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The Effects of Scenario-Based Face-to-Face and Virtual Training on Advanced Cardiopulmonary Resuscitation Skills in Nurses

Abstract

Concerning the pivotal role that nurses play in the cardiopulmonary resuscitation (CPR) of patients with cardiac arrest, this study compares the effect of face-to-face and virtual scenario-based training of CPR procedures on CPR skills of nurses at Imam Khomeini Hospital in Arak in 2022. An educational trial was conducted on nurses who met the inclusion criteria and they were selected and randomly allocated to two groups with 35 nurses in each. The advanced CPR skills of nurses before and after the training sessions were assessed using the standardized checklist for CPR quality control. The advanced CPR skills of nurses were again assessed using the same checklist one month after the training sessions. The data were analyzed using descriptive and inferential statistics in IBM SPSS Statistics. Mean age in the virtual scenario-based training group and face-to-face scenario-based training group were 37.94 ± 6.25 years and 39.71 ± 7.27 years, respectively. There was no significant difference in terms of the various domains of CPR skills in the checklist between the two groups immediately after training ($p = 0.833$) and one month after the end of the training sessions ($p = 0.612$). Scenario-based educational intervention upgrades the CPR knowledge and skills of nurses. Both face-to-face and virtual scenario-based training sessions exert the same effect on the advanced CPR skills of nurses. Thus, these findings spotlight the need for implementing constant training programs and defining a criterion to identify the patient's clinical condition (scenario) and to motivate nurses to define the current problem.

Keywords: *Virtual scenario-based training, Face-to-face scenario-based training, Advanced cardiopulmonary resuscitation, Skills*

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1. Introduction

Cardiac arrest is indisputably a critical medical condition that requires prompt and deliberated action to save the patient's life and avoid permanent damage to the body's vital systems (1). Cardiopulmonary resuscitation (CPR) is a crucial treatment procedure conducted to maintain the blood supply to the brain and other organs to safeguard their functioning. Typically, CPR proceeds until the blood supply to the brain and other vital organs returns to its normal condition (2). CPR is among the life-saving skills that all physicians and nurses need to acquire (3). Healthcare providers with poor CPR skills are more likely to experience enhanced morbidity and mortality in critically ill patients with cardiac arrest (4). Nurses are generally the first initiators of basic CPR procedures (before advanced CPR), and if they perform efficiently, their actions can largely reduce patient mortality rates. Thus, trained and skillful nurses are crucial for preserving the lives of patients in critical conditions (5).

A body of evidence advocates poor CPR skills among healthcare providers such as physicians and nurses (6, 7). Research indicates that the training of CPR skills to healthcare providers can deliver measurable results (8, 9). Liu et al. reported that Chinese nurses have a positive and appropriate attitude toward learning CPR skills, but they have restricted knowledge and trivial CPR practice (10). Research further triggers nurses to learn CPR techniques (11, 12) and accentuates implementing repeated and periodical training to enhance the efficacy of these sessions (13).

Clinical education is a key pillar of nursing education. Nursing education mainly deals with applying theoretical knowledge of the students at the bedside and in actual medical settings to improve their decision-making power in real and acute situations (14). Modern training fills the existing gap between the theoretical knowledge of pre-hospital emergency operatives and applying this knowledge in clinical settings, thereby playing a decisive role in promoting the quality of skills of these operatives and technicians in dealing with trauma patients (15).

A multitude of techniques are currently used to train CPR, which are structurally different in terms of structure, content, purpose, and type of participants. Each technique is proposed and tailored to conditions, requirements, and facilities (16). A scenario-based training is a novel educational process that relies on the active participation of learners and aims to assist

individuals via discussions and problem-solving. This process improves the skills of individuals by augmenting their capabilities and creativity (17). Offering scenarios during CPR training promotes the diagnostic skills of nurses in real situations (18). Indeed, the scenario improves the clinical judgment and decision-making skills of nurses and allows them to take the right action in each stage of CPR. Then, by performing the selected action on the medical moulage instantaneously, the CPR skill will be acquired (19). Compared to conventional methods, scenario-based training can efficiently convey educational content (20.

The concept of learning has been revolutionized in the current era, and employing virtual training is not only regarded as an efficient tool but is deemed a novel approach in educational programs (21). The teaching-learning process and learning patterns have evolved after the advent of various techniques, such as electronic and virtual training, workshops, and face-to-face training (22). Principally, virtual learning refers to data conveyance via an electronic medium that enables transferring learning in a novel, improved, accessible, and faster way than conventional models (23). However, it is noteworthy that virtual learning systems require more infrastructure that is largely operated based on applications and smartphones (24).

Following breakthroughs in technology, the techniques that instruct how to use smartphones as an efficacious training tool that provides innovative options for training CPR skills to healthcare professionals have been proposed and employed (25). Overall, the use of electronic methods and educational content of mobile applications is not time- and place-restricted, and their content is simple and can be repeated frequently. Thus, they can exert a marked impact on the training of nurses during service (26). For example, Semeraro et al. reported that virtual training outperforms conventional models in training CPR skills (27). Similarly, Wong et al. summarized the drawbacks of conventional training and the potential advantages of virtual training in CPR skills (28). Elsewhere, virtual training was found to improve the level of knowledge of deaf individuals about CPR procedures (29).

Concerning the importance of CPR and offering proper CPR training to nurses as key responders among medical staff, and to address the paucity of CPR knowledge among nurses, this study investigates the efficacy of face-to-face scenario-based training compared to virtual scenario-based training on advanced CPR skills in nurses.

2. Methodology

This study was conducted in 2022 based on a quasi-experimental design assessing two groups of nurses before and after the intervention and with a one-month follow-up. The participants were 70 nurses in Imam Khomeini Hospital in Arak (Markazi province, Iran). The nurses had a bachelor's (or a higher) degree in nursing and were serving in various wards of the hospital. The sample size was determined using STATA software based on the study by Ebrahimi et al. (30) and considering an alpha value of 0.05 (5%) and power of 80%. Considering the loss of samples, the sample size was set to 70 participants, who were allocated into two groups, each with 35 nurses.

$$n = \frac{\left(z_{1-\frac{a}{2}} + z_{1-\beta}\right)^2 (\delta_1^2 + \delta_2^2)}{(\mu_1 - \mu_2)^2}$$

The nurses who met the inclusion criteria and worked at various wards and units of Imam Khomeini Hospital were instructed about the type of study and its educational content. Then, nurses who were willing to attend the study were randomly allocated to virtual or face-to-face training groups.

The participants were allocated to virtual or face-to-face scenario-based training groups one by one and based on the pre-designed random allocation process. The randomization process was unforeseeable, and the associated sequence generation was entirely randomized. The samples were allocated through block randomization with a block size of 4 and 6. That is, the randomization sequence was generated using the random number generator software such that it would meet the required sample size for the study's two groups. First, all the states in which the letters "A" and "B" stay together in blocks with sizes of 4 and 6 were defined. Next, one block was chosen randomly and placed among the blocks, and the allocation pattern in that block was used to allocate the participants. Then, this block was placed in the main container, and the next block was selected. All these actions were performed in Sealed Envelope software. This allocation process allowed for observing the concealment principles. Concealment is used to make the process of allocating the participants to the groups unpredictable, such that the researcher can no longer predict the group to which the next participant will be allocated.

The inclusion criteria included having a bachelor's or higher degree in nursing, working at Imam Khomeini Hospital in Arak, signing the consent form to attend the study, having clinical work experience of at least six months, and not attending the CPR workshop(s) during the past six months. The exclusion criteria were withdrawal from the study at any stage and not attending two or more training sessions.

The virtual scenario-based advanced CPR training intervention was conducted by creating a group on the Eitaa app that was accessible to the participants. The educational content about advanced CPR was offered to the participants within five sessions, where the duration of each session was to be one hour, concerning the time required to present the content and the number of educational scenarios required for one session. The educational content covered topics about advanced CPR algorithm (version 2020), in-hospital training scenarios provided by the American Heart Association (AHA), and images and training clips about CPR skills (e.g., correct CPR massage, proper depth of chest compressions, a right number of cardiac massages, advanced airway establishment, proper defibrillation, a right position and placement of defibrillator paddles and proper pressure of the paddles when giving a shock, alerting the team members when giving a shock, proper administration of drugs, proper dosage of medications, adequate intervals between drug administration, compliance with CPR sequences based on the 2020 version of the CPR, investigation of reversible causes, and taking proper measures to resolve the reversible cause of cardiac arrest). The nurses were then instructed to practice each procedure at home on an object such as a maquette, moulage, or pillow. Moreover, the face-to-face scenario-based advanced CPR training intervention was performed within five one-hour sessions in the hospital by forming groups of 10 nurses to deliver the advanced CPR training content with the same items. The nurses were then trained to practice each procedure at home on an object such as a maquette or moulage.

All the nurses received demographic information questionnaires before training. Furthermore, the standardized checklist for CPR quality control reported by Afzali Moghadam et al. (61) was used to assess the advanced CPR skills of the nurses before, immediately after, and one month after the training sessions. For this, the nurses were first provided with a certain scenario of a patient requiring CPR in the skill lab in the hospital for 10 to 15 min. They were then asked to immediately implement the required actions based on the patient's situation on the maquette. Simultaneously, the researcher scored each nurse's skill according to the items defined in the checklist.

The educational content was the same for both groups and has been scientifically and practically approved by the professors. The groups were only different in terms of the method of implementing the training sessions. The data were gathered using the following questionnaires.

1. The demographic information questionnaire consists of items about the nurses' personal characteristics, i.e., age, gender, marital status, place of residence, education level, and employment status. This questionnaire was prepared based on similar studies and opinions of the academic staff members of the Nursing Faculty (AUMS).
2. The standardized checklist for advanced CPR quality control reported by Afzali Moghadam et al. (61). This checklist was designed in 2019 to assess CPR skills in nine domains, including the survival rate after CPR and before discharge from the hospital, the return of spontaneous circulation (ROSC) rate, depth of chest compression, the number of chest compressions, the compression-to-ventilation ratio, CPR duration, delay in the initiation of CPR, and post-ROSC initial cardiac rhythm and cerebral function. Each question is scored from zero to two (i.e., 2 is correct, 1 is almost correct, and 0 is incorrect), with an overall score that spans from zero to 62. Briefly, performing all the items correctly according to the CPR algorithm will grant a score of 2 to the participant. Similarly, performing none of the items will grant a score of zero, while performing only one item will award a score of 1 for the participant.

Data analysis

The data were analyzed in IBM SPSS Statistics 23 by employing descriptive statistics, i.e., measures of central tendency (mean, mode, and median), dispersion, and graphs, as well as statistical tests, including t-test, chi-square, repeated measures ANOVA, and linear regression. Results with a p-value of less than 0.05 were considered to be statistically significant.

Findings

In this study, 35 nurses (mean age: 37.94 ± 6.25 years) were allocated to the virtual scenario-based training group, and 35 (mean age: 39.71 ± 7.27 years) were allocated to the face-to-face scenario-based training group. Based on the independent t-test and chi-square test results, all the participants were homogenous, and there was no significant difference between the two groups in terms of age, duration of work experience, marital status, education, contract status, gender, and history of CPR training (Table 1).

Table 1. The demographic information of nurses allocated to virtual and face-to-face training groups

Variable/ groups	Groups			p-value
	Virtual	F-to-F	Total	
	Mean (SD)	Mean (SD)	Number (%)	

Age (years)		37.94 (6.25)	39.71 (7.27)	35 (100)	+ 0.278
Work history (years)		14.28 (6.35)	15.51 (6.68)	35 (100)	+ 0.433
Marital status	Single	7 (20)	7 (20)	14 (20)	*0.999
	Married	28 (80)	28 (80)	56 (80)	
	Total	35 (100)	35 (100)	70 (100)	
Education	BC	32 (91.43)	33 (94.29)	65 (92.86)	*0.643
	MSC	3 (3.57)	2 (5.71)	5 (7.14)	
	Total	35 (100)	35 (100)	70 (100)	
Type of employment contract	Full-time (formal)	32 (91.43)	31 (88.57)	63 (90)	*0.260
	Contractual	1 (2.86)	3 (8.57)	4 (5.71)	
	Fixed-term	2 (5.71)	0 (0)	2 (2.86)	
	Enterprise	0 (0)	1 (2.86)	1 (1.43)	
	total	35 (100)	35 (100)	70 (100)	
Gender	Female	25 (71.43)	31 (88.57)	56 (80)	*0.624
	Male	10 (28.57)	4 (11.43)	14 (20)	
	Total	35 (100)	35 (100)	70 (100)	
History of CPR training	Yes	24 (68.57)	22 (62.86)	46 (65.71)	*0.615
	No	11 (31.43)	13 (37.14)	24 (34.29)	
	Total	35 (100)	35 (100)	70 (100)	
+ t-independent * Chi-squared					

Table 2. Comparison of advanced CPR skills of the nurses between virtual and face-to-face training groups

CPR variables/ investigation times		Before intervention		After intervention		One month after the intervention	
		Mean	SD	Mean	SD	Mean	SD
Cardiac massage	Virtual T	37.94	6.25	81.71	27.91	80	26.45
	F-to-F T	39.71	7.27	82.57	23.05	77.71	25.21
	p-value	0.370		0.9		0.54	
Airway examination	Virtual T	70	30.19	91.42	22.64	88.57	21.30
	F-to-F T	57.14	36.66	95.71	14.20	90	20.29
	p-value	0.143		0.5		0.77	
Rescue breathing	Virtual T	57.14	39.62	81.42	27.34	74.28	30.61
	F-to-F T	51.42	37.34	78.57	30.40	74.28	30.61
	p-value	0.531		0.82		0.99	
Ambu bag and mask breathing	Virtual T	59.14	25.93	86.85	16.58	79.42	19.54
	F-to-F T	52.77	25.36	84.85	8.68	79.42	18.14
	p-value	0.278		0.79		0.99	
Cardiac monitoring	Virtual T	65.71	27.98	86.85	16.57	79.42	19.54
	F-to-F T	52.57	25.36	84.85	18.68	79.42	18.14
	p-value	0.139		0.77		0.35	
Defibrillation	Virtual T	62.38	28.68	77.61	24.89	71.42	26.98
	F-to-F T	44.76	27.64	79.52	22.17	65.23	26.92
	p-value	0.010		0.73		0.34	
Appropriate drug delivery	Virtual T	55.71	27.84	76.42	24.95	70.71	24.61
	F-to-F T	47.14	25.56	83.57	23.43	72.85	28.03
	p-value	0.184		0.20		0.62	

Use of proper medications	Virtual T	44.28	29.41	77.91	29.68	76.66	27.47
	F-to-F T	41.42	27.52	69.52	32.20	69.52	29.56
	p-value	0.676		0.2		0.27	
Advanced airway establishment	Virtual T	56.42	18.53	85.71	17.97	78.92	19.82
	F-to-F T	50.35	25.08	83.57	19.11	77.14	18.80
	p-value	0.253		0.6		0.70	
Commitment to the AHA CPR algorithm	Virtual T	40	29.20	70	24.85	64.28	25.92
	F-to-F T	38.57	27.34	71.42	25.10	60	92.20
	p-value	0.51		0.81		0.83	
Reversible causes	Virtual T	23.57	29.66	49.28	25.35	40.71	27.84
	F-to-F T	20	34.19	59.28	28.49	42.85	31.83
	p-value	0.37		0.12		0.37	
Total	Virtual T	52.95	19.12	80.04	16.37	74.85	18.24
	F-to-F T	42.76	21.21	80.33	13.86	72.71	17.41
	p-value	0.286		0.83		0.61	
*Mann–Whitney U test							

Table 2 provides data about the advanced CPR skills of the nurses in both virtual and face-to-face groups. According to the Mann-Whitney U test, there is no significant difference in the mean scores of cardiac massage, airway examination, rescue breathing, ambu bag and mask breathing, cardiac monitoring, defibrillation, appropriate drug delivery, use of proper medications, advanced airway establishment, commitment to AHA CPR algorithm, reversible causes, and the total score before the intervention between the study groups, indicating that both groups are homogenous with each other ($p>0.05$). Besides all the sub-scales for immediate and one month (four weeks) after the training, there is no significant difference in the total score between the virtual and face-to-face intervention groups ($p>0.05$). For example, based on the Mann-Whitney-U test, there exists no significant difference in the mean score between the virtual and face-to-face groups before the intervention ($p=0.286$), after the intervention ($p=0.833$), and one month after the intervention ($p=0.61$) (Table 2).

Discussion

This study compared the effects of face-to-face and virtual scenario-based training methods on the advanced CPR skills of the nurses. The results revealed no significant difference between the two intervention groups in terms of the total score and CPR's sub-domains. In a study to investigate the efficacy of scenario-based training, Parvaresh et al. (31) evaluated the effects of lecture-based and scenario-based training methods on the level of awareness and attitude of 160 emergency medical technicians in managing chest trauma patients and found that the scenario-based training outperforms lecture-based training in increasing awareness of the participants. Jiang et al. (32) investigated the effectiveness of clinical scenario dramas in teaching doctor-patient relationships and communication skills to sixth-year medical students. They found that clinical scenario dramas markedly improve the self-confidence and learning ability of medical students. The study by Parvaresh et al. (31) showed that both scenario-based and lecture-based training can significantly increase the mean level of knowledge of emergency medical technicians. The mean post-intervention score of awareness in the scenario-based training group was significantly higher than that in the lecture-based training group. However, Parvaresh et al. (31) considered scenario-based training as the main intervention (and compared it with lecture-based training), whereas the present considers the scenario-based training method in both groups, and the difference between the two groups is in the process of implementing training sessions. This may be the major reason why the differences between the two groups are not significantly different.

In a 2015 quasi-experimental study (33), Koohpayeh et al. compared the effect of two virtual and traditional training methods on learning the lesson titled "Familiarity with dental tools and equipment and their maintenance." They found no significant difference in increasing the level of knowledge and performance of students between traditional and virtual training methods. The results of the present study agree with those reported by Koohpayeh et al. (33) in both face-to-face and virtual training methods. Farahmand et al. (34) compared the effects of two multimedia-based virtual training methods (i.e., educational CDs against traditional training) on the ability of two groups of 60 medical students of Tehran University to manage patients with trauma. They found that virtual training outperforms traditional face-to-face training in enhancing the trauma management capacity of students. The sample size in the present study is smaller than that conducted by Farahmand

et al. (34). In addition, the present study covers topics on advanced CPR skills instead of dealing with (and managing) trauma patients. Compared to the study conducted by Farahmand et al. (34), there was no significant difference between the two face-to-face and virtual training methods in this study.

In another 2015 quasi-experimental study, Hashemi Parast et al. (35) compared the effect of two electronic-based and lecture-based training methods on the awareness level of administrative staff in the clinical wards of selected hospitals affiliated with Tehran University of Medical Sciences in terms of hospital infection control. The mean post-intervention score of the learners in the lecture-based training group was higher than that in the electronic-based training group. A higher willingness to learn through face-to-face training in the study by Hashemi Parast et al. (35) may be because their study was conducted before the COVID-19 pandemic, where the students were not afraid of disease transmission if attending the classes. Moreover, equipment for conducting virtual training was insufficient before the Covid-19 pandemic. Thus, the students were not highly satisfied with virtual training because of its low educational effectiveness.

In a 2013 quasi-experimental study, Zaraati et al. (36) compared the effect of virtual (electronic) and traditional (lecture) educational methods on improving the academic performance of undergraduate students at Mazandaran University of Medical Sciences who had epidemiology, epidemiology of common diseases, maternal and child health, and reproductive health courses. The mean scores of students were not significantly different between the two methods. Regarding the content of the virtual courses in which all the topics were theoretical and non-practical, it can be concluded that virtual training can be as effective as face-to-face training in transferring scientific concepts.

Rabiepoor et al. (37) compared the effect of web-based and traditional teaching methods on midwifery students' knowledge about a survey of fetus health. The results revealed no significant differences between web-based and traditional education groups' scores before the teaching sessions between the two groups. However, both web-based and face-to-face teaching methods increased the mean score of students' knowledge before and after the training. Pre-post test results showed that both education methods are effective in improving students' learning capacity. Based on these results, they concluded that web-based teaching seems to be as effective as traditional teaching in offering educational programs to students. Hogenholtz et al. (38) reported that both e-learning and traditional teaching methods are effective in improving the learners' awareness, while no significant difference was detected between the two educational approaches. Elsewhere, research advocates that both electronic and traditional (face-to-face) methods are equally effective in improving the awareness of learners (39-42). Nourian et al. (43) compared e-learning and traditional classroom instruction of dentistry topics. They found that the mean +/- SD of the academic achievement test score is similar in the two groups of e-learning and traditional classroom teaching, and no significant difference is detected in this respect. The discrepancy between the results of other studies and the results obtained in this study may emanate from the COVID-19 pandemic, where nurses had to receive teaching virtually while preferring to attend face-to-face training sessions. Furthermore, having insufficient knowledge about social media for education may be a factor that influences the results of this study.

Educational centers can seemingly realize and develop educational goals by merging traditional and virtual education training systems (44). As a novel tool for progression, virtual learning can allow for the distribution of knowledge and practice skills by offering easy and accessible platforms, but it is not a full substitution for practical clinical experiences (45). However, the efficacy of virtual learning is reduced by numerous obstacles, including the need for alteration, lack of financial resources, unsuitable design of virtual training packages, unsatisfactory technology, lack of skills, the time-consuming nature of e-learning, and the need for face-to-face training. However, these constraints can be overcome by standardizing software and hardware, selecting the right strategy, providing financial resources, including virtual learning in the educational curriculum of universities, balanced education, improved access to technology, skill training, sufficient support, and allocating enough time for virtual learning (46).

This study investigated the effect of scenario-based virtual and face-to-face training on the CPR skills of nurses. Although the scores of the virtual training method were higher than face-to-face training before, immediately after, and one month after the training sessions, there was no statistically significant difference in the advanced CPR skill scores of the nurses between the two groups. This indicates that both methods exert the same impact on the nurses' advanced CPR skills. The major factor contributing to the rise in advanced CPR skills is developing comprehensive educational content that covers the educational requirements of the participants, regardless of providing the developed content via virtual or face-to-face training methods.

Research limitations

The first limitation of this study was that CPR skills were practiced on a maquette and were not performed on the patients under real conditions. Most importantly, performing these skills on real patients and feeling the associated stress when the nurse should exhibit his/her best performance in implementing

theoretical knowledge challenges the nurse's CPR skills in various aspects. Thus, it will better show the effectiveness of acquiring advanced CPR skills during operations. The standardized checklist for CPR quality control reported by Afzali Moghadam et al. (61) measures the general aspects of CPR skills of the participants. However, investigating the CPR skills of nurses in real situations can illustrate the hidden effects of both virtual and face-to-face training sessions.

Conclusion

In this study, both virtual and face-to-face scenario-based training methods effectively upgraded the advanced CPR skills of nurses and thus can enhance the quality of training sessions intended for nurses. However, there was no significant difference between these two training methods. Since virtual training on social media is relatively easy, affordable, and accessible, it can be simply employed to train healthcare professionals. Nevertheless, the effects of virtual and face-to-face training on other parameters in nurses' learning need to be fully scrutinized through further investigations.

Ethical considerations

This study was approved by the Research Ethics Committee with the ethical code of IR.000000000000000000 and registered by the Research Council with the registration code of IR.ARAKMU.REC.1401.301 at Arak University of Medical Sciences (AUMS). All the nurses who met the inclusion criteria attended the study after signing the consent form.

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Conflict of interest

The authors declare no conflict of interest.

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