Original Article

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Effects of "FIRST2ACT" Model on Knowledge and Practical Skills of Difficult Airway Management in Nurse Anesthesia Students: An Interventional Study

ALI KHALAFI[1], PhD; ALIREZA TORKASHVAND[1*], MSc; REZA AKHOONDZADEH[1], MD; SEYED MAHMOUD LATIFI[2], PhD

[1]*Department of Anesthesiology, School of Allied Medical Science, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran;*
[2]*Department of Biostatistics and Epidemiology, School of Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*

Introduction: An important part of anesthesia management is opening and maintaining the patient's airway. Failure to establish and maintain a safe airway for patients during anesthesia is a life-threatening condition. Despite advances in science and technology, difficult airway management is far from ideal. Providing a simulated environment for critical situations seems to be the best way to better educate and prevent medical errors. This study aimed to compare the effect of the FIRST2ACT (Feedback Incorporating Review and Simulation Techniques to Act on Clinical Trend) model on knowledge and practical skills of difficult airway management and respiratory accidents between the intervention and control groups.

Methods: This study was a quasi-experimental intervention with before and after design. Sampling was done by census method and the participants were third and fourth-year nurse anesthesia students (n=62). The students were randomly allocated to an intervention group (n=31) educated and practicing based on the FIRST2ACT model and a control group (n=31). The intervention consisted of five stages: developing core knowledge, assessment, simulation, reflective review, and performance feedback, all based on the FIRST2ACT model. Theoretical and practical skills were examined in the participants. Data collection tools included a questionnaire and a checklist.

Results: The results showed that after applying the FIRST2ACT model, the intervention group scored higher than the control group in both theoretical knowledge (17.87±1.43 vs. 12.67±1.35) and practical skills (134.28±3.21 vs. 81.58±8.55). This difference in results between the two groups was statistically significant (P<0.001).

Conclusion: It can be concluded that using this model was effective to improve the knowledge and practical skills of nurse anesthesia students in the field of difficult airway management and respiratory accidents during anesthesia.

Keywords: Anesthesia; High fidelity simulation training; Education; Evaluation

**Corresponding author:*
Alireza Torkashvand, MSc;
Department of Anesthesiology,
School of Allied Medical Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.
Tel: +98-9226769765
Email: tralireza1376@yahoo.com

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Introduction

An important part of anesthesia management is opening and maintaining the patient's airway. This part is critical because the patient is exposed to apnea, hypoxia, and upper airway obstruction under anesthesia or sedation (1). Studies by the American Anesthesia Association show that 37% of adverse outcomes related to respiratory events were attributed to anesthesia, in most of which death or brain injury has occurred (2). In the Iranian educational curriculum, advanced airway management is traditionally taught first in the classroom and later in the bedside student model when and if the patient presents. Given the breadth of the curriculum and current trends in practice, it is unlikely that every learner will be exposed to sufficient examples to achieve the necessary proficiency (3). One of the most crucial difficulties for anesthetists is difficult airway management (4).

A difficult airway is defined by the American Anesthesia Society as "a clinical situation in which a professional anesthesiologist's usual endeavor to mask ventilation or tracheal intubation, or both, is impeded" (1). Difficult airway management, despite advances in knowledge and technology, is far from ideal (4), so improvements in knowledge, technical skills, and cognitive skills are required for training and internships in difficult airway management (5). It has been found that the less time spent on training, the less likely it is that trainees will be exposed to a sufficient number of challenging cases. Today, the only way to overcome this shortage in anesthesia training is to better prepare trainees outside the operating room to use clinical training opportunities more effectively if they occur (6).

On the other hand, given that the limited facilities and spaces in clinical internships can affect students' learning opportunities; it seems that providing a simulated environment to the clinical situation is the best way to better educate and prevent medical errors. For decades, simulation has been a key educational strategy for developing clinical skills. Simulation is an instructional strategy that helps a person learn without fear of personal weakness, fear of harming the patient, and via interactive activities by offering all or part of a clinical encounter in a safe setting (7). This approach to medical education allows students to encounter and intervene in unusual circumstances (8). Simulation exercises in the field of anesthesia significantly strengthen the skillful aspects of learners (9).

One of the models which provide the simulation framework in an experienced model is the FIRST2ACT (Feedback Incorporating Review and Simulation Techniques to Act on Clinical Trend) model. This model was developed in 2011 by Buykx, in a study entitled "Educating nurses to identify patient deterioration—A theory-based model for best practice simulation education" based on empirical learning theory. Haukedal et al. in 2018, Al-Ghareeb et al. in 2019, and Cooper et al. in 2020 have also used this educational model as a simulation framework in their studies (10-12).

Despite conducting some studies in the field of training using simulation methods in the field of difficult airway management, there was little empirical evidence in evaluating the results of using these methods, and further research was necessary. Therefore, considering the importance and sensitivity of difficult airway management in the anesthesia field and the lack of study on difficult airway management skills using simulation techniques in nurse anesthesia students, the need for study in this area becomes apparent. This study aimed to determine the effect of "Feedback Incorporating Review and Simulation Techniques to Act on Clinical Trend" educational model on knowledge and practical skills of difficult airway management and respiratory accidents during anesthesia in nurse anesthesia students.

So the evaluation objective was to compare the effect of FIRST2ACT model on knowledge and practical skills of difficult airway management and respiratory accidents between an intervention and a control group.

Methods

Study type and Population

This study was a quasi-experimental intervention with a pre- and post-design in two groups of control and intervention. Due to the limited number of participants, random sampling was not possible and sampling was done by census method. All third and fourth-year nurse anesthesia students who met the inclusion criteria were included (n=68). The final number of participants was 62. The sample included 62 third and fourth-year undergraduate nurse anesthesia students, in the 5th and 7th semesters. 52 students were female and 10 were male. The matching process of the two groups was done. In this way, the participants were classified according to an academic semester and grade point average, and then using Random number table allocated to the control or intervention group. Therefore, in each group, the number of participants was the same, and in terms of the academic semester and grade point average, both groups had the same distribution (Figure 1).

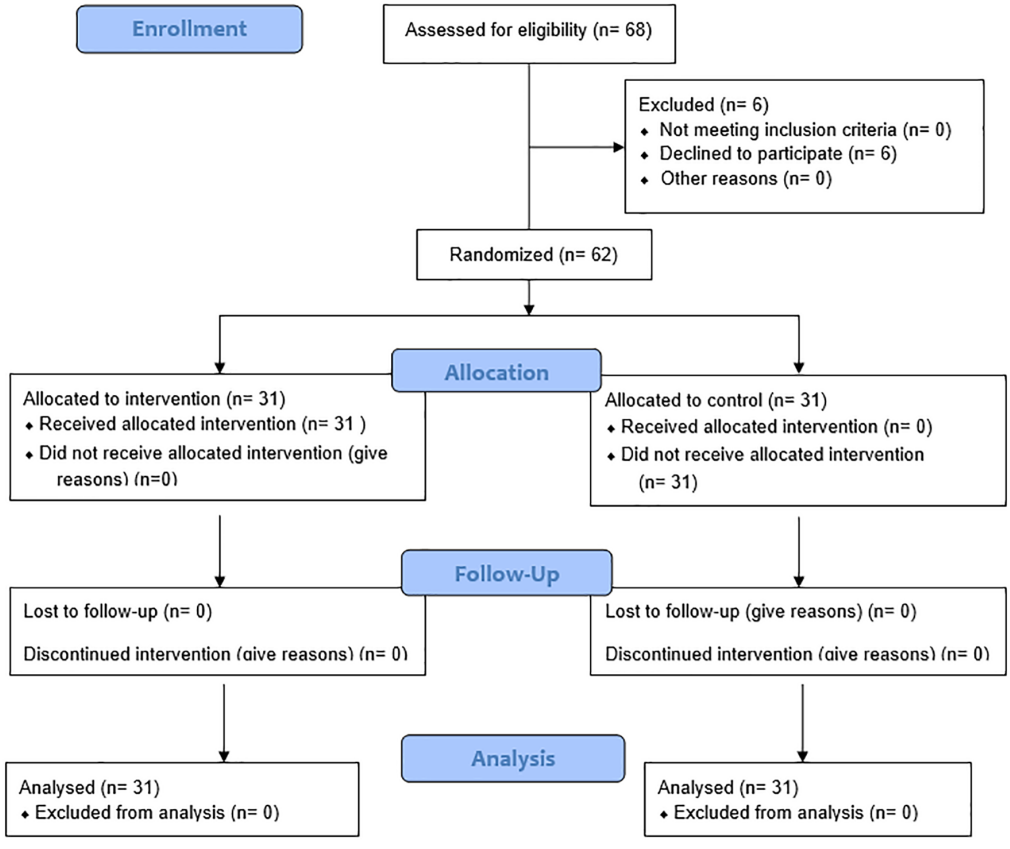

Figure 1: Flowchart of CONSORT

Data collection tools

The tool used in this study had two parts. The first part included a "20-item multiple-choice questionnaire" of difficult airway management and respiratory accidents. The content and face validity of this tool was approved by experts. After collecting experts' opinions, the necessary changes in the tool were considered, then to quantitatively evaluate the validity of the content and to ensure that the most important and correct content (necessity of the question) was selected, the content validity ratio (CVR) and Content validity index (CVI) were used to ensure that the instrument questions were designed in the best way to measure the content. To determine the content validity of the questionnaire, it was sent to 14 anesthesiologists and they were asked to answer each of the questions of the tool as "necessary", "not necessary but useful" and "not necessary". The answers were calculated based on the CVR (Content Validity) formula and adapted to Lawshe's table. Numbers higher than 0.59 were accepted. After determining and calculating the CVR, the CVI (Content Validity Index) was checked based on the content validity index of Waltz and Basel (10). For this purpose, the questionnaire to calculate CVI was again given to the mentioned experts and they were asked to comment on the following three criteria based on the four-part Likert scale: relevance, simplicity and clarity for each of the questions. (eg1: unrelated, 2: somewhat related, 3: related, and 4: completely related). For this purpose, the CVI score will be calculated by the sum of the favorable scores for each item that received the 3rd and 4th rank (the highest score) on the total number of voters. In this study, the content validity index was calculated using the CVI formula. Acceptance of items based on CVI score was higher than 0.79. The tool was tested in a pilot study with 15 students who were not part of the final research sample to determine its reliability. Internal reliability for this instrument was obtained with Cronbach's alpha coefficient of 0.873.

Another part was the "Practical Skills Checklist for Difficult Airway Management and Respiratory accidents during Anesthesia" made by the research team to consider difficult airway details, such as mask ventilation failure, oral intubation failure, and use of advanced equipment, etc., as well as respiratory accidents that may occur during anesthesia, such as aspiration of stomach contents, laryngospasm, accidental disconnection of tubes, etc. This tool was set in 6 subscales. Each subscale had a

specific number of items, which were 46 items in total. The items were adjusted to measure the practical skills of the participants in the field of difficult airway management based on the designed scenarios. A three-point Likert scale was used to score this tool. After collecting the anesthesiologists' suggestions and applying changes in this tool, with the help of CVR/CVI as in the first tool, the content and face validity were approved by 7 experts. The inter-rater reliability was utilized to assess the tool's reliability. The evaluation of 15 students who were not among the study's final sample was then conducted on an advance mannequin in the faculty's practice room, with each student being examined concurrently by three assessors. Cronbach's alpha coefficient for this tool was 0.926 after examining the collected data.

Study stages

This study was conducted from October 2021 to January 2022 and included the following three stages:

First stage: before the intervention steps, the samples were identified based on the inclusion criteria. These criteria included: 1) passing semester 4, and 2) not participating in similar courses of difficult airway management. Since the participants were in the 5th and 7th semesters, the topic of airway management was taught to them in the conventional curriculum, so this topic was re-teaching them more specifically and with more details in this study. But according to the inclusion criteria, none of the participants had participated in previous specific courses in difficult airway management. The exclusion criteria were to refuse to participate in the study at any time. The total number of identified students was 68, of which 62 participants were finally included in the study. Six students refused to participate in the study due to personal reasons. How to participate in this study was announced in the context of cyberspace and through WhatsApp software. The participants in a face-to-face meeting were thoroughly explained the objectives of the study, and their informed consent was obtained. The participants were divided into two blocks based on the academic semester and were allocated to control (n=31) and intervention groups (n=31), using a random number table. Therefore, the participants were matched based on their academic semester.

Second stage: At this stage, the intervention was performed in the intervention group based on FIRST2ACT model. This model incorporates the five steps of developing core knowledge, assessment, simulation, reflective review, and performance feedback into one educational model. A) The first step was called the developing core knowledge. At this stage, the researcher organized two 1.5-hour training sessions to re-teach the concept of airway management and challenging airway care in detail. In these sessions, difficult airway management including anatomy, types of devices, types of actions, difficult airway guidelines and other items to create a safe airway and with emphasis on recognizing difficult and critical situations, effective and predictive factors, necessary measures, necessary equipment and tips related to each situation were taught to the students. B) The pre-test was the second step of the model, which was taken in both the control and intervention groups. This step included a multiple-choice test to examine students' theoretical knowledge and a checklist to assess the participants' practical skills. The theoretical test was given to the students in the classroom of the Paramedical School by the researcher. Students' practical skills were also assessed by an assessor in a simulated space located in the practice room of the Paramedical School. He was fully acquainted with the study tools and the process of assessing students' practical skills and was aware of the objectives of the study. Moreover, he was blinded to group allocation. C) The third step was the main implementation of the intervention, i.e., simulation: this step consisted of four 1.5-hour sessions. Difficult airway scenarios and respiratory accident situations, such as failure of mask ventilation, failure of oral intubation, laryngospasm, aspiration during induction of anesthesia, etc. were used by the research team. According to scenarios, the participants were educated and were then asked to establish a proper airway over the advanced difficult airway mannequin. It was the difficult airway management mannequin model MW14 produced by KYOTO KAGAKU company. This mannequin has the necessary features to create difficult conditions for mask ventilation and tracheal intubation, including the ability to change the size of the tongue, the ability to restrict neck movement, the ability to restrict mouth opening, the ability to separate the front teeth, or the ability to block the entrance to the glottis using a built-in cuff that mimics the condition of laryngospasm well. D) The fourth step according to the model was called reflective review, which was done in such a way that during the implementation of the previous step, the participants were recorded on a video while establishing an airway on the mannequin. They were given the recorded films at the end of the simulation session in order to assess their performance and identify their strengths

and faults. E) The last step was performance feedback, which was accomplished through a debriefing session. This two-hour session took place at the end of the educational model implementation procedure, two days following the third step of the intervention in the faculty's practice hall in which the researcher tried to give feedback to each participant on his / her performance, and make suggestions to improve their work. In this session, the students had the opportunity, in addition to receiving feedback from the researcher, to express their performance in stage D and to express their strengths and weaknesses. The control group in this study did not undergo any education or simulation based on the FIRST2ACT model. They had acquired their knowledge and skills from previous traditional teaching, i.e., lectures and internships. But it should be noted that since all intervention steps were applied to the control group after the end of the study, the members of the control group were not dissatisfied with being randomly placed in this group.

Third stage: In the last stage, the practical skills, as well as the theoretical knowledge of all participants in the management of difficult airways and respiratory accidents during anesthesia, were measured after applying the educational model.

Assessment process and scoring

A theoretical knowledge assessment was designed in the classroom based on the mentioned multiple-choice test with 20 items. Likewise, measuring practical skills according to the same checklist with numerical criteria and on advanced difficult airway mannequins was designed with 46 items, but this time in the operating room of Hospital (to increase the degree of proximity to reality). In this way, the sound and scenes related to the scenarios were prepared. The participants provided all the necessary equipment to create a safe airway on the mannequin according to the relevant scenario. The scenarios were read to the participants by the assessor, and they were asked to establish a proper airway on the mannequin and take the necessary actions.

Following data collection and aggregating the scores, the evaluation process of the intervention and control group members was performed.

Data analysis

The collected data was evaluated by SPSS version 21 statistical program. The normal distribution of data was measured by Shapiro-Wilk test. If the distribution of the variables was not normal, the non-parametric Wilcoxon and Mann-Whitney tests were used. If the distribution was normal, the analysis of covariance, independent t and paired t tests were used. The significance level was less than 0.05.

Ethical consideration

All research protocols were conducted under the supervision of the University Ethics Committee (Ethic NO: IR.AJUMS.REC.1400.520). The participants´ information remained preserved, and all the selected individuals participated in this study based on their consent. In addition, the participants had the absolute right to withdraw from the study at each stage.

Results

The difference of participants' theoretical knowledge before and after the study was not significant in the control group (P=0.108), whereas it was significant in the intervention group (P<0.001). The difference between the theoretical knowledge scores of the control and intervention groups at the end of the study was statistically significant (P<0.001), but at the beginning of the study the difference was not significant (P=0.259). Also, a significant difference between the practical scores of the control and intervention groups at the end of the study was observed (P<0.001), but not at the beginning of the study (P=0.267)). Moreover, by intragroup review in the control group, no significant difference was observed in the pre-test and post-test (P=0.738), while this difference was significant in the intervention group (P<0.001) (Table 1). The same pattern was true for the participants' practical skills based on the subscales of the checklist in intervention group (P<0.01) (Table 2). The difference as was, of course, not significant in the control group (P>0.05) (Table 3).

Discussion

The findings of this research revealed that using the FIRST2ACT model improved the knowledge and skill of the intervention group. The intervention group in both theoretical knowledge and practical skills had greater scores than the control group. It seems that simulating and then examining the strengths and weaknesses of students using the recording of their performance, used in this educational model, can effectively strengthen the aspects of students' knowledge and performance compared to when only routine training is used.

Buyks et al. (2011) conducted a study to describe and develop the educational model based on the theory of experiential learning. In this study, the FIRST2ACT educational model

Table 1: Comparison of before and after scores of theoretical knowledge and practical skills in both groups

Variables		Intervention group (Mean±SD)	Control group (Mean±SD)	P
Theoretical knowledge	Before	13.32±1.22	12.96±1.32	0.259
	After	17.87±1.43	12.67±1.35	<0.001*
	Change	4.55	-0.29	_
	p	<0.001	0.108	_
Practical skills	Before	83.96±8.25	81.64±8.64	0.267
	After	134.28±3.21	81.58±8.55	<0.001*
	Change	50.32	-0.06	_
	p	<0.001	0.738	_

*ANCOVA analysis

Table 2: Comparison of pre-test and post-test scores of "Ability to assess and identify required action", "Positioning and pre-oxygenation", "Mask ventilation", "Laryngoscopy", "Intubation", "Professionalism" in intervention group

	Pre-test (Mean±SD)	Post-test (Mean±SD)	P
Ability to assess and identify required action	13.38±2.10	23.39±1.13	<0.001*
Positioning and pre-oxygenation	4.90±1.32	8.80±0.40	<0.001*
Mask ventilation	19.87±2.17	31.93±1.20	<0.001*
Laryngoscopy	15.83±2.09	20.64±0.55	<0.001*
Intubation	25.42±3.30	43.80±1.10	<0.001*
Professionalism	4.54±0.85	5.90±0.30	<0.001*

*paired t-test

Table 3: Comparison of pre-test and post-test scores of "Ability to assess and identify required action", "Positioning and pre-oxygenation", "Mask ventilation", "Laryngoscopy", "Intubation", "Professionalism" in control group

	Pre-test (Mean±SD)	Post-test (Mean±SD)	P
Ability to assess and identify required action	13.19±2.50	13.38±2.51	0.310*
Positioning and pre-oxygenation	5.16±1.18	5.35±1.22	0.310*
Mask ventilation	18.64±2.10	18.77±2.21	0.161*
Laryngoscopy	14.83±2.81	14.96±2.90	0.063*
Intubation	25.93±3.28	25.87±3.36	0.423*
Professionalism	3.80±0.65	3.83±0.63	0.573*

*Paired t-test

was used to examine the ability of nurses and midwives to recognize critical situations that require timely identification and action under different scenarios. This study was conducted on three groups, including final-year nursing students, final-year undergraduate, and master midwifery students, as well as nurses working in the surgery department of a rural hospital. Finally, the evaluations showed the high level of acceptance of this educational model by the students, as well as the improvement of their theoretical knowledge and the development of their skills (13). As a result, the alignment of the stated research with the current study is shown by the students' improved knowledge and practical skills as a result of using the same educational model approach.

Haukdal et al. (2018) conducted a study to investigate the effect of educational intervention using the first2act educational model on students' theoretical knowledge acquisition. Results of this study showed significantly greater improvement of scores in the intervention group than in the control group. They concluded that this pedagogical model can positively influence students' knowledge acquisition. So, the parallelism of the mentioned study with the present study is proved (10).

The results of this study are consistent with other studies which were performed using simulation method to teach difficult airway management to anesthesia students. Lucisano et al. (2012) in their study, which aimed to compare the two methods: 1) teaching content in the traditional way of lectures and internships and 2) scenario-based simulation method, found that students in the group of scenario-based simulation method indicated the benefits such as improved knowledge and adaptation to complex difficult airway management algorithm (14). Nguyen et al.

(2019) conducted a study to examine a curriculum based on long-term simulation for airway management training. They stated that simulation exercises significantly improved technical skills such as tracheostomy, cricothyroidotomy, and neonatal intubation. The researchers concluded that a long-term simulation-based medical curriculum could be an effective method for teaching airway management and team-based skills to residents (15). As a result, the alignment of the stated research with the current study is shown by the students' improved knowledge and technical abilities as a result of using the simulation teaching approach.

It seems that the reason for the efficiency of the method used and obtaining better results for the intervention group than the control group in this study is not only training and holding simulation sessions, but also the following:

The first factor was to accompany these sessions by providing feedback and debriefing session. The process of experiential learning combined with the reflective review and feedback used in this article leads to "deep" learning that is not provided by conventional and traditional education (13). To Grant et al. in their study, debriefing sessions is an essential part of the human patient simulation process and they proved the effect of video recording and retelling sessions by comparing two groups of students (16). Savoldelli, Georges L stated in their study that from an educational perspective, being in a simulated critical environment without accompanying debriefing sessions seems to have little benefit for learners (17). The next factor can be simultaneous cognitive and functional education in this study. In the traditional and common method in the Iranian educational curriculum, only theoretical training in the classroom is sufficient and there is no opportunity for both theoretical and practical training on difficult airway management in patients or specialized mannequins; therefore, applying this educational model for the first time on students by providing the opportunity for simultaneous theoretical and practical training showed its positive results.

One of the limitations of this study is the low number of participants. Because this research was limited to a single institution and a single nation, it is difficult to extrapolate the findings to other communities. The limitation of the design of this study was that the time conditions did not allow long-term measurement of learning achievements; therefore, pre-test recall may have influenced the post-test data.

The present study has some differences in terms of simulation style from other studies; because in this study, simulation were used with mannequins, and in other studies, human samples were used (14, 18, 19). Therefore, it is not clear exactly how much this increase in skills indicated by the participants has increased their skills in clinical conditions and on real patients. It is suggested that further studies in this field be performed with different simulation styles, and the results of applying this method on the practical skills of anesthesia nurses in the clinical environment and on human samples be reviewed.

Conclusion

Based on the results of this study, it can be said that this study achieved its goal of determining the effect of the educational model on students' knowledge and practical skills in the field of difficult airway management and respiratory accidents during anesthesia. The findings of this research showed that using this teaching approach enhanced the competence of the intervention group when compared to the control group. Therefore, the FIRST2ACT model is a reasonable model for training and preparing anesthesia nurses for difficult airway situations and respiratory accidents that require their rapid diagnosis and action to manage the patients' condition.

Authors' Contribution

A.Kh Conceptualization, Methodology, Formal analysis, Writing - Review & Editing, Project administration and A.T Conceptualization, Methodology, Data curation, Formal analysis, Software, Investigation, and Writing-Original Draft and R.A Conceptualization, Methodology, Writing - Review & Editing, Supervision and S.M.L Conceptualization, Statistical Analysis, Review & Editing. All authors contributed to the discussion, read and approved the manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated resolved.

Conflicts of Interest: None declared.

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