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# The impact of scenario-based simulation training on nursing students' knowledge and performance in patient care after coronary artery surgery

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## Abstract

**Background** Coronary artery bypass graft (CABG) surgery is one of the most effective treatments for coronary artery disease. Despite its many benefits, this surgery can also lead to potential complications. Studies have shown that nurses play an important role in managing these complications. Studies have shown that nurses play an important role in controlling these complications. Conventional nursing education often fails to prepare graduates for employment in complex and evolving clinical environments like cardiac wards. Meanwhile, scenario-based learning has recently emerged as a valuable educational method in the clinical training of healthcare professionals. Therefore, this study aimed to determine the effect of scenario-based learning on nursing students' knowledge and performance in patient care after coronary artery surgery at Kashan University of Medical Sciences.

**Methods** The present study used a pretest-posttest design in 2024(April to December), with the research population consisting of fifty nursing students of Kashan University of Medical Sciences. All students were included in the study using convenience sampling method and were randomly assigned to two groups: one receiving conventional training methods and the other participating in scenario-based simulation training. First, the scenarios were written and validated. Data were collected using a demographic questionnaire, a knowledge assessment questionnaire, and a performance assessment checklist. The validity and reliability of the instruments were investigated and confirmed. After data collection, the analysis was conducted using SPSS 16 software, with a significance level of 0.05.

**Results** According to the study results, a significant increase was observed in the performance scores of nursing students in patient care after coronary artery surgery after receiving the training ($P < 0.05$). However, the change in the knowledge score was not significantly different between the two groups ($P < 0.05$). The results of the independent T-test showed no significant difference in the change in knowledge score between the two groups. But the increase in performance score between the two groups was significant ($P < 0.05$). The results of the ANCOVA test showed that the type of training had no effect on the change in knowledge scores ($P = 0.301$) but significantly affected the change in performance scores ($P = 0.036$).

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**Conclusion** Given the effectiveness of scenario-based simulation training, it is recommended that this method be used in the clinical education of nursing students and nurses.

**Keywords** Nursing, ICU, Cardiac surgery, Simulation-based training, Scenario-based training

## Background

Cardiovascular diseases are among the leading causes of death worldwide. In 2022, the American Heart Association reported that approximately 19 million deaths from cardiovascular diseases occur annually worldwide, marking a significant increase of 18.7% compared to 2010 [1]. A study in Iran examined 9,828 people in 2022 and reported the prevalence of cardiovascular diseases in men and women to be 16.5% and 12.6%, respectively. Coronary heart disease is the most common form of cardiovascular disease in adults [2]. Coronary artery disease affects 18 million people in the United States each year [3]. In Iran, deaths caused by coronary artery disease have nearly doubled in 2015 compared to 1990 [4].

Coranary artery bypass graft (CABG) surgery is one of the most effective treatments for coronary artery disease and can play a significant role in reducing mortality and disease complications [5, 6]. Despite its numerous advantages, this surgical procedure can pose potential complications due to its complexity and the establishment of extracorporeal circulation during the operation [7, 8]. In this regard, the intensive care units (ICU) nurses play an important role in preventing potential complications, managing complications, reducing readmissions and treatment costs, and getting the patient back to life as quickly as possible [9]. At the same time, the quality of care in cardiac intensive care units (CICUs) is not at the desired level [10]. In support of this, Dehghani et al. (2014) argued that the average performance scores of ICU nurses were significantly lower than the standard scores [11]. Similarly, Hameed et al. (2022) found that nurses had inadequate knowledge regarding complications after open heart surgery [12].

One of the reasons for the low quality of care in ICUs is that traditional nursing education does not adequately prepare graduates for employment in complex and changing clinical environments such as CICUs [13]. The challenges for clinical education using traditional methods include the growing trend and complexity of care, rapid advancements in knowledge, a large number of students, limited number of professors, insufficient clinical training environments, and inconsistencies in teaching on live patients while ensuring patient safety [14]. In this regard, Serafin et al. (2022) found that new nurses felt unprepared to assume responsibilities in ICU and attributed their inability to care for patients to their lack of skills and knowledge [15]. Therefore, the need for innovative approaches and methods is evident. Such new methods can bridge the gap between the preparation of nurses in the classroom and the acquisition of real-world skills in clinical practice and produce graduates who are well prepared to provide safe and effective patient care in the clinical setting. Researchers have used various educational approaches, including simulation, hybrid learning, problem-based learning, multimedia learning, mentorship and preceptorship teaching methods, and technology-optimized practice processes to empower nursing students [16].

Simulation-based training is an effective educational technique that emulates real-life processes in clinical settings. It utilizes methods such as role-playing and various devices, including fixed mannequins, warning mannequins, mannequins connected to computer software, and interactive videos [17]. Among the various simulation techniques, scenario-based learning is one of the most innovative and cost-effective teaching methods. Scenario-based simulation involves activities where learners can practice and acquire skills through simulated scenarios in an environment free from real-world consequences. This method has a structured approach based on critical thinking and problem solving skills [18]. As shown by Du et al. (2021) in China, students in the scenario-based group scored higher on the post-test than the lecture group [19]. In line with this, Izadi et al. (2020) found that after implementing scenario-based educational interventions for nurses, patient satisfaction scores with nurses increased significantly both immediately and one month after the intervention [20]. In contrast, Hu et al. (2021) found no statistically significant difference between nurses' knowledge scores in delirium management in the scenario-based and control groups [21]. In Iran, Sadeghi et al. (2023) indicated that there was no statistically significant difference in the general competency scores of nursing students between the control and intervention groups following scenario-based training [22]. Given the contradictory results in the field of scenario-based simulation training and the limited studies on critical nursing care for patients undergoing CABG surgery, this study aimed to assess the effect of scenario-based simulation training on nursing students' knowledge and performance in patient care after coronary artery surgery.

## Methods

This study was a pretest-posttest study designed to determine the effect of scenario-based simulation training on nursing students' knowledge and performance in caring for patients after coronary artery surgery. The study was conducted on 50 students in the seventh semester of the undergraduate nursing program at the Faculty of Nursing and Midwifery, Kashan University of Medical Sciences in 2024. In this study, the training course was designed using the ADDIE systemic model (Analysis, Design, Development, Implementation, Evaluation) and structured into five phases as follows:

**Phase 1: Analysis**

At this phase, several types of analysis were conducted, including needs analysis, audience analysis, and resource analysis, based on an extensive literature review. Seven common and important issues in the care of patients after coronary artery surgery were selected for scenario writing. These included patient discharge from the operating room, hemodynamic monitoring, bleeding, cardiac tamponade, cardiogenic shock, and postoperative hyperglycemia and hypokalemia.

**Phase 2: Design**

In this phase, the educational objectives of the course were developed based on the needs assessment conducted in the previous phase.

**Phase 3: Development**

During the development phase, educational content, scenarios, and tests to assess student knowledge and performance were designed and psychometrically evaluated. To this end, clinical practice guidelines for the care of patients after coronary artery surgery were extracted based on an extensive literature review.

The scenario was written using Tanner's clinical judgment model. According to this model, nurses develop effective attention and understanding of patients through focused assessment and data collection, and then interpret and prioritize data. They also respond calmly to patient needs, plan interventions with clear and concise communication, and arrive at final conclusions through evaluation and self-analysis [23]. After the clinical scenarios were written, they were approved by three faculty members from the School of Nursing who specialize in critical care. Finally, the scenarios were reviewed and approved by the research team.

In the next stage, the necessary tools for collecting data on students' knowledge and performance were developed and integrated into the psychometric evaluation process. The opinions of 15 faculty members of the School of Nursing, nurses, and matrons of the Open Heart ICU were used to examine face and content validity. In the face validity section, the instrument items were examined for font, writing style, grammar, sentence structure, and the appropriate placement of phrases, and experts' corrective feedback was implemented. Two quantitative and qualitative methods were used to determine content validity. To qualitatively assess content validity, a group of experts was asked to identify any inappropriate, ambiguous, or overly complex statements and questions. Two coefficients of content validity ratio and content validity index were used to quantitatively examine content validity. To assess content validity, the expert group was asked to rate each question based on a three-option criterion including (1) essential, (2) useful but unnecessary, and (3) unnecessary. Finally, based on the responses, the content validity ratio was calculated using CVR formul (Fig. 1). The acceptable range based on the criteria of the Lawshe model in this study was considered by 15 experts to be 0.49. In other words, the content validity of the item is confirmed if the calculated value for each item is equal to or greater than 0.49 [24]. In the present study, the average CVR was calculated to be 77.50% for the knowledge questionnaire and 93.3% for the performance checklist.

$$\mathrm{CVR} = \frac{\mathrm{ne} - \frac{\mathrm{N}}{2}}{\frac{\mathrm{N}}{2}}$$

**Fig. 1** CVR *formul*

In this equation, **ne** is the number of experts who considered the question absolutely necessary and **N** refers to the total number of experts who commented on the question.

To calculate the content validity index, the raters commented on each of the questionnaire items for relevance, simplicity, and clarity based on a 4-point Likert scale and proceeded according to CVI formula (Fig. 2). The minimum acceptable value for the CVI index is 0.79. If an item's CVI is between 0.70 and 0.79, it needs to be modified, and if it is less than 0.70, it should be removed [25]. In evaluating the Content Validity Index (CVI), the calculated mean was 92.3% for the knowledge assessment test and 97.1% for the performance assessment checklist.

$$\mathrm{CVI} = \frac{\text{Number of experts who chose options 3 and 4}}{\text{Total number of experts}}$$

**Fig. 2** *CVI* formula

To assess the reliability of the knowledge assessment questionnaire, the Cronbach's alpha coefficient was calculated, yielding a value of 0.71. To measure the reliability of the performance evaluation checklist, the inter-rater agreement method was used with the kappa coefficient, which resulted in a value of 0.78.

The knowledge assessment questionnaire comprised 35 multiple-choice questions covering three areas of diagnosis and management of postoperative complications, hemodynamic monitoring, and nursing interventions. Of the four options, only one was correct and three were incorrect. Each correct answer was given a score of one, while incorrect answers and unanswered questions received a score of zero. The performance assessment checklist consisted of 10 questions in the two areas of hemodynamic monitoring and nursing interventions. Each student's performance on each question was rated with four scores: zero (did not do it), one (did it incompletely), two (needs guidance to complete), and three (did it independently).

### Phase 4: Implementation

To conduct the research, student sampling was performed using the convenience sampling method, after obtaining the necessary ethics code and permission for the study. The sample size was determined using sample size formula (Fig. 3) and Farahani et al. (2018) [26], with 16 participants in each group, based on a 95% confidence interval, 95% test power, and a maximum difference of 12 units between the two groups. In this study, 24 participants were included in the intervention group and 22 in the control group.

In this study, the inclusion criterion required participants to have obtained a passing score in all nursing courses prior to the internship, while the exclusion criterion was based on not attending all training and evaluation sessions. In the next stage, students were randomly assigned to two intervention and control groups using the permuted block randomization. For this purpose, six blocks of four letters, A and B, were created. Each block was assigned numerical codes from one to six. Random numbers between one and six were then selected from a random number table, and based on the selected numbers, one of the blocks was chosen. By continuing this process, a sequence of letters A and B was generated. Randomly, one of the letters was assigned as the intervention group and the other as the control group. The instruments used in this study included a demographic questionnaire, a knowledge assessment questionnaire, a performance assessment checklist, and a survey form administered at the end of the training. The demographic questionnaire included questions about age, gender, previous semester grade point average) GPA (part-time nursing experience, interest in nursing, and interest in cardiovascular topics was completed by all students prior to the start of the program. In the pre-test phase, each student's level of knowledge and performance was assessed. To assess students' knowledge levels, they were asked to answer knowledge assessment questions in an environment similar to exam session. To assess student performance, the stations for the checklist questions were simulated in the clinical skills center, and the students were tested individually at each station by an evaluator. To reduce potential bias, the evaluator was blinded at the post-test stage because he truly had no knowledge of which student was in which group. The evaluator was a critical care nurse with master science degree.

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

**Fig. 3** Sample size formula

Scenario-based training was conducted in three 2-hour sessions in the form of training scenarios. In the scenario-based training method group, the teaching area was first prepared with simulation models, the necessary equipment and tools for caring for a patient undergoing CABG surgery. This group was then trained in the form of designed scenarios. At each stage of the scenario, the students responded to the required actions for handling each situation with the guidance of the instructor. Students were able to discuss with each other and with the instructor. The instructor tried to activate problem-solving and critical thinking skills in the students. An effort was made to engage all students in the discussion by calling out their names from the list. After the scenario was completed, the instructor summarized and closed each scenario.

The training in the conventional teaching method group was provided through the traditional lecture method. The lecture structure was based on educational content which was developed in development phase. The educational content was delivered in three 2-hour sessions in the nursing school classroom with interactive approach between lecturer and students. The lecturer in was one person who is specialist in this scope. The training content, training hours, and instructor were the same in both groups. The core differences were only between the two teaching approaches(scenario based training versus lecture method).

### Phase 5: Evaluation

At this phase, the outcomes of the course were evaluated at two levels based on the Kirkpatrick model. Kirkpatrick's four-level model of evaluation is one of the models considered for educational evaluation. In this model, the first level measures the learner's immediate reaction or satisfaction with a training program, which is often assessed through survey forms. The second level measures the extent to which knowledge, skills, or objectives are achieved, typically through pre- and post-training evaluation. The third level of the Kirkpatrick model evaluates the extent to which participants apply what they have learned when they return to the workplace. This level of assessment requires observing changes in behavior over time. The fourth level evaluates the impact of training on organizational goals and outcomes as measured by the organization's key performance indicators [27].

In this research, the level of student satisfaction at the first level (reactive and emotional) was qualitatively assessed at the end of the training session. Therefore, the students were invited to write a brief reflection on their satisfaction and experiences from the training course. In the second stage (learning), the learners' level of learning was measured three weeks after the completion of the training sessions. The reason why the period of three weeks was selected for the evaluation was based on the Ebbinghaus theory. The Ebbinghaus showed that when you first learn something, the information disappears at an exponential rate (Figure Error: Reference source not found 1). It means that based on Ebbinghaus forgetting curve (Fig. 4), people forget most of the information in the first few days, and after 21 days you remember only 20% of the material, and then the rate of forgetting decreases [28]. Also, a time delay can verify the lasting effectiveness of a teaching method. However, there are various opinions about the appropriate interval time. This time should not be so long that the learner receives a lot of relevant information in other ways and it should also not be so short that the learner can remember all the pre-test answers. Typically, a time interval of 3 to 6 weeks is recommended to evaluate effectiveness [29], and this study considered a 3-week interval.

### Data analysis

Statistical software (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.) was used to analyze all data. Kolmogorov-Smirnov test was used to check the normality of quantitative variables. Given the normality of the data, parametric tests were used. Means, standard deviation, and frequency were used to describe demographic information and individual characteristics. The chi-square test was employed to examine the relationship between qualitative variables, while the independent t-test was used to compare normally distributed quantitative variables. A paired t-test was used to compare the scores before and after the intervention in each group. Analysis of covariance (ANCOVA) was used to examine the multivariate effects of changes in knowledge and performance scores. The significance level was considered to be 0.05 in all tests.

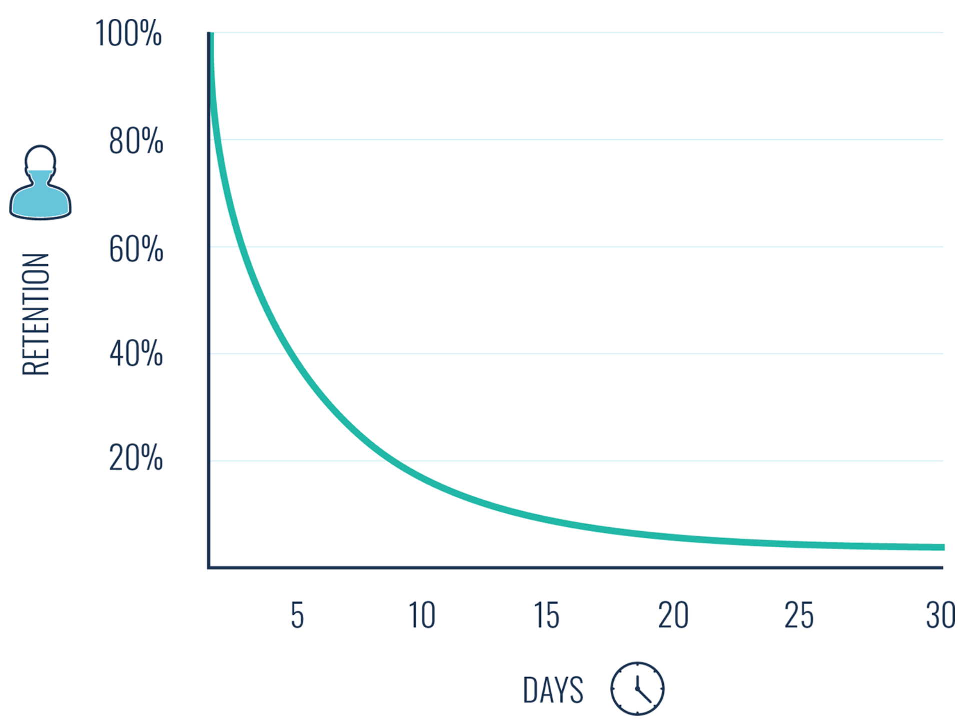


**Fig. 4** Ebbinghaus forgetting curve

**Table 1** Distribution of demographic characteristics of nursing students

| Variable | Status | Groups | | *P*–value |
|---|---|---|---|---|
| | | Control | Intervention | |
| Gender | Female | 11(50%) | 19(79.2%) | 0.063[1] |
| | Male | 11(50%) | 5(20.8%) | |
| Part-time work experience | Yes | 11(50%) | 17(70.8%) | 0.227[1] |
| | No | 11(50%) | 7(29.2%) | |
| Interest in nursing | Low | 5(22.7%) | 3(12.5%) | 0.339[1] |
| | Medium | 7(31.8%) | 13(54.2%) | |
| | High | 10(45.5%) | 8(33.3%) | |
| Interest cardiac topics | Low | 3(13.6%) | 3(12.5%) | 1 |
| | Medium | 13(59.1%) | 15(62.5%) | |
| | High | 6(27.3%) | 6(25%) | |
| Age ($\bar{X} \pm SD$) | | 22.13 ± 0.83 | 22.20 ± 1.25 | 0.821[2] |
| GPA ($\bar{X} \pm SD$) | | 16.82 ± 1.48 | 17.09 ± 1.49 | 0.543[2] |

(1) Chi Square test (2) Independent T-test

**Table 2** Mean and standard deviation of knowledge and performance scores before and after the training

| Outcome | Groups | Before training | After training | *P*–value[1] |
|---|---|---|---|---|
| Knowledge | Control | 13.5 ± 5.5 | 13.31 ± 4.27 | 0.87 |
| | Intervention | 13.16 ± 3.48 | 14.45 ± 3.93 | 0.235 |
| | P–value[2] | 0.351 | 0.806 | - |
| Performance | Control | 5.86 ± 4.27 | 10.22 ± 6.66 | 0.001 |
| | Intervention | 6.54 ± 3.96 | 14.41 ± 6.8 | 0.001 |
| | P–value[2] | 0.58 | 0.041 | - |

(1) Paired T-test (2) Independent T test

**Table 3** Mean and standard deviation of change in knowledge and performance scores after the training

| Variable | Groups | | *P*[1] | *P*[2] |
|---|---|---|---|---|
| | Control | Intervention | | |
| knowledge | -0.18 ± 5.15 | + 1.29 ± 5.18 | 0.34 | 0.301 |
| performance | + 4.36 ± 5.13 | + 7.88 ± 5.75 | 0.035 | 0.036 |

1. Paired T-test 2. Ancova test; Negative scores indicate an decrease in the score

**Table 4** Mean and standard deviation of change in knowledge and performance scores according to Part-time work

| Part-time work experience | Variable | Groups | | P–value |
|---|---|---|---|---|
| | | Control | Intervention | |
| Yes | Knowledge | -0.09 ± 5.61 | + 0.71 ± 5.63 | 0.717 |
| | Performance | + 2.64 ± 5.44 | + 7 ± 5.18 | 0.043 |
| NO | Knowledge | -0.27 ± 4.92 | + 2.71 ± 3.90 | 0.195 |
| | Performance | + 6.09 ± 4.36 | + 10 ± 6.90 | 0.158 |

**Table 5** Changes in knowledge and performance scores according to interest in nursing

| Interest in nursing | Variable | Groups | | P–value |
|---|---|---|---|---|
| | | Control | Intervention | |
| Low | Knowledge | + 0.4 ± 1.51 | + 5 ± 4.35 | 0.066 |
| | Performance | + 2.40 ± 4.93 | + 13.67 ± 8.08 | 0.046 |
| Medium | Knowledge | -0.71 ± 6.10 | -1.08 ± 4.49 | 0.881 |
| | Performance | + 4.29 ± 6.37 | + 6.08 ± 4.60 | 0.477 |
| High | Knowledge | -0.1 ± 5.97 | + 3.75 ± 5.007 | 0.164 |
| | Performance | + 5.40 ± 4.5 | + 8.62 ± 5.7 | 0.198 |

## Results

### Demographic and clinical characteristics

This study included 46 students, of whom 22 were in the control group and 24 in the intervention group. The mean age of the students was 22.2 ± 1.25. In addition, the mean of their scores was 16.82 in the control group and 17.09 in the intervention group. No significant relationship was observed between the two groups in terms of age, gender, GPA, part-time work experience, and interest in nursing and cardiac topics ($P < 0.05$) (Table 1).

The results showed that there was no statistically significant difference between the average knowledge score before training in the control and test groups ($P = 0.351$). Also after training, there was no statistically significant difference between the average knowledge score in the control and test groups ($P = 0.806$). The results showed that there was no statistically significant difference between the average performance score before training in the control and test groups ($P = 0.580$). Also the results showed that there is statistically significant difference between the two groups in performance scores after training ($P = 0.041$) (Table 2).

The results of the independent T-test showed no significant difference in the change of knowledge score between the two groups. Analysis of covariance (ANCOVA) was used to eliminate the effect of pre-test knowledge values on post-test. The results of the ANCOVA test indicated that the training groups had no effect on the change in knowledge score ($P = 0.301$). In terms of change in performance score, this score increased by 4.36 points in the control group 7.88 points in the intervention group. Based on results of the independent T-test, performance score increased significantly in both groups. ANCOVA was used to eliminate the effect of pre-test performance values on post-test. The results of the ANCOVA test showed the effect of training groups on the change in performance score ($P = 0.036$) (Table 3).

The results indicated that the only statistically significant difference between the two groups was in the increased performance of nursing students with part-time work experience ($p = 0.043$) (Table 4). Additionally, the only statistically significant difference between the two groups was found to be significant in enhancing the performance of nursing students with limited interest in nursing topics ($P = 0.046$) (Table 5). It was also observed that the only statistically significant difference between the two groups in improving the performance of nursing students with moderate interest in heart topics was found to be significant ($P = 0.022$) (Table 6).

In the content analysis of the students' writings about their satisfaction and experiences with this educational

**Table 6** Changes in knowledge and performance scores according to interest in cardiac topics

| Interest in cardiac topics | Variable | Groups | | P–value |
|---|---|---|---|---|
| | | Control | Intervention | |
| Low | Knowledge | -0.33 ± 2.51 | + 1.33 ± 1.52 | 0.382 |
| | Performance | + 4.33 ± 6.80 | + 3.67 ± 1.52 | 0.877 |
| Medium | Knowledge | -0.77 ± 5.65 | + 0.8 ± 5.77 | 0.476 |
| | Performance | + 3 ± 4.84 | + 8.13 ± 6.08 | 0.022 |
| High | Knowledge | + 1.77 ± 5.38 | + 2.5 ± 5.20 | 0.672 |
| | Performance | + 7.33 ± 4.5 | + 9.33 ± 5.85 | 0.522 |

**Table 7** Frequency of keywords in the survey form

| Keyword | Frequency (control) | Frequency (Intervention) |
|---|---|---|
| Motivation of learning | 0 | 11 |
| Improvement of reasoning skills | 0 | 8 |
| Need for guidance during training | 0 | 4 |
| Necessity of prior preparation | 5 | 9 |
| stressful method | 0 | 5 |
| Applicability of training | 5 | 15 |
| Satisfaction with the training course | 10 | 19 |
| Dissatisfaction with the training course | 9 | 3 |

course, 8 keywords were identified. The frequency of keywords is shown in Table 7. These 8 key concepts included: motivation of learning, improvement of reasoning skills, the need for guidance during training, the necessity of prior preparation, a stressful method, the applicability of training, satisfaction with the training course and dissatisfaction with the training course (Table 7). The satisfaction level with the training course was higher in the scenario-based group. Regarding this, a participant from the scenario-based group stated, "considering that we could not receive training in the post-cardiac surgery intensive care unit, participating in this course was very enjoyable for me." Some students described the scenario-based method as stressful. In this regard, a participant from the scenario-based group said, "Since my prior knowledge and skills on the subject were limited, I would experience anxiety when answering the scenario questions." Some students emphasized the need for prior preparation before attending this training course. On this topic, a participant from the scenario-based group mentioned, "I feel that if I had entered this course with prior preparation, I could have challenged my knowledge and learned more."

## Discussion

In this study, no statistically significant relationship was observed between the two groups in terms of age, gender, GPA, part-time work experience, and interest in nursing and cardiac topics, and both groups were homogeneous before the intervention. The results of the present study indicated that the performance scores of nurses in patient after coronary artery surgery increased in both the control and intervention groups following the training, with a more significant increase observed in the training group that utilized the scenario-based simulation method compared to the traditional method. In other words, the scenario-based teaching method improved students' performance to a greater extent. Zeng et al. (2024) confirmed this finding, showing a significant improvement in scenario-based group students' performance in providing necessary heart disease care [30]. Jahanbazi et al. (2022) also showed a significant increase in cardiac department nurses' performance scores after scenario training [31]. In this regard, Sabzevari et al. (2022) demonstrated that scenario-based training enhanced the performance of nursing interns in the area of pharmacotherapy [32]. Similarly, scenario-based training improved the performance of nursing students in cardiopulmonary resuscitation in the study by Habibili et al. (2020) [33]. Almomani et al. (2021) also showed that scenario-based training improved the performance of nonspecialist nurses and prepared them better and faster for ICU work [34]. However, in contrast to these findings, Sadeghi et al. (2023) found that scenario-based training did not improve the general child care skills of nursing students compared to the control group [22]. These differences may be attributed to the educational method used in each study. Thus, while our study used face-to-face scenario-based training with simulation facilities, Sadeghi's study used virtual social networks, which may have faced limitations inherent to virtual simulations.

Based on the results of the present study, although the knowledge of nursing students in the care of patients after coronary artery surgery increased in the intervention group compared to the control group, this difference was not statistically significant. Pongtriang et al. (2024) confirmed this finding, showing that while scenario-based training related to elderly care did not improve knowledge and self-confidence, it did significantly improve competence [35]. In this regard, Ho et al. (2021) found no statistically significant difference between nurses' knowledge scores in delirium management between the scenario-based and control groups [21].

In contrast, Li et al. (2024) showed that scenario-based simulation training significantly increased nurses' infection control knowledge scores [36]. Consistent with this study, Zeng et al. (2024) showed that students' knowledge improved significantly in the scenario-based training group [30]. It seems that the reason for this discrepancy is to be based on the assessment time. In two studies, student knowledge was assessed immediately after completion of the training, whereas in the present study, it was assessed after three weeks. The Ebbinghaus illustrates natural decline of acquired information over time, unless deliberate efforts are made to reinforce and preserve it. According to Ebbinghaus forgetting curve, the level of information retention is indirectly related to the time elapsed since learning, which means that information retention decreases over time [37]. The curve highlights the importance of strategies such as repetition, spaced learning, and active recall to reinforce information and improve retention [28]. Moreover, simulation in the study by Zeng et al. (2024) was based on artificial intelligence scenarios and Kolb's experiential learning model. However, in the present study, simulation was based on writing scenarios based on Tanner's clinical judgment model. Jahanbazi et al. (2022) also found that scenario-based training significantly increased cardiac nurses' knowledge scores [31]. The contradictory finding may be explained by the fact that the previous study's participants—nurses in a cardiac ward—were motivated to enhance their knowledge for work-related reasons, leading to deeper learning through continuous application. This finding is fully in line with the theory of adult education or the theory of andragogy. This theory argues that the adult group is interested in learning topics that have direct relevance and impact on their work, and that more effective and sustainable learning will be created in these topics [38]. Furthermore, based on Cimer (2012), the main reason for better learning is the nature of the topic and its difficulty level. He also illusreated that teachers' teaching style, students' learning and studying habits, students' negative feelings, attitudes towards the topic and a lack of resources are other reasons. To overcome these difficulties and make learning more effective, some strategies such as teaching through the use of visual materials, teaching through practical work, using various study techniques, teaching through connecting the topics with daily life were suggested [39].

Furthermore, the authors attribute the lack of significant improvement in knowledge scores during scenario-based training to the limited number of training sessions. Specifically, the three 2-hour sessions appeared insufficient for fostering a deep understanding of such challenging content. Consequently, achieving better learning outcomes may necessitate additional time and guidance to comprehend complex concepts effectively and promote deep, lifelong learning [40].

Mahran et al. (2019) also found that scenario-based training significantly improved the knowledge and understanding of ICU nurses and physicians about fluid therapy [41]. One of the differences between this study and the present study was the length of training. In this study, the training consisted of fourteen 45-minute sessions in which all scenarios were related to fluid balance and, in fact, knowledge was reviewed throughout the 14 sessions. It appears that deeper learning and increased knowledge scores were achieved through long and continuous training. Rigg et al. also showed that continuing education is more effective than short-term training in improving knowledge, skills, and increasing competence [42].

This study revealed that scenario-based simulation had a greater impact on performance enhancement than knowledge acquisition. Unlike passive learning methods, such as reading or lecturing, scenario-based simulation engages learners in active problem-solving, decision-making, and reflective practices that foster deeper learning. In this approach, students are not merely recipients of information delivered by the instructor; instead, they actively engage in dynamic interactions, exchanging information and receiving immediate feedback. This feedback enables learners to identify and correct mistakes, adjust strategies, and enhance their performance progressively.

Moreover, performance often depends on the ability to apply knowledge effectively rather than merely possessing it. Scenario-based simulation serves as a bridge between theoretical concepts and practical application, enhancing both decision-making and practical skills [43]. While foundational knowledge remains essential, this teaching method transforms knowledge into actionable skills, thereby improving performance outcomes more effectively.

Additionally, one possible explanation for the insignificant improvement in knowledge levels observed in this study is that all participants had successfully completed their theoretical nursing courses but had not yet entered their internship (practical training). Consequently, they possessed a relatively adequate level of knowledge on the subject, which may have limited the potential for scenario-based learning to further enhance their knowledge.

Another finding of the study was that the performance of nursing students with part-time nursing experience improved more in the scenario-based training group than in the control group. Several studies have supported this finding, showing that prior clinical experience effectively improves nurses' competence and theoretical knowledge [44, 45]. This finding is consistent with the constructivist view of learning, which argues that a learner's prior experiences form the basis for subsequent instruction and enable more effective learning [46].

The current study found no statistically significant relationship between interest in the field of nursing, specifically regarding the topic of the heart, and the levels of knowledge and performance following training. This finding aligns with the results of Salari et al. (2018), who demonstrated that interest in a field of study is not an independent predictor of academic success among nursing students [47]. However, contrasting evidence is provided by Harifa et al. (2023), who reported a direct correlation between student interest and learning outcomes in biology [48]. The discrepancy may be attributed to differences in the number of training sessions and the relative simplicity of the training topic in the latter study.

Results from this study indicated higher levels of satisfaction among participants in the scenario-based training group. This finding is corroborated by several studies, which demonstrate that scenario-based training is linked to increased positive feedback and higher satisfaction levels reported in survey forms [18, 49]. Enhanced satisfaction with the educational experience fosters greater motivation and engagement among learners. Furthermore, a positive attitude toward learning contributes to improved focus, perseverance, and effort, all of which are essential for achieving academic success [50].

### Limitations of the study

This study did not assess the long-term retention of knowledge or the transferability of skills to real clinical settings, which remains the ultimate objective of such educational interventions. Furthermore, convenience sampling from a single setting was employed in the current study. This methodology may introduce selection bias and limit the generalizability of findings to other contexts with differing cardiac programs or educational infrastructures. Nevertheless, to mitigate sample bias, random allocation was implemented.

## Conclusion

The findings of this study demonstrated scenario-based simulation training can be considered an effective method for enhancing students' performance in patient care post-coronary artery surgery in comparison with conventional training approache. However, the improvement in knowledge did not reach statistical significance.

One notable challenge in implementing simulation-based methods is the high cost associated with equipment and logistical requirements. Despite this, scenario-based simulation stands out as an innovative and cost-effective educational strategy among simulation techniques. This study utilized readily available resources and simple equipment, avoiding the need for purchasing expensive mannequins. Therefore, it is recommended that universities consider the cost-effectiveness of such training programs when planning their curricula.

### Abbreviations

| | |
|---|---|
| CABG | Coranary Artery Bypass Graft |
| ICU | Intensive Care Units |
| CICU | Cardiac Intensive Care Units |
| ADDIE | Analysis, Design, Development, Implementation, Evaluation |
| GPA | Grade Point Average |
| SPSS | Statistical Package for the Social Sciences |
| ANCOVA | Analysis of covariance |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12912-025-03148-z.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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### Author contributions

M.S & E.M collaborated to conceptualize the study, collect data, and write the initial manuscript. While M.S interpreted the findings and made critical revisions of the manuscript. H.A conducted the data analysis. All authors carefully reviewed and approved the final version of the manuscript.

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### Data availability

Data sets and/or analyses related to all phases of the present study are available upon request from the corresponding author.

## Declarations

### Ethics approval and consent to participate

The study was approved by the Research Ethics Committee of Kashan University of Medical Sciences (Ethical code NoIR.KAUMS.NUHEPM.REC.1402.081) and is conducted in accordance with the current ethical guidelines, and in accordance with the last version of the Helsinki Declaration, good clinical practice, and national regulation. Written informed consent was obtained from all participants and they were assured that all their information would remain confidential.

### Consent for publication

Not applicable.

### Competing interests

The authors declare no competing interests.

### Conflict of interest

The authors of this article report no conflicts of interest.

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