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Animation Shows Promise in Initiating Timely Cardiopulmonary Resuscitation

Results of a Pilot Study

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Delayed responses during cardiac arrest are common. Timely interventions during cardiac arrest have a direct impact on patient survival. Integration of technology in nursing education is crucial to enhance teaching effectiveness. The goal of this study was to investigate the effect of animation on nursing students' response time to cardiac arrest, including initiation of timely chest compression. Nursing students were randomized into experimental and control groups prior to practicing in a high-fidelity simulation laboratory. The experimental group was educated, by discussion and animation, about the importance of starting cardiopulmonary resuscitation upon recognizing an unresponsive patient. Afterward, a discussion session allowed students in the experimental group to gain more in-depth knowledge about the most recent changes in the cardiac resuscitation guidelines from the American Heart Association. A linear mixed model was run to investigate differences in time of response between the experimental and control groups while controlling for differences in those with additional degrees, prior code experience, and basic life support certification. The experimental group had a faster response time compared with the control group and initiated timely cardiopulmonary resuscitation upon recognition of deteriorating conditions ($P < .0001$). The results demonstrated the efficacy of combined teaching modalities for timely cardiopulmonary resuscitation. Providing opportunities for repetitious practice when a patient's condition is deteriorating is crucial for teaching safe practice.

KEY WORDS

Animation • Cardiac arrest • CPR • Nursing students

Nurses are often the first responders to cardiac arrest in acute care. Research has shown that the assessment and resuscitation skills of nursing students and staff are inadequate,[1,2] which may contribute to survival rates following in-hospital cardiac arrest (I-HCA) of less than 30%.[3] Approximately 70% of the initial rhythms of I-HCA are pulseless electrical activity and asystole,[4] and cardiopulmonary resuscitation (CPR) is the top priority for patient survival. Even in ventricular fibrillation (VF), CPR is recognized as a life-saving therapy prior to defibrillation.[5]

The chance of survival to hospital discharge has been reported to be more than double among patients who received CPR within the first minute after collapse, as compared with those who received CPR after 1 minute.[6] Delayed CPR is commonly due to the intense situations often found with cardiac arrest that require rapid leveraging of psychomotor skills and critical thinking. Therefore, significant and repetitious training is required to maintain familiarity with evolving guidelines[7] and hone individual competencies.

Alternative methods of teaching are needed due to several factors, including high numbers of students entering nursing programs, a national shortage of nursing faculty, and prelicensure nursing students' learning styles.[8,9] The current generations that are entering higher education in nursing programs have grown up with technology in their personal and educational lives.[9] Consequently, educational institutions need to adapt their teaching styles to this generation

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of learners to maintain credibility and teach them effectively. Moreover, the medical-surgical inpatient units, where students typically begin their clinical training, are in high demand; as a result, they have the heaviest student traffic. It is becoming increasingly difficult to secure clinical placement in these settings due to increasing student enrollment and competition for clinical rotation among nursing programs.[10] Far too often, students are given clinical placement wherever there is availability rather than based on course objectives.[8]

The National League for Nursing emphasizes that educators must challenge long-held traditions in nursing education and design evidence-based curricula that are responsive to student needs, integrate current technology, and improve quality and safety in practice settings.[11,12] Using multimedia computer-based learning (MCBL) may be a complementary way to respond to these challenges. The visual and auditory modalities of multimedia, such as animation,[13] allow the students to build upon previous assessment skills and facilitate a higher level of understanding of the process and ideally a more timely response to a deteriorating patient in a lethal rhythm.

Appropriate and fast response has been recognized as a crucial step in managing patients with cardiac arrest and is an obvious first step for attempting training enhancement. We previously observed long delays in response time of students to a patient with a deteriorating condition during simulation activities and decided to evaluate the effect of animation on their response times. The goal of this pilot study was to investigate the effect of animation on nursing students' response time to cardiac arrest and performance of safe patient care upon recognition of cardiac arrest. We hypothesized that student nurses who were prepared with both animation training and discussion prior to the simulation laboratory experience would have faster response times for patients with deteriorating conditions and a higher incidence of demonstrating safe practices (eg, calling for help and initiating CPR) than those students who had not undergone animation training.

METHODS

Design and Sample

The sample consisted of senior-year, bachelor degree nursing students, randomized into control (n = 14) and experimental (n = 17) groups. Participation in a high-fidelity simulation was mandatory for students as part of their clinical course.

Both the control and experimental groups received a form requesting information about age, other educational degrees, previous participation in "code blue" situations, certification in basic life support (BLS), and how long they had been certified in BLS. A consent letter was provided explaining the procedures, including the required forms and activities to be completed. To protect the study from group contamination, all groups were reminded of the nursing school's confidentiality form that they signed prior to simulation and were advised not to share any information about this project, consent letters, or simulation experience with their peers.

Animation Development

A multimedia-project two-dimensional animation was developed to illustrate the initial steps taken by a registered nurse in treating an unresponsive patient according to the American Heart Association (AHA) guidelines. Three short scenarios demonstrated the performance of a nurse finding a patient unresponsive in a hospital bed. Two scenarios showed the nurse performing the correct response to an unresponsive patient, including calling for help, decreasing the head of bed angle, and initiating CPR after shaking the patient and calling the patient's name with no response; one scenario displayed an incorrect response by the nurse to an unresponsive patient. The nurse in this scenario got scared upon finding the patient unconscious and left the room to focus on a different task instead of calling for help. After each short scenario, the software program asked, "Did the nurse perform correctly?" The students then could choose yes or no answers. If the student answered correctly, the next scenario was presented. If the student answered incorrectly, she/he would ask the primary investigator for clarification of the scenario, and the scenario was repeated.

The experts for creating animations in Instructional Technology Services (ITS) at the university were initially contacted, the project was discussed, and the parameters of the project were agreed upon. The storyboard was created on paper by the ITS graphic designer/illustrator based on the scenarios provided. Character voices were recorded by the ITS video department. The sound was imported into Flash 5.5 (Adobe Systems, Inc, San Jose, CA), edited, and laid out on the timeline. The illustrations for the animations were created in Adobe Illustrator 5.5 and brought into Flash as separate pieces. The voices and animation were then created in sync in Flash. Some programming was required in Flash to coordinate the animation with the question and answer parts of the animation. As the final step, the animation was exported as a Flash .swf movie and included the HTML files. After developing, reviewing and revising the application, the fully animated interactive version was completed.

Procedure

The study received institutional review board approval from San Diego State University. All students were prepared generally for the simulation scenario that was focused on caring for a mannequin with sepsis/septic shock. The general preparation for this scenario consisted solely of a discussion about the definitions and hemodynamic consequences of systemic inflammatory response syndrome, sepsis, septic shock, and multiple organ dysfunction syndrome. The students were familiar with the septic shock concepts including nursing interventions because they completed a series of lectures on the topic prior to their participation in simulation laboratory. No cardiac arrest procedures were discussed with any group during this portion of the training. Subsequently, the experimental groups received additional preparation through the animation. All students were BLS certified.

The primary investigators provided instruction on the animation format and individual headphone use and monitored the students in the event of questions or software issues. When all students completed the animation scenarios, a discussion forum was started by the investigator to answer students' questions, emphasizing the updated version of the AHA guidelines that require immediate CPR at 100 times per minute without checking for a pulse, in managing unresponsive patients.[7] The animated preparation, including preparation for using software and the discussion following the animation, was completed in approximately 30 minutes.

The simulation laboratory was equipped with cameras that transmitted to a television in an adjacent room which recorded the simulation event. This equipment allowed the investigators to monitor and record the students' actions without interfering with the simulation experience. In the simulation scenario, the mannequin presents to the emergency department (ED) from an extended care facility without family. Patient care evolves from the ED to the intensive care unit, with the end result of cardiac arrest. Deterioration to cardiac arrest was presented as decreasing blood pressure followed by VF shown by the arterial line reading and the electrocardiogram tracing on the bedside monitor. Once the mannequin presented with VF, each group of students was expected to demonstrate safe patient care by working as a team to (1) call a code blue, (2) flatten the head of the bed and put the bedside rails down, and (3) start timely chest compressions without checking for a pulse, as per the AHA guidelines. Once this sequence began, the primary investigator began recording the response time to cardiac arrest. Response time to cardiac arrest was defined as the duration of time from students' recognition of cardiac arrest to their initiation of safe patient care and CPR. The clinical instructors were present during the scenarios and they monitored the CPR techniques such as chest compressions and corrected student technique as needed.

Statistical Analysis

Univariate analyses, including Fisher exact tests for small cell sizes and *t* tests, were performed to test for significant associations between the experimental and control groups across previous training, experience, and age. An exploratory model analysis was completed to assess whether a significant relationship existed between the covariates and the students' response time.

A linear mixed model was run to investigate the association of variables, including additional degrees (yes/no), those with a prior code experience (yes/no), and those with BLS certification (0–6 months or >6 months), with response time. A group variable was included as a random effect. Data management and statistical analyses were conducted using SAS software (Version 9.3, SAS Institute, Inc, Cary, NC).

RESULTS

A total of 31 participants were included in this pilot study, with 100% having complete covariate and outcome data. Table 1 shows the demographic characteristics of the participants.

Table 1

Characteristics of Study Participants by Animation or Traditional Training

Characteristics	Population	Animation	Traditional
Other degree			
No	24 (77.4)	13 (76.5)	11 (78.6)
Yes	7 (22.6)	4 (23.5)	3 (21.4)
Prior code blue experience			
No	26 (83.9)	14 (82.4)	12 (85.7)
Yes	5 (16.1)	3 (17.6)	2 (14.3)
BLS certification			
0–6 mo since	19 (61.3)	11 (64.7)	8 (57.1)
>6 mo since	12 (38.7)	6 (35.3)	6 (42.9)
Age, mean (SD), y	28.3 (7.5)	29.0 (9.0)	27.4 (5.3)

No significant difference ($P < .05$) was found between the experimental and control groups using Fisher exact test or *t* test. Data are presented as n (%), unless otherwise indicated.

Table 2

Linear Mixed Model to Investigate Associations With Time to Complete Exercise

Characteristics	Population, n (%)	Least Square Means, Mean (SE)	P^a
Training			
Traditional	14 (45.2)	50.3 (7.2)	<.0001
Animation	17 (54.8)	6.4 (6.8)	
Other degree			
No	24 (77.4)	37.8 (5.9)	.099
Yes	7 (22.6)	18.8 (9.8)	
Prior code experience			
No	26 (83.9)	20.2 (5.5)	.14
Yes	5 (16.1)	36.5 (9.8)	
BLS certification			
0–6 mo since	19 (61.3)	32.0 (6.8)	.38
>6 mo since	12 (38.7)	24.7 (7.6)	
Age, mean (SD), y	28.3 (7.5)		.55

[a] *P* value from linear mixed model.

Table 2 presents the results from the mixed model. The variable group was included as a blocking factor and was found to be insignificant and was removed from the model. The effects left in the full model included training type, additional degrees, prior code experience, recency of BLS certification, and age. Training type (discussion and animation vs only discussion) was significantly associated with response time ($P < .0001$). The median response time for control group was 42.75 seconds, with a range of 16 to 101 seconds, and for the experimental group was 7.6 seconds, with a range of 1.7 to 13.8 seconds. The experimental group had a least square mean of 44 seconds faster response time than the control group. There were no other statistically significant differences in the model. However, the model suggested that those with additional degrees and recent BLS certification might have lower assessed time, whereas those with prior code experience might have increased assessed time. The experimental group followed the correct steps for safe patient care, including (1) calling a code blue, (2) flattening the head of the bed, and (3) starting chest compressions. One of the control group participants started CPR without flattening the head of the bed.

When students had completed all three scenarios, the primary investigator started a discussion forum. The students asked the rationale for eliminating the step that involved checking the patient's pulse. The primary investigator then explained the AHA guidelines, which the students had not previously been taught in the community BLS classes. Students' evaluations after finishing the animation session were positive and strongly agreed that it enhanced their knowledge in managing unresponsive patients during cardiac arrest (79%) and must be incorporated in future education (86%). Their narrative responses also confirmed the effectiveness of animation. The following are two examples of the written evaluation: "Not every student gets the opportunity of code blue experiences in clinical, good alternative" and "It gave an actual visual of what the situation was instead of just reading everything."

DISCUSSION

To the best of our knowledge, this is the first pilot study to report an effective use of a complementary animation program prior to simulation laboratory to teach nursing students, including timely initiation of CPR upon finding an unresponsive patient. Although this was a pilot study, we found a significant difference in response time between the control and experimental groups, resulting in a near 1 minute difference in adjusted mean response time between these groups.[6]

The results are in agreement with previous studies that were conducted among students in the field of science and medicine. Students who used animation could understand more difficult concepts both in surgical procedures[14] and in basic science courses[15,16] and retain the information significantly better than the control groups could. The advantages of animation in teaching students should be emphasized because different scenarios can be created and made available online to enhance repetitious practice for students. This is important as online education is increasing in popularity along with the number of nursing programs offering online degrees. Faculty needs to adapt their teaching styles to this generation of learners to maintain credibility; however, there has been limited use of animation in nursing education. In this study, students had positive comments about using animation and had a faster response time after using animation compared with the control group. One implication is to create a series of animations that shows safe nursing practice and make them available for students prior to using the simulation laboratory.

The delayed response and deviation from the AHA guidelines have been documented during in-hospital-based mock codes using simulation and during I-HCA.[4,6,17] One way to minimize or prevent such errors is to use high-fidelity simulation combined with MCBL (eg, animation) that provides replicated scenarios of cardiac arrest situations that have occurred at hospitals. Timely interventions in the chaotic times of a cardiac arrest must be reinforced in teaching resuscitation therapy. Proper techniques of CPR and timely CPR are equally important and should be emphasized during training sessions to eliminate disastrous consequences, especially when the survival rate for asystole is less than 5%.[18] Timely intervention can be incorporated as a crucial concept of resuscitation therapy to students by using animation that make the cognitive processes easier to learn and retain rather than lectures on safe practice including timely CPR.

Approximately 60% of the students had BLS certification through different community organizations within 6 months prior to their participation in the study. It is interesting to note that the students in the experimental group were not aware of 2010 changes in resuscitation therapy based on AHA guidelines. According to the most recent AHA guideline,[8] "look, listen, and feel" is removed from the BLS algorithm and early CPR with chest compressions is emphasized. One implication for such a finding is that opportunities must be given to nursing students during simulation to practice their BLS knowledge and skills and clarify any misconceptions to ensure safe nursing practice. Our study suggests that animation provided an opportunity for students to learn the updated important concepts in safe patient care according to AHA guideline and stimulated a lively discussion afterward.

The approach of random allocation of students to the experimental and control groups was efficiently carried out and confirmed with no statistical differences in characteristics among students in the control and experimental groups. Nonsignificant although notable differences of mean times were identified across characteristics and should be considered for further analysis with a more robust sample size. Furthermore, different types of nursing students should be included in future studies to reflect the mixed backgrounds of students in nursing profession.

Creating animations can be costly where resources are limited or the technical expertise may not be readily available in some universities. Collaboration between publishing companies and academic centers should be considered as a potential solution to remove barriers in terms of cost and resources.

Limitations

This pilot study, with a small sample size, evaluated only a specific intervention (response time) during cardiac arrest. We did not evaluate the quality of CPR during simulation because clinical instructors were present during scenarios to monitor and correct the students' techniques. Cardiac arrest in adults was presented only as a part of the septic shock scenario to students and resuscitation techniques were monitored, evaluated, and corrected as part of scenario in the simulation laboratory. Future studies should include a larger sample size, a more diverse student nurse population (eg, registered nurses who are enrolled in bachelor's degree programs), more developed animation that incorporates the factor of time in managing airway, and a third arm of investigation that includes increased training that is not animated, allowing isolation of the animation effect. The small sample size limited our ability to evaluate the impact of student characteristics on their response time.

Moreover, the initial interventions prior to chest compression seem to be simple (eg, calling for help, flattening head of bed). However, these steps can be easily forgotten in a stressful environment, especially where a registered nurse has little to no experience in managing a patient with cardiac arrest. Although we did not have any long-term follow-up with students in the study to monitor them for their response during I-HCA, research studies have indicated that the repetitious performance may increase teaching effectiveness.[19]

CONCLUSIONS

The fast and efficient response of a nurse in managing unresponsive patients is critical and has a direct impact on patient survival. Providing opportunities for repetitious practice during the time of deteriorating condition for a patient is crucial for teaching safe practice. Animation showed promise to initiate a timely CPR in this study, and it can be used to integrate learning opportunities in a safe environment where students have the opportunity for repetitious performance with no lethal consequences to the patients. Teaching proper and timely resuscitation technique is part of safe nursing practice and repetitious training by animation may decrease the chance of error during the chaotic and stressful time of cardiac arrest.

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