Original Article

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The effect of cardiac arrhythmias simulation software on the nurses' learning and professional development

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Abstract

Introduction: One of the important tasks of nurses in intensive care unit is interpretation of ECG. The use of training simulator is a new paradigm in the age of computers. This study was performed to evaluate the impact of cardiac arrhythmias simulator software on nurses' learning in the subspecialty Vali-Asr Hospital in 2016.
Methods: This study was conducted by quasi-experimental randomized Salomon four group design with the participation of 120 nurses in subspecialty Vali-Asr Hospital in Tehran, Iran in 2016 that were selected purposefully and allocated in 4 groups. By this design other confounding factors such as the prior information, maturation and the role of sex and age were controlled by Solomon 4 design. The valid and reliable multiple choice test tools were used to gather information; the validity of the test was approved by experts and its reliability was obtained by Cronbach's alpha coefficient 0.89. At first, the knowledge and skills of the participants were assessed by a pre-test; following the educational intervention with cardiac arrhythmias simulator software during 14 days in ICUs, the mentioned factors were measured for the two groups again by a post-test in the four groups. Data were analyzed using the two way ANOVA. The significance level was considered as $p<0.05$.
Results: Based on randomized four-group Solomon designs and our test results, using cardiac arrhythmias simulator software as an intervention was effective in the nurses' learning since a significant difference was found between pre-test and post-test in the first group ($p<0.05$). Also, other comparisons by ANOVA test showed that there was no interaction between pre-test and intervention in all of the three knowledge areas of cardiac arrhythmias, their treatments and their diagnosis ($p>0.05$).
Conclusion: The use of software-based simulator for cardiac arrhythmias was effective in nurses' learning in light of its attractive components and interactive method. This intervention increased the knowledge of the nurses in cognitive domain of cardiac arrhythmias in addition to their diagnosis and treatment. Also, the package can be used for training in other areas such as continuing medical education.

Keywords: Cardiac arrhythmia, Software, Learning, Nursing education

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Introduction

Electrocardiogram (ECG) is the recording of electrical activity of the heart and one of the most valuable diagnostic tools. The proper interpretation of the ECG can prevent unnecessary medical interventions. ECG is an important technique for the diagnosis of heart diseases and is the main tool in the diagnosis of acute myocardial infarction (1-3). Its differential diagnosis is complex and difficult, especially by less experienced staff; moreover, its prompt and correct diagnosis can save the patients' lives. Cardiac dysrhythmia is the disruption in the sequence of normal functioning of the heart muscle at any age. In people with heart disease, 50% of deaths are caused by cardiac arrhythmias. Even though the interpretation of the ECG is an important skill in the training program, due to its abstract nature, complex mechanism and scattered content, it appears to be one of the hardest parts in teaching. On the other hand, there is no objective data used to determine an ideal method for its training (4, 5).

There are several methods for teaching this topic. The emergence of new methods of knowledge transfer has moved the education towards virtual learning, including the simulators. The simulator-based training has strong educational effects on psychomotor domain and causes immediate feedback and repetitive task training. Simulations in innovative nursing critical care increase the self-confidence, commitment and active learning and develop a significant increase in knowledge and critical thinking along with improved performance among nurses in critical condition. The use of simulation as a training strategy and complementary to other training methods would lead to active learning (6-9). Bregard et al. assessed the effectiveness of a simulation-based teaching to improve life-threatening pediatric cardiac arrhythmias with four teams. Each group consisted of one pediatric resident, one emergency medicine resident, and two pediatric nurses; they were randomly allocated to the experimental group participating in 5 video-recorded simulation sessions with examination or to the control group which was assessed 2 times with video-recorded simulation sessions without debriefing at a 2-week interval. Questionnaires assessed the self-reported changes in self-efficacy, stress, and satisfaction about skills. However, there was no significant change in self-efficacy, and the progress of the 2 groups regarding the time to initiate cardiopulmonary resuscitation was not significantly different between the first and last simulation sessions (8). In a study conducted by Johnson et al. (2017) aiming at assessing simulation-based medical education for providers for critical situations such as advanced cardiac life support, enhanced performance and patient safety, 65 nursing and 26 medical students participated. The results showed that improvement was seen in the cognitive assessment and each affective item after the intervention. Psychomotor scores improved in most items on the team performance checklist and improved for five items on the stroke task checklist (10). The aim of this study was to evaluate the impact of cardiac arrhythmias simulator software on the nurses' learning in the subspecialty Vali-Asr Hospital in Tehran, Iran in 2016.

Methods

Study design

A quasi-experimental comparative study with a randomized study group, using Solomon 4 group design was conducted in 2016-2017 in Vali-Asr hospital. Solomon 4 group design is recognized as one of the more powerful research designs. In this study, randomized Solomon Four Group Design was used to deal with a potential validity threat such as historical event, another educational program, maturation or growth existent in any educational intervention.

Solomon 4 group design uses an experimental group (E1) that receives a pre-test and training program and a post- test, a control group (C1) that receives a pre-test and a post-test, another experimental group (E2) that receives training and a post-test, and another control group with only posttest (C2) (Table 1). A barrier to the use of Solomon 4 group design is the complex statistical analysis of data. There are more than one method for analyzing data gathered using this design, and the methods used are dependent on the questions under investigation (11-13). A brief explanation of each design will assist the understanding of application in this field. The first group attended a pre- and post-test after training that showed the effectiveness of the training program or intervention. In the second group with pre- and post-test without intervention, we examined the influence of the testing; also, in the third group design we used an intervention and a post-test. This allowed the examiner to determine the effect of the pre- test on the post-test and the interaction effect of the pre-test and training (13).

Participants

The participant of this study consisted of 120 staff nurse, who were designed as the experimental and control groups with non-random sampling, but they were assigned by random allocation

Table 1: Solomon Four-Group Design

Group	Pre-test	Education (intervention)	Post-test
E1	O_1	X	O_2
C1	O_3		O_4
E2		X	O_5
C2			O_6

O=Outcome= pre-test and post-test, X= Education (intervention), E1= Experimental group that receives a pre-test and training program and a post- test, C1= Control group that receives a pre-test and a post-test, E2= Experimental group that receives training and a post-test, C2= Control group with only post-test

method into certain groups. The inclusion criteria for the study samples included having at least a bachelor's degree, employment for at least one year in the hospital, and willingness to participate in this project. The exclusion criteria were non-willingness to stay in the study, failure to participate in the pre- and post-test, and the lack of training with the software.

The study environment included the intensive care units at Vali-Asr subspecialty Hospital. To carry out the research, the researcher obtained the approval of the Ethics Committee, Shiraz University of Medical Sciences, the Hospital President and the Head of Nursing Department. Explaining the research objectives, we had their approval for cooperation with the study. According to a timetable, during three sessions in different hours and days, the nurses attended the pre-test based on Randomized Solomon Four Group Design. After the pre-test, the simulator training software was installed on the computers of ICUs, and the requirements to use the program were provided for 14 days. At the end of 14 days, during 3 sessions, the subjects participated in the post-test in different hours and days.

The educational content of the simulator software included important and common cardiac arrhythmias in authentic ECG training books as well as the causes, treatments and recognition of dysrhythmias incorporated at the heart of the simulator software. This software is designed based on the student-centeredness, problem-based, integration, community-based nature, electiveness and systematic design of education, which means SPICES strategy. In this study, the data collection tools were researcher-made questionnaires, with demographic information and assessment inventory of knowledge and skills levels on cardiac arrhythmias consisting of 30 multiple choice questions (MCQs) in three sections of causes, treatments and analysis of cardiac arrhythmias based on educational content of the software.

Their content validity was confirmed by experts in education, nursing and cardiac specialists; reliability was determined by Cronbach's alpha coefficient of 0.89. After obtaining the necessary permits and the consent of the participants in the study and reassuring them about the confidentiality of the information collected, the test scores were taken from randomized Solomon four groups and summarized. The mean values of the scores in each group were calculated. Then, the data were analyzed using SPSS Ver. 24 software. Two ways ANOVA was used to determine the effect of training (intervention), pre-test and their interaction in 4 comparisons. The significance level was considered as $p<0.05$, throughout a Solomon four-group design.

Results

In total, 120 nurses participated in this study. According to the results of this study, the respondents' mean age was 31.48±5.3 years. The frequency distribution by gender was that 18.1 percent of respondents were male and 81.9 percent were female. The results of demographic information questionnaire showed that the factors of age, gender, education level, job experience, previous educational courses on cardiac arrhythmias, using a similar software, and ward of service, using analysis of variance, led to no significant difference in the exam mean scores of nurses of Vali-Asr Hospital in 2016 ($p>0.05$).

The results of statistical and comparison analyses of pre- and post-test scores of the study subjects separated by Randomized Salomon Four Group in assessment test of knowledge, diagnosis and treatment of cardiac arrhythmias are presented in the following Tables, respectively.

In this study, the influence of pre-test and its interaction with the intervention (training) was studied by two-way ANOVA test. The results showed that there was no interaction between pre-test and training knowledge of cardiac arrhythmias (Table 2). Therefore, it can be concluded that nurses who are trained have a higher mean scores (1.8; $p<0.001$) and in those who had only pre-test, of the mean score was 0.8310 ($p<0.05$), so the intervention or training was effective.

As shown in Table 3, the influence of the pre-test and its interaction with the intervention (training) was studied by a two-way ANOVA.

Table 2: Mean score and standard deviation in the case and control groups by Solomon Four-Group in knowledge of cardiac arrhythmias

Source	Coefficient (Standard error)	p
Intervention	-1.800 (0.368)	<0.001
Pre-test	0.830 (0.378)	0.016
Intervention pre-test	-0.363 (0.528)	0.493

Table 3: Mean score and standard deviation in the case and control groups by Solomon Four-Group in treatments of cardiac arrhythmias

Source	Coefficient (Standard error)	p
Intervention	-1.900 (0.253)	<0.001
Pre-test	0.410 (0.262)	0.122
Intervention pre-test	-0.248 (0.367)	0.500

This table shows that there is no interaction between pre-test and training on treatments of cardiac arrhythmias.

Therefore, it can be concluded that nurses who have been trained have a higher mean scores (1.9; $p<0.001$) and those who attended the per-test only an average of scores was 0.41 ($p<0.05$), so the intervention or training was effective (Table 4).

Table 4 shows the impact of pre-test and its interaction with intervention (training) was studied by a two-way ANOVA. This Table shows that there is no interaction between pre-test and its training diagnosis of cardiac arrhythmias. Therefore, it can be concluded that nurses who have been trained have a higher mean score (2.99; $p<0.001$) and in those who had only pre-test, of the mean score was 0.63 ($p<0.05$), so the intervention or training was effective.

Discussion

In this study, the impact of cardiac arrhythmias simulator software on the nurses' learning in the subspecialty Vali-Asr Hospital in 2016 was evaluated. Results showed that the effect of cardiac arrhythmias simulator software on the knowledge, skills and attitudes of nurses trained by this software was significantly different from the control case in which the nurses had not used the software on factors such as diagnosis, treatment and analysis of the causes of arrhythmias.

Treatment methods and analyses of various cardiac dysrhythmias. Also, the result of ANOVA revealed that in this study other confounding factors such as the prior information, maturation and role of sex and age were controlled by Solomon 4 design.

Evaluation of test questions shows that the rates of answers to the correct options in the sections of causes, identifying treatment, and recognizing the type of cardiac dysrhythmias have increased respectively. Other studies such as that conducted by Tubaishat et al. (2015) mentioned that training cardiac arrhythmias with simulator will improve the knowledge of nurses (14). Olaiya et al. (2017) also recognized this manner as a factor further improving the nurses' knowledge in interpreting the dysrhythmias (15). Omidifar et al. (2006) showed that new teaching methods of ECG are more effective in teaching, critical thinking and creating opportunities for learning (16).

The results of this study indicated that the use of student-centeredness, problem-based learning, and integration of the subjects as the components of SPICES strategy in training cardiac dysrhythmias is effective, useful, innovative and acceptable by nurses. Zarifsanaiey et al. (2017) considers the context for creating an integrated learning opportunity, problem-solving and integrative training approach with a product of innovative and creative curriculum (17). O'Connell (2009) believes that a lot of trials and errors and ineffective and inaccurate models occur in traditional setting of the curricula, while SPICES strategy leads to accurate and orderly planning of courses (18). Kuo et al. (2013) also believes that performing training programs

Table 4: Mean score and standard deviation in the case and control groups by Solomon Four-Group in diagnosis of cardiac arrhythmias

Source	Coefficient (Standard error)	p
Intervention	-2994 (0.312)	<0.001
Pre-test	0.626(0.312)	0.025
Intervention pre-test	-0.247(0.43)	0.578

based on this strategy leads to satisfaction and better learning results in students (19). Aga et al. (2013) suggest that the use of simulators will improve the knowledge and skills (20). Moreover, Bloch(2013) sees it as a promoting factor of learners' self-confidence and a tool for easy transfer of training to clinical practice (21). The study by Granero et al. (2015) has shown that learning with a simulator improves and enhances the satisfaction, learning, performance, and better grades of the learners. They have also found the positive impact of the web-based ECG simulator on the development of reflective learning styles, motivation improvement and deep learning approach (22). These citations are consistent with the results of this study and confirm them.

Beetham et al. (2013) consider "learning by doing" as a stimulus for learning. Learning assisted by information and communication technology is a new solution for problems, which leads to innovative and active thinking. The use of simulators provides freedom with a framework of interactive constraints (23). In this study, the participants' learning with SPICES strategy could cause a significant difference in training the nurses since learning is based on comprehensive interest, cost-effectiveness, effectiveness, availability, flexibility, reasonable design, and integrity. Many studies have examined different uses of this strategy in different settings with various results (24-27).

Due to the rigor methodology, the controlled four-group Solomon design is rarely found in educational research, so it was one of the strengths of this study. However, there were some limitations to our study. The non-probability sampling in a single hospital might limit its generalizability to different settings. Furthermore, inability to complete the quarantine of subjects in tests and randomized Solomon groups led to the circulation of subjects in groups and possibly influenced the results.

This study was expected to acquire and promote experience in adoption of educational theories in the design of associated medical education applications. Considering the effectiveness of Cardiac Arrhythmias Simulation Software on the nurses' learning, and professional development in medical education practice, we recommend this strategy and method to be highlighted in other areas of health care system in addition to the contents in developing the electronic curricula.

Conclusion

We found that the software-based simulator for cardiac arrhythmias was effective in the nurses' learning in light of its attractive components and interactive method. This intervention increased the knowledge of nurses in cognitive domain of cardiac arrhythmias in addition to their diagnosis and treatment. Also, the package can be used for training in other areas such as continuing medical education. Using the SPICES strategy in the design of the software-based simulator for cardiac arrhythmias leads to more efficiency and positive impact on the education of cardiac arrhythmias. Determining the exact effect size of using this strategy in other curricula demands further research.

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