Effect of High Fidelity Simulation on Nursing Students' Knowledge and Skills Regarding Assessment and Nursing Intervention of Acute Coronary Syndrome

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Abstract

Background: ACS is a common, life-threatening condition due to decreased blood flow in the coronary arteries. Simulation is one of the approaches that could lead healthcare students to construct their knowledge and skills comprehensively within complex clinical situations. **Aim:** This study was done to assess the effect of high fidelity simulation on nursing students' knowledge and skills regarding assessment and nursing intervention of acute coronary syndrome (ACS). **Hypothesis:** nursing students who undergo high fidelity simulation program show improvement in knowledge and skills regarding acute coronary syndrome. **Design:** quasi experimental research design. **Setting:** critical care lab in faculty of nursing at Alexandria University hospital. **Subject:** Convenient sample of approximately forty critical care nursing students. **Tools**: Two tools were used in this study acute coronary syndrome assessment questioner (tool I), performance checklist about acute coronary syndrome (tool II). **Methods**: The current study was carried out on four phases; assessment, preparation, implementation and evaluation. Assessment of the baseline nursing students' knowledge and skills were done using (tool I, tool II) before the preparation of teaching program and all nursing students were received the lecture about ACS and scenario case by using human patient simulation. Assessment of nursing students' knowledge and skills was done using (tool I, II) immediately after the implementation of teaching program and scenario case by using human patient simulation. **Results:** A statistical significant improvement was found between the nursing student knowledge and skills before and immediately after application of teaching program with scenario case by using human patient simulation. **Conclusion:** The level of nursing students' knowledge and skills were general improved after application of teaching program with simulation learning strategy about ACS.

Key words: ACS, simulation, critical care nursing, knowledge, skills

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Introduction

The intensive care unit (ICU) is a stressful and high error-prone environment due to the acuity and complexity of the cases encountered. Stress in turn directly correlates with increased nursing and medical errors. In addition, critical care training in ICUs is further hindered by the difficulties in ensuring exposure of nurses' learners to a broad range of clinical situations with a risk-free method and assessing learner performance under standardized conditions one of this cases are acute coronary syndrome (ACS) (**Yang C et al 2019**).

ACS is a syndrome due to decreased blood flow in the coronary

arteries such that part of the heart muscle is unable to function properly or dies. is commonly associated with three clinical manifestations, named according to the appearance of the electrocardiogram (ECG):ST elevation myocardial infarction (STEMI, 30%), non-ST elevation myocardial infarction (NSTEMI, 25%), or unstable angina (38%) (G**rech ED et al 2003**). Coronary heart disease (CHD) is responsible for more than half of all cardiovascular events in individuals less than 75 years of age. Egypt is the most populous country in Middle East and North Africa and has one of the highest rates of the cardiovascular (CV) deaths in the region. Despite governmental primary preventive efforts, very little is known about the prevalence and characteristics of premature coronary artery disease (CAD) among Egyptian patients with Acute Coronary syndrome (ACS) (**Aljefree N et al 2015**).

ACS is a common, life-threatening condition and, in our ageing population, its incidence is likely to rise. Nurses have a crucial role in the clinical management of patients with ACS, by helping them understand their condition and care, and promoting secondary prevention (**Jarvis S& Saman S 2017**). A diagnosis of ACS should be considered in all patients presenting with ischemic symptoms. Clinical signs and symptoms of ischemia include various combinations of chest pain, upper extremity, mandibular or epigastric discomfort, dyspnea, diaphoresis, nausea, fatigue, or syncope. The pain and discomfort associated with an ACS event may occur with exertion or at rest and is often diffuse rather than localized. Pain radiating to the left arm, right shoulder, or both arms is more likely to be associated with MI, as is pain associated with diaphoresis. It is essential to evaluate patients with suspected ACS immediately to prevent potentially fatal clinical consequences **Morton P (2015)**.The current emergency department pathways for assessing and managing patients who may have ACS rely on 4 main diagnostic tools: clinical history, ECG results, levels of cardiac markers, and the results of stress testing. On the basis of the initial information, patients are assigned to one of 4 categories: a non-cardiac diagnosis, chronic stable angina, possible ACS, or definite ACS (**Jarvis S& Saman S 2017), (Morton P 2015**).

In-hospital mortality from ACS has fallen from 20% to around 5% over the past 30 years, which may be due to better drug therapies; prompt recognition and treatment protocols. Timely management is crucial to reduce the risk of mortality and further cardiac events. Treatment aims to ease symptoms, improve coronary artery blood flow and prevent complications. Immediate management, combined with cardiac rehabilitation and secondary prevention, can improve patients' outcomes and quality of life. When a patient presents with cardiac symptoms, labs are drawn and a 12-lead ECG is completed. Through these labs and ECG interpretation, the healthcare team can obtain more detailed clinical information which will determine the sub-condition of ACS **Bremner et al (2015).** Thereafter, more specific and appropriate treatment can then be initiated. The primary goal is to stop myocardial ischemia and restore blood flow to the myocardium. In part, this can be done with certain types of medications such as Oxygen, aspirin, nitrates, analgesics, beta-blockers, ACE-inhibitors/ARBs, antiplatelet and fibrinolysis (**Malik M 2013**).

Nurses have a key role in: Facilitating and administering prompt treatment to patients with ACS; Promoting the swift recognition of deterioration; providing holistic care and

psychosocial support; Encouraging patients to engage in healthy secondary-prevention behaviors. Nursing practice is intellectually and emotionally challenging because it requires quick judgments and responses to life-threatening conditions. Nursing students experience _reality shock 'while learning in the clinical environments (**Jarvis S, Saman S 2017**). Advanced technology like simulation based learning is used for improving active learning, participation and communication with students. It helps student engagement in active learning, faculty-student interaction and diverse experiences (**Durham C, Alden K 2018, Lewis R et al 2012**). Simulation is one of the approaches that could lead nursing students to construct their knowledge and skills comprehensively within complex clinical situations. Simulation in nursing is becoming a popular way of enhancing the skills of nursing students (**Silva M et al 2019).**

High Fidelity Simulation refers to a simulation experience gained from a simulator or a manikin that can be accessed and manipulated with computer system to produce a realistic way in nursing student intervention and control outward appearance. The simulation experience aims to imitate reality while offering skills-based experience and provides the student with the opportunity to be involved in patient experience before they have the experience at the bedside. It is an interactive scenario where the students actually get to use their skills and have hands on experience. Simulations take place in a safe, controlled, nonthreatening environment. The realistic hands-on experience enhances the students' knowledge before they take care of real patients (**Barstow C& Rice M 2017).**

Practice and successful implementation of critical care nursing skills regarding acute coronary syndrome during a simulation can have a positive impact on nursing students' performances in assessment and intervention of patient with acute coronary syndrome and increase students' confidence in clinical settings .Simulation makes the unfamiliar familiar, improving team dynamics and clinical competencies providing nursing students the experience and confidence to act quicker and more effectively and may result in improved patient outcomes (**Lewis R et al 201**2). National Organizations such as the National League of Nursing (NLN) provide standards for nursing education and endorse simulation as a proven method to prepare students for a complex health care environment where they must think critically, act quickly, and communicate effectively with health team members to prioritize safe, effective patient care actions in a nonthreatening, controlled setting. Therefore the study was done to assess the effect of high fidelity simulation on critical care nursing students' knowledge and skills regarding assessment and nursing intervention of acute coronary syndrome (ACS)

Aim of the study:

This study was done to assess the effect of high fidelity simulation on critical care nursing students' knowledge and skills regarding assessment and nursing intervention of acute coronary syndrome (ACS)

Research hypothesis:

Nursing students who undergo high fidelity simulation program show improvement in knowledge and skills regarding acute coronary syndrome.

Subject and methods:

Research design

A quasi-experimental research design (pretest posttest research design) was used in this study

Setting

This study was conducted in critical care nursing lab of Faculty of Nursing at Alexandria Main University.

Subject:

Convenient sample of approximately forty critical care nursing students were enrolled in this study during the period of data collection from October (2019) to January (2020).

Tools: Two tools were used in this study:

Tool one: "Acute Coronary Syndrome Assessment Questionnaire"

This tool was developed by the researcher after reviewing the related literature (Jarvis S& Saman S 2017, Morton P et al 2015, Lewis R et al 2012).and used to assess the baseline critical care nursing students' knowledge regarding ACS. This tool consists of thirty questions. Two types of questions were used; multiple choice questions and true /false questions. The total number of multiple choice questions was twenty three and the total number of true/false questions was seven. These questions covering the theoretical aspects of ACS in ICU which focus on categories namely:

Definition; which includes six questions, four of them is multiple choice questions and two true /false questions.

Etiology and assessment signs and symptom; which includes six questions; three of them are multiple choice questions.

Diagnostic evaluation; which includes six questions; five of them are multiple choice questions and one true /false questions.

Medical management and nursing intervention and complication; which includes eleven questions, eight of them are multiple choice questions and three true/false questions

The score of each question was assigned as follows:

Correct answer = score one

Incorrect answer = score zero

The cut point for "Good" is > 75% of the total score, "fair" is between 50% to less than 75% of the total score, and "poor" is less than 50 % of the total score.

- In addition to critical care nursing students' characteristics which include demographic data such as age, marital status and previous attendance of in-service education /training regarding ACS.

Tool two: "Performance checklist for assessment and nursing intervention of ACS":

This tool was developed by the researcher after reviewing the related literature (Durham C& Alden K 2018, Silva M et al 2019). It used to assess the baseline critical care nursing students' skills regarding ACS by using human patient simulation. It consists of four items namely; Patient-nurse relationship, Symptom recognition, Assessment, and Nursing interventions of ACS

Score for each item was assigned as follows:

Correct steps: perform the step according to the standard procedure or guidelines equal score two

Incorrect steps: unable to perform the step according to the standard procedure or guidelines equal score one

Not Done: step or skill not performed equal score zero.

Method

- Permission to conduct the study was obtained from the faculty of nursing after explanation of the aim of the study.

- "Acute coronary syndrome Assessment Questionnaire" (Tool I) was developed by the researcher based on reviewing the related literature (Jarvis S& Saman S 2017, Morton P et al 2015, Lewis R et al 2012)

- "Performance checklist for assessment and nursing intervention of ACS" (Tool II) was developed by the researcher based on reviewing the related literature (Durham C& Alden K 2018, Silva M et al 2019).

- The ACS teaching program (lecture and case scenario about ACS) were developed by the researcher based on reviewing the related literature (Lewis R& Strachan A 2012, Silva M et al 2019, Barstow C et al 2017)

- All tools and ACS teaching program were tested for content validity by five experts in the fields of critical care and emergency nursing, and nursing education and the necessary modification were done accordingly.

- **A pilot study** was conducted on four critical care nursing students to test all tools and teaching program for the clarity, objectivity, feasibility, then necessary modifications were carried out and the results were excluded from the study.

- All tools (tool I, II) were tested for reliability by using Cronbach's coefficient alpha (r= 80, 86% respectively) which is acceptable.

Data Collection:

- The current study was carried out on **four phases**; assessment, preparation, implementation and evaluation phases.

I. Assessment phase:

- Assessment of the baseline critical care nursing students' knowledge was done using pretest "Acute Coronary Syndrome Assessment Questionnaire" (tool I)

- Assessment of the baseline critical care nursing students' skills on simulation manikin was done using pretest "Performance checklist for assessment and nursing intervention of ACS" (tool II).

Preparation phase:

- ACS teaching program (lecture and scenario case about ACS) was developed by the researcher based on reviewing the related literature (Lewis R& Strachan A 2012, Silva M et al 2019, Barstow C et al 2017) and the data which was obtained as a result of the assessment phase**.** It includes the following components:

1 - **General objective**:-

- By the end of teaching program the critical care nursing students' knowledge and skills were improved regarding assessment and nursing intervention of ACS.

2- **Intended Learning Outcomes (ILOS):-**

- By the end of teaching program the critical care nursing students' were able to:

Knowledge and understanding:

• Define ACS in critically ill patients.

• Identify the etiology of ACS in ICU.

• Discuss the nursing intervention for critically ill patients suffer from acute coronary syndrome.

• Recognize treatment suitable for ACS in critically ill patient.

Intellectual capabilities:

• Compare between the different types of unstable angina.

• Differentiate between the ST elevation MI and Non-ST elevation MI.

Professional and practical skills:

• Assess critically ill patients suffering from ACS in ICU.

• Implement nursing intervention for critically ill patient suffering from ACS.

The Contents of the program:

- The theoretical contents was focus on; lecture about definitions, risk factors, hallmark features, pathophysiology, types, diagnosis, medical management and nursing intervention of ACS.

- The practical content was focus on scenario case about assessment and nursing intervention of ACS in ICU.

III. Implementation phase for simulation based learning group:

- For the theoretical content:

The program was implemented four times for the four subgroup of nursing student. All students were divided into small groups ten in each. All groups were exposed to the lecture by PowerPoint presentations about ACS.

- For practical contents:

1- Presimulation student preparation:

Instructions to the each subgroup of students should be:

- Prior to simulation, complete assigned readings, case scenario.

- Prompt to your assigned simulation time.

- Address and treat mannequin as though a patient.

2-Presimulation briefing

- Each subgroup of students is oriented to the mannequin and the learning environment. Then given case scenario included written clinically based patients' information related to ACS physical examination, diagnostic test and medical management with some

incomplete, uncertain or insufficient information to better reflecting the reality of clinical practice. Students are encouraged to uncover and examine and touch the mannequin, listen to the breath sounds, assess the chest pain, palpate the peripheral pulse, spo_2, blood pressure, temperature, skin color and ECG. The voice of the mannequin is demonstrated. It is important to remind students that they are to treat the mannequin as they would a patient in the scenario.

3- Intrasimulation:

Student in each subgroup were asked to assess, begin primary intervention for chest pain, placed patient in high fowlers position, assess vital signs and cardiovascular status and maintain cardiac monitoring, establish an IV access route, administer analgesic (Morphine) and anti dysrhythmic as prescribed, apply oxygen therapy and prepare patient for 12-lead ECG and interpreted then evaluate the effectiveness of these interventions for patient with signs and symptoms of acute coronary syndrome by using human patient simulator.

4-Postsimulation:

The researcher debriefing the simulation to correct any misinformation or improper practice techniques the students may demonstrate.

IV. Evaluation phase:-

- Reassessment of nursing students' knowledge was done using the posttest "Acute coronary syndrome Assessment Questionnaire" (tool I) immediately after finishing the theoretical content to determine the effect of teaching program on the students' knowledge regarding ACS.

- Assessment of nursing students' skills was done using the posttest "Performance checklist for assessment and nursing intervention of ACS" (tool II) to determine the effect of simulation learning strategy on the students' skills regarding ACS in critically ill patients.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent. Quantitative data were described using range (minimum and maximum), mean and standard deviation. Significance of the obtained results was judged at the 5% level.

The used tests were

1 - Student t-test

For normally distributed quantitative variables, to compare between two studied groups

2 - Paired t-test

For normally distributed quantitative variables, to compare between two periods

3 –Wilcoxon signed ranks test

For abnormally distributed quantitative variables, to compare between two periods

Ethical considerations:

- The researcher explained to the critical care nursing students the objectives of the study orally, additionally to the written explanations on the covering letter of questionnaire.

- Critical care nursing students were assured about the confidentiality of the data collected and the right to refuse to participate in the study.

Results

The aim of this study is to determine the effect of simulation on critical care nursing students' knowledge and skills regarding the assessment and nursing intervention of acute coronary syndrome.

To fulfill this aim the current study results presented in the following order:

Part I: studied critical care nursing students' characteristics

Table (1): shows the distribution of the studied critical care nursing students according to their characteristics. This table indicates that more than two third (70%) of studied nursing students aged between 20 to less than 25 years old and single. Moreover, the majority of them (87.5%) of nursing students' did not attend education/training program about ACS.

Part II: studied critical care nursing students' level of knowledge.

Part II: studied critical care nursing students' level of knowledge before and after application of teaching program about ACS

Table (2): demonstrates distribution of the studied critical care nursing students' level of knowledge before and after application of teaching program about ACS. It was found that the more than two third of nursing students (70%) had poor level of knowledge before application of teaching program about ACS. Moreover, all of the nursing students (100%) had good level of knowledge after application of teaching program about ACS.

From this table, it can be noted that there are statistical significant differences between the nursing students pretest and posttest level of knowledge after application teaching program about ACS.

Table(3) presents the mean score percentage of the studied critical care nursing students' level of knowledge before and immediately after application of teaching program about acute coronary syndrome. It was observed that there are statistical significant differences between the nursing students' level of knowledge before and after application of teaching program in relation to definition, etiology ,assessment, diagnostic evaluation , medical , nursing intervention and complication of ACS ($p<0.001$**).

Part III: studied critical care nursing students' level of performance for their skills after application simulation based learning regarding ACS

Table (4): illustrates distribution of the studied critical care nursing students' level of performance for their skills before and after application of simulation based learning regarding ACS. It was found that more than two third of nursing students (70%) had poor and one third (30%) had fair level of performance before application of simulation based learning. Moreover all of nursing students (100%) had good level of performance for their skills after application of simulation based learning about ACS.

From this table, it can be noted that there are statistical significant differences between critical care nursing students' level of performance for their skills before and after application of

simulation based learning about ACS (P<0.001**).

Table (5): explain the mean score percentage of the studied critical care nursing students' level of performance for their skills after application of simulation based learning regarding ACS.

It was found the lowest mean score percentage of nursing students' level of performance for their skills before application of simulation based learning in relation to patient preparation (45.18 ± 17.82) While that the highest mean score percentage of nursing students' level of performance for their skills after application simulation based learning in relation to ECG (99.72 ± 1.23)

the same table revealed that a statistical significant differences between nursing students level of performance before and after application of simulation based learning in relation to patient assessment , preparation , oxygen therapy, perform and interpret ECG and drug administration as order and patient condition (P<0.001**).

Part IV: Relationships

Table (6): describes relationship between the studied nursing students' level of knowledge regarding ACS and their characteristics. It was observed that there are no statistical significant differences between the nursing students' level of knowledge before and after application of teaching program regarding ACS and their characterizes

Table (7): illustrates relationship between the studied nursing students' level of performance for their skills regarding ACS and their characteristics. It was found that there are statistical significant differences between the nursing students' level of performance before application of simulation based learning regarding ACS and their different age.

Table (1): Distribution of the studied critical care nursing students according to their characteristics

Nursing students' characteristics	No.	%
Age (Years)		
< 20 years	12	30.0
20: < 25 years	28	70.0
Marital status		
Single	28	70.0
Married	12	30.0
Attendance of training courses about ACS		
Yes	5	12.5
No	35	87.5

Table (2): Distribution of the studied critical care nursing students' level of knowledge before and after application of teaching program about ACS (n = 40)

Students' Knowledge regarding ACS	Study			
	Pre		Post	
	No.	%	No.	%
Poor	28	70.0	0	0.0
Fair	12	30.0	0	0.0
Good	0	0.0	40	100.0
P. value	**<0.001***			

p: p value for **Wilcoxon signed ranks test** for comparing between pre and post
*: Statistically significant at $p \leq 0.05$

Table (3): The mean score percentage of the studied critical care nursing students' level of knowledge before and immediately after application of teaching program about acute coronary syndrome (n = 40)

Nursing students' knowledge regarding ARDS	Study			
	Pre	Post	t	P. value
	Mean ± SD.	Mean ± SD.		
Definition	41.88 ± 19.93	91.25 ± 13.34	13.584*	<0.001*
Etiology and assessment	45.00 ± 25.65	97.92 ± 7.72	12.554*	<0.001*
Diagnostic evaluation	41.50 ± 23.27	85.0 ± 9.87	10.435*	<0.001*
Medical and nursing intervention	30.0 ± 21.96	96.94 ± 7.95	18.094*	<0.001*
Complications	46.67 ± 39.62	92.50 ± 11.91	7.170*	<0.001*
Total	**39.83 ± 14.34**	**93.50 ± 5.39**	21.868*	<0.001*

t: Paired t-test
p: p value for comparing between pre and post
*: Statistically significant at $p \leq 0.05$

Table (4): Distribution of the studied critical care nursing students' level of performance for their skills after application of high fidelity simulation based learning regarding ACS (n = 40)

Level of Performance	Study			
	Pre		Post	
	No.	%	No.	%
Poor	28	70.0	0	0.0
Fair	12	30.0	0	0.0
Good	0	0.0	40	100.0
P. value	**<0.001***			

p: p value for **Wilcoxon signed ranks test** for comparing between pre and post
*: Statistically significant at $p \leq 0.05$

Table (5): The mean score percentage of the studied critical care nursing students' level of performance for their skills after application of high fidelity simulation based learning regarding ACS (n = 40)

Performance checklist	Study		t	P. value
	Pre	Post		
	Mean ± SD.	Mean ± SD.		
Assessment	36.88 ± 12.48	99.38 ± 1.90	30.293*	<0.001*
Patient preparation	45.18 ± 17.82	97.32 ± 4.77	17.868*	<0.001*
Oxygen therapy	40.0 ± 49.61	91.67 ± 14.62	6.125*	<0.001*
ECG	22.92 ± 25.60	99.72 ± 1.23	18.732*	<0.001*
Drugs administrated as doctor order	0.0 ± 0.0	85.0 ± 36.16	14.866*	<0.001*
Total mean score	**34.09 ± 19.02**	**97.86 ± 2.82**	20.926*	<0.001*

t: Paired t-test
p: p value for comparing between pre and post
*: Statistically significant at $p \leq 0.05$

Table (6): Relationship between the studied nursing students' level of knowledge regarding ACS and their characteristics

Nursing students' characteristics	Mean %score of knowledge	
	Simulation group	
	Pretest	Post-test
	Mean ± SD.	Mean ± SD.
Age		
< 20 year	42.22 ± 14.45	91.11 ± 7.83
20: < 25 year	38.81 ± 14.44	94.52 ± 3.65
t(p)	0.685 (0.498)	1.444 (0.172)
Marital status		
Single	41.67 ± 15.19	92.86 ± 6.13
Married	35.56 ± 11.58	95.00 ± 2.66
t(p)	1.387(0.177)	1.158(0.254)
Attendance of training courses about ACS		
Yes	36.67 ± 15.46	96.0 ± 2.79
No	40.29 ± 14.36	93.14 ± 5.60
t(p)	0.523(0.604)	1.113(0.273)

t: Student t-test
p: p value for association between different categories

Table (7): Relationship between the studied nursing students' level of performance for their skills regarding ACS and their characteristics

Nursing students' characteristics	Mean %score of performance Simulation group	
	Pretest Mean ± SD.	Post-test Mean ± SD.
Age		
< 20 year	21.97 ± 14.74	97.73 ± 2.70
20: < 25 year	39.29 ± 18.46	97.92 ± 2.92
t(p)	3.147*(0.004*)	0.198(0.844)
Marital status		
Single	30.32 ± 18.63	97.99 ± 2.90
Married	42.88 ± 17.60	97.58 ± 2.72
t(p)	1.984(0.055)	0.418(0.678)
Attendance of training courses about ACS		
Yes	48.0 ± 14.06	99.27 ± 1.63
No	32.10 ± 18.95	97.66 ± 2.91
t(p)	1.797(0.080)	1.202(0.237)

t: Student t-test
p: p value for association between different categories
*: Statistically significant at $p \leq 0.05$

Discussion

Chest pain is a frequently encountered emergency room presentation, of which about 15% of cases are due to acute coronary syndromes (**Barstow C et al 2017**). Critical care nursing students have limited opportunities to participate in emergent situations. Simulation-based education has been shown to enhance patient outcomes by teaching these high acuity low occurrence (HALO) presentations in a safe environment. Simulation allows students to be immersed in critical care scenarios, requiring them to be active participants identifying pertinent changes in patient status and intervening appropriately, in a timely manner. Therefore this study was carried out to assess the effect of simulation on critical care nursing students' knowledge and skills regarding assessment and nursing intervention of acute coronary syndrome (ACS)

Critical nursing students' knowledge regarding ACS:

Acute coronary syndrome (ACS) is a syndrome (set of signs and symptoms) due to decreased blood flow in the coronary arteries such that part of the heart muscle is unable to function properly or dies (**Yang C et al 2019**). A key role for the critical care nurse is early detection and prevention of ACS. Evidence suggests that lack of education is a major reason for poor recognition rates by nurses and other health care workers. Therefore, with respect to ACS it is essential for critical care nursing students to be knowledgeable of risk factors, assessment tools and protocols, and preventive strategies.

Results of the current study revealed that more than two third of nursing students had poor level of knowledge before application of teaching program about ACS. Moreover, all of the nursing students had good level of knowledge after application of teaching

program about ACS because of insufficient knowledge and minimal educational emphasis on ACS in nursing schools, faculty of nursing, absence of teaching materials.

(**Fares S, Maghraby M , EL-shafiey O & Mehany M 2019**) supported the current study result, they found that the total score of nurses' knowledge and practice of the nurses before implementation of the educational program, was poor scores regarding total items of assessment of ACS.

Results of the present study revealed that a statistical significant differences between the pretest and post test critical care nursing student level of knowledge after application of education program about ACS. The same result was found in the study of (**Fares S, Maghraby M , EL-shafiey O & Mehany M 2019**) found that a statistically significant improvement in nursing staff knowledge and practice after implementation of an educational program.

These findings are in the line with another study conducted by (**Logan S 2016**) which suggested the significant difference between the scores of the pretests and the scores of the posttests with P=.00. The significant difference in the mean scores of pretests and posttests could be explained by the fact the positive effect of high-fidelity simulation on the students' knowledge between the pre and post-tests. These results supported (**Jeffries 2017**) conclusion that high-fidelity simulation shows promise as an essential teaching strategy for nursing students.

Critical nursing students' skills regarding ACS:

In practice-based healthcare professions, methods of teaching and learning focus on enabling students to use the clinical knowledge and skills. Critical care nursing students need to learn how to apply classroom learning in the clinical context. Human patient simulation help the educator to achieve of these outcomes as it uses active learning. Results of the current study revealed that more than two third of nursing students had poor level of performance before application of simulation based learning. Moreover all of nursing students had good level of performance for their skills after application of simulation based learning about ACS because the simulations take place in a safe, controlled, nonthreatening environment. The realistic hands-on experience enhances the students' knowledge and skills before they take care of real patients.

These findings are in the line with another studies conducted by (**Silva M, Passos P, Lemos T, Marino B, Dias T et al 2019**) which suggested the effectiveness of human patient sumilation on clinical skill performance of healthcare practitioners in the post-test was better than in the pretest. More than 66.0% of the professionals achieved better results in the post-test in the first phase and 78.0% in the second phase. There was a significant improvement in 8 out of the 10 questions with statistical significance ($p < 0.05$) in the first phase. It shows that, after training, professionals had an increase in the theoretical and practical domain regarding managing ACS patients, which contributes to better use of these lessons in clinical practice.

Relationship between nursing students' knowledge and skills regarding ACS and their characteristics

Few papers have addressed the predictive relationship between the

demographic variables such as; age, marital status, and attendance to training program about ACS and nursing students' level of knowledge and skills. The result of the current study revealed that no statistical significant differences between the nursing students' level of knowledge and their age, marital status and pervious training about ACS. (**Dolatabadi A , Yousefian sh , Shojaei M , Hatamabadi M , Shahrami A ,Kashani 2016**) supported the result of the current study they found no significant difference in the level of nursing students' knowledge regarding ACS after application of simulation based learning and their different age, marital status and attendance to training program about ACS

Result of the present study revealed that significant relationship between level of performance regarding ACS and their different age. This may be attributed to past experience of student may had an association with skills attainment. In contrast to the finding of the current study, (**Tubaishat A, Tawalbeh L 2018**) found that no statistically significance difference in the level of nursing students' performance regarding ACS after application of simulation based learning and their different age. The use of simulation-based education has increased gradually in recent years and it has been considered an important method to improve nursing students' skills, patient safety and to enable team work practice especially in critical care units. It is a student-centered learning process that enables students to build their own knowledge from mistakes.

Conclusion:

The present study highlights the critical care nursing knowledge and skills regarding ACS Based on the results of this study, it can be concluded that:

- The level of critical care nursing students' knowledge and skills were general improved after application of teaching program with simulation learning strategy about ACS.
- A statistical significant differences in study group level of skills and their age

Recommendations:

Based on the findings of the current study, the following recommendations can be suggested:

- Consider further studies about exploring the effect of simulation based learning on the nursing students' clinical judgment and decision making
- Prevention, assessment and early detection of ACS in critically ill patients should be integrated in the undergraduate courses to equip the students with the necessary knowledge and skills that enable them for identifications of ACS in the ICUs.

Conflict of interest

There were no conflicts of interest.

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