training method, such as expensive equipment, adequate technical knowledge, and structured debriefing.[29] Regarding video-assisted teaching, it is a well-known teaching method[30] that

Table 2. Competency in each of 28 items -skills of the guideline (Successful performance).

28 Items of the Guideline	**Control Group (n=41)**	**Intervention Group (n=46)**	***p***
	% Successful performance		
1. Hand hygiene	97.6	100.0	0.287
2. Preparation of materials depending on the patient	58.4	84.8	**0.006**
3. Identification of the patient	78.0	100.0	**0.001**
4. Explaining the procedure to the patient	53.7	87.0	**0.001**
5. Patient's clinical assessment	61.0	89.1	**0.002**
6. Measuring the Vital Signs before the procedure	34.1	78.3	**<0.001**
7. Placing the patient on Semi Fowler's position	29.3	93.5	**<0.001**
8. Wearing Personal Protective Equipment (PPE)	78.0	89.1	0.160
9. Pre-oxygenation (before suction) for 1-2 min	14.6	73.9	**<0.001**
10. Selecting an appropriate catheter size	65.9	97.8	**<0.001**
11. Functionality Test of wall or portable suction unit (-110 mmHg)	41.5	91.3	**<0.001**
12. Use of Sterile gloves	46.3	69.6	**0.028**
13. Aseptic technique with sterile gloves throughout the procedure	19.5	50.0	**0.003**
14.Open and adjusting of the Nelaton catheter in the suction tube	80.5	93.5	**0.069**
15.Spraying the suction catheter with Lidocaine nasal spray	29.3	80.4	**<0.001**
16. Liquidation of secretions with NaCl 0,9%	36.6	84.8	**<0.001**
17. Disconnect the patient from ventilator and advance catheter gently until a cough is stimulated or resistance is felt	24.4	60.9	**0.001**
18. Gradually removing the catheter with rotational movements	65.9	89.1	**0.009**
19. Duration of the procedure 10-15 seconds each time	48.8	93.5	**<0.001**
20. Evaluation of the clinical status during the procedure	26.8	43.5	0.106
21. Connect the patient to the ventilator and oxygenate for 1-5min	31.7	54.3	**0.034**

22. Rinse suction tubing with sterile water	22.0	73.9	**<0.001**
23. Clear patient's oral secretions if required	41.5	71.7	**0.004**
24. Wrapping the suction catheter around their hand in such a way that by removing the gloves, it is enclosed inside	73.2	97.8	**0.001**
25. Removal of personal protective equipment	70.7	89.1	**0.031**
26. Wash hands	48.8	60.9	0.258
27. Documentation of Vital Signs	48.8	94.8	**<0.001**
28. Updating and signing of the patient's record file	43.9	82.6	**<0.001**

x^2 test for each item separately

visualizes new concepts and procedures for students. This visualization helps students see and understand new concepts in a more concrete and tangible way than a picture or a presentation.[22] This can be particularly useful for complex procedures or concepts that may be difficult to understand through lecture-based teaching alone.[4,22] Consequently, by combining video-assisted teaching with simulation training, educators can create a more wholesome learning experience than solely using one method. This combination could allow students to gain a deeper understanding of concepts and procedures through visualization and then apply that knowledge by utilizing/practicing it in a simulated learning environment. Therefore, this combination of teaching methods, as indicated by our findings, may help to improve knowledge acquisition and performance of nursing students when learning the aseptic endotracheal suctioning technique and possibly other nursing techniques.

Limitations

Our study had a few limitations, first the relatively small sample size, and that it was conducted only with nursing students (mostly female) from a single university; thus, the results may not be generalizable to different populations. Second, the study evaluated the effect of the combination after only one use; longitudinal studies with multiple follow-ups are required to determine the long-term effects of the combination on the knowledge and performance of students. Finally, the use of a single video and simulator model (MegaCode Kelly) may limit the generalizability of the findings to other simulation technologies or teaching methods.

Conclusion

In conclusion, the findings of the present study suggest that by combining video-assisted teaching with simulation training, educators could improve the knowledge acquisition and competency of their students more than by using only video-assisted teaching when teaching the aseptic endotracheal suctioning technique. Therefore, nursing schools could include simulation training combined with video-assisted teaching in their curriculums and assist their faculty members in how to effectively use them. In doing so, educators should be able to teach the aseptic endotracheal suctioning technique (and possibly other nursing techniques) more efficiently by improving the knowledge acquisition and competency of their students. This improvement could help students become more competent health care professionals, who will provide better quality of care.

ΠΕΡΙΛΗΨΗ

Ο συνδυασμός της εκπαίδευσης στην προσομοίωση ασθενών με τη βοήθεια βίντεο βελτιώνει τις γνώσεις και την απόδοση των φοιτητών νοσηλευτικής στην άσηπτη ενδοτραχειακή αναρρόφηση

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Εισαγωγή: Οι νοσηλευτές θα πρέπει να αναπτύξουν υψηλή ικανότητα στην τεχνική άσηπτης ενδοτραχειακής αναρρόφησης κατά τη διάρκεια των σπουδών τους για να μειώσουν τις σχετικές επιπλοκές των διασωληνωμένων ασθενών. Η διδασκαλία με τη βοήθεια βίντεο και η εκπαίδευση με προσομοίωση είναι δύο μέθοδοι μάθησης που βελτιώνουν σημαντικά τις γνώσεις, τις δεξιότητες και τις ικανότητες των φοιτητών. Ωστόσο, υπάρχουν περιορισμένα εμπειρικά στοιχεία σχετικά με τη συνδυασμένη επίδρασή τους κατά τη διδασκαλία της τεχνικής άσηπτης ενδοτραχειακής αναρρόφησης.

Σκοπός: Η μελέτη στοχεύει στην αξιολόγηση της επίδρασης της μεθόδου διδασκαλίας με τη βοήθεια βίντεο που συνοδεύεται από εκπαίδευση προσομοίωσης σε φοιτητές νοσηλευτικής.

Υλικό και μέθοδος: Πρόκειται για μια τυφλή, τυχαιοποιημένη πιλοτική μελέτη με 87 προπτυχιακούς φοιτητές νοσηλευτικής. Οι φοιτητές χωρίστηκαν τυχαία σε δύο ομάδες: μια ομάδα ελέγχου, n1=41 και μια ομάδα παρέμβασης, n2=46. Οι δύο ομάδες συμμετείχαν στη διάλεξη με τη βοήθεια βίντεο, αλλά μόνο η ομάδα παρέμβασης εξάσκησε την τεχνική στον προσομοιωτή. Στη συνέχεια και οι δύο ομάδες αξιολογήθηκαν με βάση τις γνώσεις και την ικανότητά τους για την τεχνική.

Αποτελέσματα: Η ομάδα παρέμβασης έδειξε σημαντικά μεγαλύτερη απόκτηση γνώσεων ($p<0,001$) σχετικά με την τεχνική. Επίσης, εκτέλεσαν την τεχνική σημαντικά καλύτερα από τους φοιτητές στην ομάδα ελέγχου (80,9% έναντι 49,0%, διάστημα εμπιστοσύνης 95%). Επιπλέον, η ομάδα παρέμβασης είχε υψηλότερο επίπεδο ικανοποίησης με τη μέθοδο της προσομοίωσης ($rho=0,469$, $p<0,001$).

Συμπέρασμα: Ο συνδυασμός της διδασκαλίας με τη βοήθεια βίντεο με την εκπαίδευση προσομοίωσης φαίνεται να βελτιώνει την απόκτηση γνώσεων και την ικανότητα των φοιτητών νοσηλευτικής κατά τη διδασκαλία της τεχνικής της άσηπτης ενδοτραχειακής αναρρόφησης. Ως εκ τούτου, οι εκπαιδευτικοί θα μπορούσαν να συνδυάσουν αυτές τις μεθόδους για να διδάξουν την προαναφερθείσα τεχνική πιο αποτελεσματικά.

Λέξεις κλειδιά: Εκπαίδευση προσομοίωσης, Νοσηλευτική εκπαίδευση, Γνώση, Ικανοποίηση

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