

Effect of an Intervention Protocol regarding Safety Measures on Knowledge, Practices and Attitude of Nurses Caring for patients undergoing cardiac catheterization.

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Abstract

Background: Ensuring patient safety is a fundamental aspect of healthcare delivery across all settings. Identifying any deficiencies in care and enhancing nurses' awareness of their pivotal role are critical in saving patients' lives. **This study aims** to assess the impact of an intervention protocol focused on safety measures, with a focus on knowledge, practices, and attitudes of nurses caring for patients undergoing cardiac catheterization. **Design:** A quasi-experimental research design with a pre/post-test approach was employed for this study. **Setting:** The study was conducted within the cardiac catheterization unit at Benha University Hospital, which is affiliated with Benha University, located in Qalyubia Governorate, Egypt. **Sample:** A convenience sample of 40 cardiac nurses of both genders was included in the study. **Tools:** Three distinct tools were employed: I. A structured interview questionnaire to assess nurses' knowledge concerning safety measures. II. A safety measures observational checklist to evaluate nurses' practical implementation of safety measures. III. A safety attitude questionnaire to gauge nurses' overall attitude towards safety. **Results:** Following the implementation of the intervention protocol, significant positive outcomes were observed: A highly statistically significant correlation between total knowledge and attitude among the studied nurses ($p \leq 0.001$). A statistically significant correlation between total practices, total knowledge, and attitude among the studied nurses ($p \leq 0.05$). **Conclusion:** The study's findings indicate a substantial improvement in nurses' overall knowledge, practices, and attitude concerning cardiac catheterization and safety measures immediately post-intervention protocol. **Recommendations:** To uphold patient safety and quality care, it is recommended that nurses working in cardiac catheterization units actively engage in continuous educational and training programs. These initiatives are crucial for updating nurses' knowledge and enhancing their practical skills with respect to safety measures concepts. Such ongoing professional development ensures that nurses remain current and competent in providing safe care for patients undergoing cardiac catheterization.

Keywords: Attitude, Cardiac Catheterization, Knowledge, Practices, Safety measures

Introduction

Cardiac catheterization (CC) is the gold standard for identifying, assessing, and treating heart conditions (Shaik, et al., 2020). Using a procedure called cardiac catheterization, a cardiologist can learn more about the pattern of blood pressure and blood flow inside the heart (Sameen, 2018).

Surgeons can get a close-up view of the arteries leading to the heart through catheter operations. Additionally, they enable them to fix structural issues that result in erratic heartbeats, tiredness, and other potentially fatal symptoms (Hansmann et al., 2020).

Cardiac catheterization is an invasive technique which may lead to several major and

minor complications which may contribute to morbidity and mortality. Early diagnosis of problems and appropriate treatment are logically related to taking action to receive timely care, hence reducing further complications. (Wankhede & Biradar, 2019).

Patient safety, which is defined as the avoidance of causing injury to patients while providing healthcare services, is the cornerstone of high-quality treatment and necessitates knowledge and abilities in numerous fields. A significant global public health concern is patient safety. Sometimes when people receive medical treatment, mistakes in the care may cause serious injury, such death, disability, or extra protracted therapy. (El-Hosany et al., 2019).

As a result of the nature of their work, which entails ongoing patient monitoring and care coordinating, nurses play a significant role in ensuring patient safety. Through the use of established infection control standards and maintaining aseptic technique during the insertion of cardiac catheters, nurses play a critical role in the prevention of cardiac catheterization problems (Rahman et al., 2020)

Preserving safety precautions during CC is essential for the early detection and management of problems. Nurses who can quickly spot issues are best positioned to initiate crucial action and enhance patient outcomes. Thus, the mortality and morbidity rates for patients undergoing this operation in the cardiac catheterization unit might be reduced by nurses who are skilled in patient care during CC. (Coomes et al., 2020).

Improving nurses' knowledge results in nurses' high self-efficacy when providing nursing management to patient undergoing cardiac catheterization. (Thapa, & Neupane, 2018). Compliance with safety measures is crucial, particularly in critical care settings like cardiac catheterization units. The nurse in this unit must adhere to safety precautions to safeguard patients from healthcare risks and to safeguard themselves from workplace risks (Ebekozi et al., 2020). As a result, developing nursing care standards for patients having cardiac catheterization is empirical.

Significance of the study:

Since the 1960s, cardiovascular disorders have had the highest morbidity and mortality rates worldwide, and cardiac catheterization is one of the most common diagnostic procedures for these conditions (Susan & Erikas, 2019). In Egypt, medical mistakes are the third biggest cause of death. Due to hazardous care, 134 million adverse events take place in hospitals each year, leading to 2.6 million fatalities (World Health Organisation, 2019). Averaging 1200 patients are hospitalised yearly to the cardiac catheterization unit at Benha University Hospital, according to records from that facility (University Hospital Statistical Office, 2021).

Nursing care for patients undergoing cardiac catheterization involves experience

and knowledge of the kinds of problems that are typically present. In order to provide safe and appropriate care and enhance both mental and physical health, nurses should combine their knowledge and abilities before to, during, and after cardiac catheterization (Abo El-Ata et al., 2020). In order to evaluate the effect of safety measures intervention protocol on the knowledge, practises, and attitude of nurses caring for cardiac catheterization patients, this study was carried out.

Aim of the Study

The purpose of this study was to evaluate the effect of intervention protocol regarding safety measures on knowledge, practices and attitude of nurses caring for patients undergoing cardiac catheterization

Research Hypotheses

Four hypotheses were evaluated in order to achieve the study's objectives:

- H1:** There will be a significantly improvement on nurses' knowledge post implementing safety measures' intervention protocol.
- H2:** There will be a significantly improvement on nurses' practices post implementing safety measures' intervention protocol.
- H3:** There will be a significantly improvement on nurses' attitude post implementing safety measures' intervention protocol.
- H4:** There will be a highly statistically significant Correlation between total knowledge, practices and attitude among the studied nurses immediately post safety measures' intervention protocol implementation.

Subject and Methods

Research Design

In order to accomplish the goal of this study, a quasi-experimental research design The research design employed in this study was a quasi-experimental pre/post-test design. Quasi-experimental designs are utilized to establish relationships between an independent variable (in this case, the Safety Measures Intervention Protocol) and dependent variables (knowledge, practices, and attitude of nurses caring for patients undergoing cardiac catheterization).

Unlike a true experimental design, where randomization is a key element, quasi-experiments do not rely on random assignment of participants to different groups. Instead, non-random criteria are used to categorize participants into different conditions. This can be particularly useful when ethical or practical considerations prevent the use of randomization.

The independent variable in this study was the Safety Measures Intervention Protocol, which refers to the specific intervention aimed at enhancing safety measures. The dependent variables were the knowledge, practices, and attitude of nurses responsible for the care of patients undergoing cardiac catheterization. These variables were measured to assess the impact of the intervention on the nurses' knowledge, practices, and attitude.

By utilizing a quasi-experimental design, the study was able to examine the effects of the intervention on the dependent variables without resorting to randomization. This approach allowed the researchers to work within the ethical and practical constraints of the study setting. The choice of this design was advantageous in this context, enabling the investigation of the relationship between the intervention and the outcomes of interest in a real-world healthcare setting (Reichardt, 2019).

Research Setting

The current study was conducted in cardiac catheterization unit, at Benha University Hospital, affiliated to Benha University at Qalyubia Governorate, Egypt. It locates on the first floor of the medical building and has four rooms: a nurse's room, a doctor's room, a room for preparing patients and a room for recovery. The unit has two cardiac catheter laboratories, each with its own equipment and X-ray equipment.

Sampling

The study's target group was a convenience sample of forty nurses from both sexes who agreed to take part in the study and were employed in the previously mentioned setting at the time of data collection.

Tools for Data Collection

Three tools were utilized to gather data in order to achieve the study's goal.

Tool I: Structured Interviewing Questionnaire:

This tool was adapted from **Elgazar, et al, 2020** to assess nurses' knowledge regarding safety measures in cardiac catheterization unit and consisted of two parts:-

Part I: The nurses' personal data:

This part aimed to identify nurses' personal data and consisted of their age, sex, educational level, marital status, years of experience and number of training courses related to safety measures in the cardiac catheterization unit.

Part II: The nurses' knowledge Assessment:

This part divided into knowledge related to nursing management regarding cardiac catheterization and knowledge about safety measures in cardiac catheterization unit. It contains (30) questions which divided as: Nurses' general knowledge about cardiac catheterization (8 questions), Nurses' knowledge about the role of nurses before, during and after cardiac catheterization (11 questions), Nurses' knowledge about patient' safety measures (4 questions), Nurses' knowledge about environmental safety measures (4 questions) and Nurses' knowledge about infection control measures (3 questions).

Scoring System: The scoring system operated as follows: For each correct response, a single point was awarded, while an incorrect response received zero points. The general knowledge scores ranged from 0 to 30. These scores were later transformed into percentages and categorized into two groups: a satisfactory level of knowledge (achieving a score $\geq 80\%$ or ≥ 24 points) and an unsatisfactory level of knowledge (scoring $< 80\%$ or < 24 points).

Tool II: Safety Measures' Observational Checklist:

The observational checklist, inspired by the work of Burns et al. (2020) and Wasserman et al. (2018), was employed to assess nurses' adherence to safety measures within the cardiac catheterization unit. The checklist encompassed three primary components:

A. Nurses' Practices for Patient Safety throughout Cardiac Catheterization Phases: This section involved various nursing practices in different phases of the cardiac catheterization procedure, which included:

- Pre-catheterization nursing practices (13 steps)
- Intra-catheterization nursing practices (5 steps)
- Post-catheterization nursing practices (15 steps)

B. Nurses' Safety Measures Practices for Infection Control: This segment focused on measures to shield nurses from infection risks and comprised the following categories:

- Personal hygiene (5 steps)
- Cleaning and disinfection (2 steps)
- Healthy behavior (3 steps)
- **Proper disposal of solid objects (5 steps)**

Mechanical safety (3 items), Thermal safety (2 items), Electrical safety (1 item), Bacteriological safety (1 item) and Chemical safety (2 items).

Scoring system: Practice score for each practice was given as follows: 1 = Done and 0 = Not done. Total score 0 - 57 score. The total practices were considered satisfactory if the score of the total practices $\geq 80\%$ (≥ 46 score). The total practices were considered unsatisfactory if the score of the total practices $< 80\%$ (< 46 score).

Tool III: - Safety Attitudes Questionnaire

This part was adapted from (Saber et al., 2017) who developed safety attitude questionnaire (SAQ) that most commonly used to assess the attitudes toward the patient safety culture in hospitals.

The questionnaire consisted of five dimensions, including teamwork (six items), safety climate (seven items), job satisfaction (five items), management perception (5 items) and work conditions (four items).

Scoring system: a Likert scale was used to score (Disagree=0, Neutral =1, Agree =2). With total score 54 score. The score of the items was summed-up and the total divided by the number of the items, giving a mean score for the part. These scores were converted into a percent score. The attitude was considered as: Positive attitude if the score of total attitudes $\geq 60\%$ (≥ 32 score) and considered negative attitude if it is $< 60\%$ (< 32 score).

Validity and Reliability of the Study Tools:

Validity:

Content validity of the suggested tools was done by a jury of five experts in the field of medical surgical nursing from the Faculty of Nursing at Benha University, which included two assistant professors and three lecturers in the department to determine whether the included items are clear and appropriate to accomplish the goal of the current study. Their feedback on the format, design, uniformity, accuracy, and applicability of the tools was solicited.

Reliability: The Alpha Cronbach's coefficient test was used to determine the reliability of the tools, and the results showed that each of the three tools had generally homogenous items, as indicated by high reliability for each tool. The internal consistency of the tools was as the following:

Reliability of knowledge questionnaire was determined using Cronbach's alpha coefficient which was 0.972. For the second tool practice, reliability was 0.884, for the attitude was 0.897. This just serves to demonstrate how reliable these tools are as instruments.

Pilot Study: Prior to beginning the actual data collection and after the tools had been developed, a pilot study was carried out to test the clarity, applicability of the study tools and the time needed to fill in the tool and to assess the feasibility of the research process. The pilot study was done on ten percent of the sample ($n=4$) who were included in the main study sample because they did not add any modifications to the study tools.

Fieldwork:

The process of data collection and teaching sessions extended over 6 months and starting at the beginning of February 2022 to the beginning of August 2022, it was carried out by the researcher through four phases:

Preparatory phase:

A comprehensive literature review was conducted, incorporating textbooks, evidence-based articles, online periodicals, and scholarly journals to gain insight into the research problem and theoretical foundations.

Assessment Phase: To determine the optimal data collection approach, an exploratory visit was conducted to the cardiac catheterization unit at Benha University Hospital. Prior to commencing the study, a preliminary interview with the nurses was conducted to establish rapport. All participating nurses provided verbal consent after the research objectives and nature of the study were explained to them. Data collection occurred three days a week, encompassing both morning and afternoon shifts (long day shift).

Data Collection Methods: The structured interviewing questionnaire (Tool I) was administered to each nurse to evaluate their knowledge before the implementation of the intervention protocol. The completion time for this questionnaire ranged from 10 to 15 minutes. Additionally, an observational checklist (Tool II) was utilized to assess nurses' practical skills before the intervention protocol during preparation, during the cardiac catheterization procedure, and after the procedure. The researcher observed compliance with infection control and environmental safety measures. The completion time for the observational checklist was between 15 and 25 minutes per nurse. Nurses also received a sheet to assess their attitudes, which took approximately 5 to 10 minutes to complete.

Planning Phase (Development of Safety Measures Intervention Protocol): The objectives of the intervention protocol were formulated based on identified needs of nurses concerning safety measures in the cardiac catheterization unit and the latest relevant literature. These objectives were reviewed and refined based on expert feedback. The protocol was designed with simplicity, containing both theoretical and practical components. A booklet written in straightforward Arabic, reinforced with images, served as a key tool for implementation.

Implementation Phase: The researchers executed the safety measures intervention protocol, delivering a single daily session between 9:30 AM and 2:30 PM. The implementation occurred through training sessions, with nurses divided into groups of 2-4 individuals. This phase spanned four months, including one month for pre-protocol baseline

assessment and one month for post-protocol evaluation. The protocol was tailored to match the nurses' proficiency levels in Arabic. Motivation was heightened through encouragement and reinforcement during training. Each nurse group underwent a total of 3 knowledge sessions and 4 practice sessions, each lasting 30 to 45 minutes, including a 10-minute discussion and feedback segment.

Session Structure and Delivery: Each session commenced with a recap of previous topics and clarification of the current session's objectives. A summary of the session's contents was also provided at the end, with feedback from nurses gathered to ensure maximum benefit.

Knowledge dissemination involved lectures and group discussions, while practice involved demonstration and repetition. Various visual aids such as handouts, movies, and images were employed. Each nurse received a booklet, reinforcing the content of the sessions.

Contained the training's course material. At last sessions, the researcher informed them that they will be evaluated by the researcher immediately.

Evaluation phase: The effect of safety measures intervention protocol on nurses' knowledge, practices and attitude was assessed by comparing the outcomes before and immediately after implementation of the protocol using the same data collection tools (utilizing tool 1, 2 and 3). This phase took one month.

Administrative and Ethical Considerations

The current study was approved by the Scientific Research and Ethics Committee of the Faculty of Nursing at Benha University. Permission to conduct this study was obtained from the dean of Faculty of Nursing Benha University, director of Benha university hospital and head nurse of cardiac catheterization unit at Benha University Hospital. The study was conducted with careful attention to the ethical standards of research and the rights of the participants to agree or decline participation in the study.

Oral consent was obtained from the studied nurses in order to participate in the study. The

aim of the study was explained to all nurses and they were reassured that all information will be kept private and it will be used only for their benefit and for legitimate research purposes, with no risk to them. The studied nurses also informed that they had the option of participating or not, and that they were free to depart the study at any moment without providing a reason.

Statistical Analysis:

The collected data were tabulated and statistically analyzed using an IBM computer and the statistical package for social science (SPSS) advanced statistics, version 25 (SPSS Inc., Chicago, IL). For determining the normal distribution of quantitative variables, Kolmogorov-Smirnov test was used. Numerical data were expressed as mean and standard deviation. Qualitative data were expressed as frequency and percentage. McNemar was used to examine the difference between qualitative variables. Chi-square tests were used to examine the relation between qualitative variables and Fisher's exact test was applied on smaller sample sizes, alternative to the chi-square test, when the frequency count is < 5 for more than 20% of cells. Spearman method was used to test correlation between numerical variables. A p-value < 0.05 was considered significant and p-value < 0.001 was considered highly significant.

Results

Table 1: Shows personal data of the studied nurses, indicated that, 50% of them aged from 25 - < 35 years old with the mean age of 34.30 ± 0.85 . concerning sex, 62.5% of them were females. Regarding marital status, 55% of them were married. Regarding educational level, 37.5% of them had been graduated from technical institute of Nursing and year of experience of 50% of them ranged from 5- < 10 years. It was notice also that, 52.5% of the studied nurses didn't attend any previous training courses related to safety measures.

Table 2: Shows that there was a highly statistically significant at $p \leq 0.001$ between total knowledge level among the studied nurses about cardiac catheterization and safety measures pre and immediately post intervention protocol except knowledge about infection

control measures, there was a Statistically Significant at $p \leq 0.05$.

Figure (1): Shows that there was marked improvement of total knowledge level among the studied nurses about cardiac catheterization and safety measures as represented by 22.5% and 80% satisfactory level of knowledge pre and immediately post intervention protocol, respectively.

Table 3: Shows that there was a highly statistically significant at $p \leq 0.001$ between total practice level among the studied nurses throughout cardiac catheterization phases pre and immediately post intervention protocol.

Table 4: Shows that there was a highly statistically significant at $p \leq 0.001$ between total safety measure practices among the studied nurses involving infection control pre and immediately post intervention protocol

Table 5: Shows that there was a statistically significant at $p \leq 0.05$ between environmental safety measure practices among the studied nurses pre and immediately post intervention protocol including thermal, electrical, bacteriological and chemical safety measure practices, there was a highly Statistically Significant at $p \leq 0.001$.

Figure 2: Shows that there was marked improvement of total practice level among the studied nurses about cardiac catheterization and safety measures as represented by 40% and 70% satisfactory level of practice pre and immediately post intervention protocol, respectively.

Table 6: Shows that there was a statistically significant at $p \leq 0.05$ between total attitude among the studied nurses toward patients' safety pre and immediately post intervention protocol including team work, management perception and work conditions. While, there was a highly statistically significant at $p \leq 0.001$ regarding safety climate and job satisfaction.

Figure 3: Shows that there was marked improvement of total attitude level among the studied nurses toward patients' safety as represented by 27.5% and 60% positive attitude

pre and immediately post intervention protocol, respectively.

Table 7: Shows relationship between nurses' personal data and their total knowledge, practice and attitude toward patients' safety immediately post intervention protocol and indicated that, there was a highly statistically significant at $p \leq 0.001$ between age of the studied nurses and their total attitude level. There was a highly statistically significant at $p \leq 0.001$ between marital status and studied nurses' total level of knowledge and practice. Also, there was a highly statistically significant at $p \leq 0.001$ between educational level and studied nurses' total level of knowledge,

practice and attitude. There was a highly statistically significant at $p \leq 0.001$ between years of experience and studied nurses' total attitude level.

Table 8: Shows that there was a highly statistically significant correlation between total knowledge and attitude among the studied nurses immediately post intervention protocol implementation at $p \leq 0.001$. while, there was a statistically significant correlation between total practice and total knowledge and attitude among the studied nurses immediately post intervention protocol implementation at $p \leq 0.05$.

Table (1): Distribution of the studied nurses according to their personal data (n = 40)

Nurses' personal data	(n = 40)	
	No.	%
Age / years		
<25	6	15.0
25 - < 35	20	50.0
35- <45	10	25.0
≥ 45	4	10.0
Mean ± SD	34.30 ± 0.85	
Sex		
Male	15	37.5
Female	25	62.5
Marital status		
Single	10	25.0
Married	22	55.0
Divorced	5	12.5
Widowed	3	7.5
Educational level		
Nursing Diploma	10	25.0
Technical institute of Nursing	15	37.5
Bachelor degree of Nursing	12	30.0
Post graduate	3	7.5
Years of Experience		
< 5	6	15.0
5-< 10	20	50.0
10-< 15	10	25.0
≥ 15	4	10.0
Mean ± SD	9.30 ± 0.85	
Attending previous training courses related to safety measures in the cardiac catheterization unit		
Yes	19	47.5
No	21	52.5

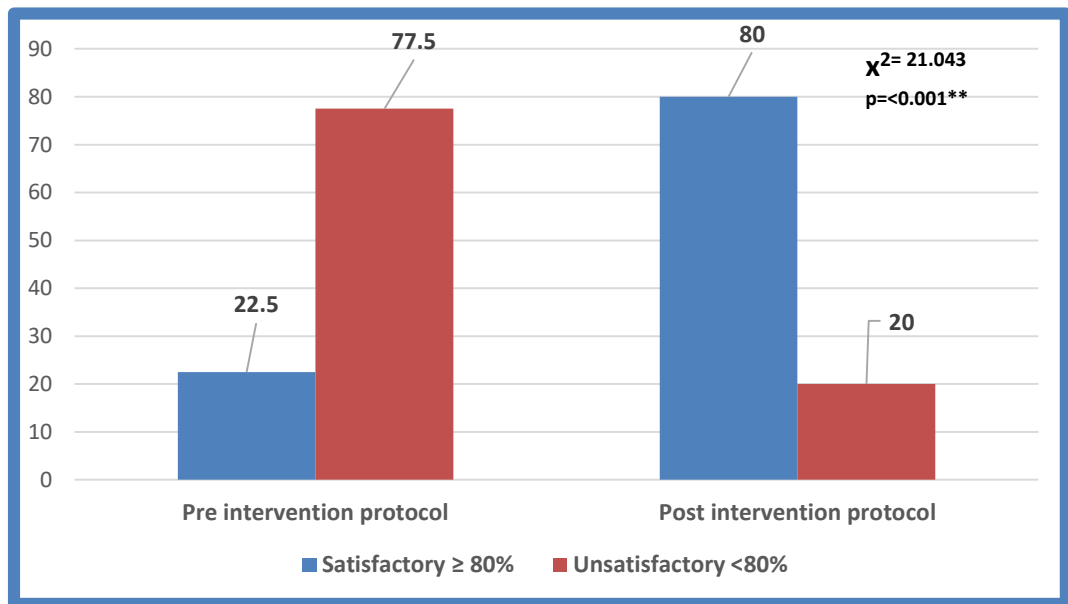
Table (2): Difference between total knowledge level among the studied nurses about cardiac catheterization and safety measures pre and immediately post intervention protocol (n=40)

Nurses' knowledge about cardiac catheterization and safety measures	Knowledge level	Knowledge (pre intervention protocol) n= 40		Knowledge (immediately post intervention protocol) n= 40		X ² test P value
		(No.)	%	(No.)	%	
General knowledge about cardiac catheterization	Satisfactory ≥ 80%	11	27.5	35	87.5	22.042 <0.001**
	Unsatisfactory < 80%	29	72.5	5	12.5	
knowledge about the role of nurses before, during and after cardiac catheterization	Satisfactory ≥ 80%	13	32.5	37	92.5	22.042 <0.001**
	Unsatisfactory < 80%	27	67.5	3	7.5	
knowledge about patient' safety measures	Satisfactory ≥ 80%	16	40.0	34	85.0	13.136 <0.001**
	Unsatisfactory < 80%	24	60.0	6	15.0	
knowledge about environmental safety measures	Satisfactory ≥ 80%	14	35.0	29	72.5	15.059 <0.001**
	Unsatisfactory < 80%	26	65.0	11	27.5	
knowledge about infection control measures	Satisfactory ≥ 80%	18	45.0	30	75.0	6.722 0.008*
	Unsatisfactory < 80%	22	55.0	10	25.0	

(*) Statistically Significant at ≤0.05

(**) Highly statistically significant at ≤0.001

Figure (1): Difference between total knowledge level among the studied nurses about cardiac catheterization and safety measures pre and immediately post intervention protocol (n=40)



(**) Highly statistically significant at ≤0.001

Table (3): Difference between total practice level among the studied nurses throughout cardiac catheterization phases pre and immediately post intervention protocol (n=40)

Nurses' practices throughout cardiac catheterization phases	Practice level	Practice (pre intervention protocol) n= 40		Practice (immediately post intervention protocol) n= 40		X ² test P value
		(No.)	%	(No.)	%	
Practices before cardiac catheterization	Satisfactory ≥ 80%	17	42.5	33	82.5	14.062 <0.001**
	Unsatisfactory < 80%	23	57.5	7	17.5	
Practices during cardiac catheterization	Satisfactory ≥ 80%	22	55.0	36	90.0	12.071 0.001**
	Unsatisfactory < 80%	18	45.0	4	10.0	
Practices after cardiac catheterization	Satisfactory ≥ 80%	15	37.5	34	85.0	17.053 <0.001**
	Unsatisfactory < 80%	25	62.5	6	15.0	
Total	Satisfactory ≥ 80%	17	42.5	31	77.5	12.071 <0.001**
	Unsatisfactory < 80%	23	57.5	9	22.5	

(**) Highly statistically significant at ≤0.001

Table (4): Difference between total safety measure practices among the studied nurses involving infection control pre and immediately post intervention protocol (n=40)

Nurses' safety measure practices	practice level	Practice (pre intervention protocol) n= 40		Practice (immediately post intervention protocol) n= 40		X ² test P value
		(No.)	%	(No.)	%	
Personal hygiene	Satisfactory ≥ 80%	16	40.0	33	82.5	11.130 <0.001**
	Unsatisfactory < 80%	24	60.0	7	17.5	
Cleaning and disinfection	Satisfactory ≥ 80%	17	42.5	37	92.5	18.050 <0.001**
	Unsatisfactory < 80%	23	57.5	3	7.5	
Healthy behavior	Satisfactory ≥ 80%	13	32.5	30	75.0	15.059 <0.001**
	Unsatisfactory < 80%	27	67.5	10	25.0	
Discard of the solid materials	Satisfactory ≥ 80%	13	32.5	34	85.0	19.048 <0.001**
	Unsatisfactory < 80%	27	67.5	6	15.0	
Total	Satisfactory ≥ 80%	17	42.5	32	80.0	13.067 <0.001**
	Unsatisfactory < 80%	23	57.5	8	20.0	

(**) Highly statistically significant at ≤0.001

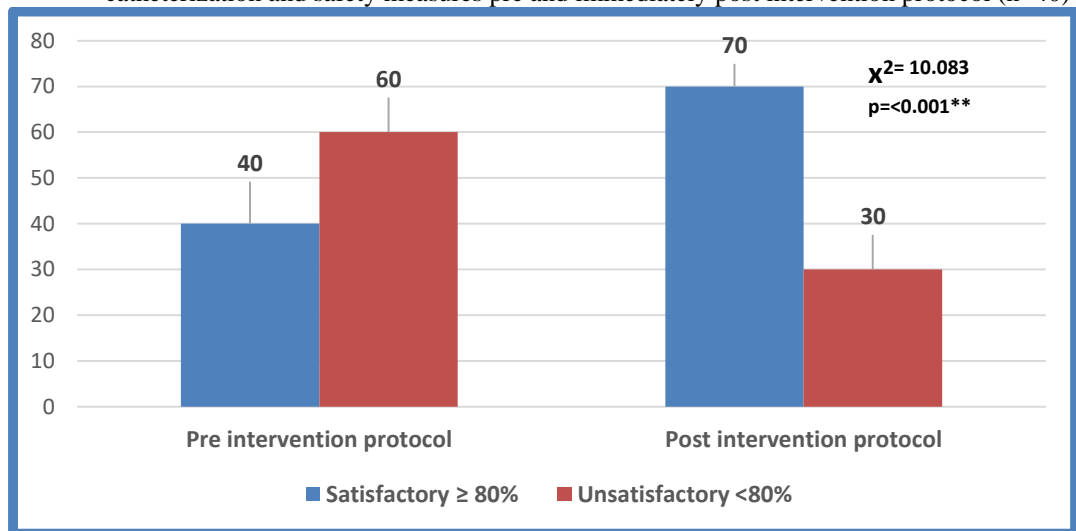
Table (5): Difference between environmental safety measure practices among the studied nurses pre and immediately post intervention protocol (n=40)

Nurses' practices of environmental safety measures	Practice level	Practice (pre intervention protocol) n= 40		Practice (immediately post intervention protocol) n= 40		X ² test P value
		(No.)	%	(No.)	%	
Mechanical safety	Satisfactory ≥ 80%	12	30.0	30	75.0	13.136 <0.001**
	Unsatisfactory < 80%	28	70.0	10	25.0	
Thermal safety	Satisfactory ≥ 80%	13	32.5	24	60.0	6.667 0.007*
	Unsatisfactory < 80%	27	67.5	16	40.0	
Electrical safety	Satisfactory ≥ 80%	13	32.5	30	75.0	7.042 0.007*
	Unsatisfactory < 80%	27	67.5	10	25.0	
Bacteriological safety	Satisfactory ≥ 80%	17	42.5	32	80.0	4.083 0.039*
	Unsatisfactory < 80%	23	57.5	8	20.0	
Chemical safety	Satisfactory ≥ 80%	16	40.0	33	82.5	7.562 0.004*
	Unsatisfactory < 80%	24	60.0	7	17.5	
Total	Satisfactory ≥ 80%	14	35.0	24	60.0	8.100 0.002*
	Unsatisfactory < 80%	26	65.0	16	40.0	

(*) Statistically Significant at ≤0.05

(**) Highly statistically significant at ≤0.001

Figure (2): Difference between total practice level among the studied nurses about cardiac catheterization and safety measures pre and immediately post intervention protocol (n=40)



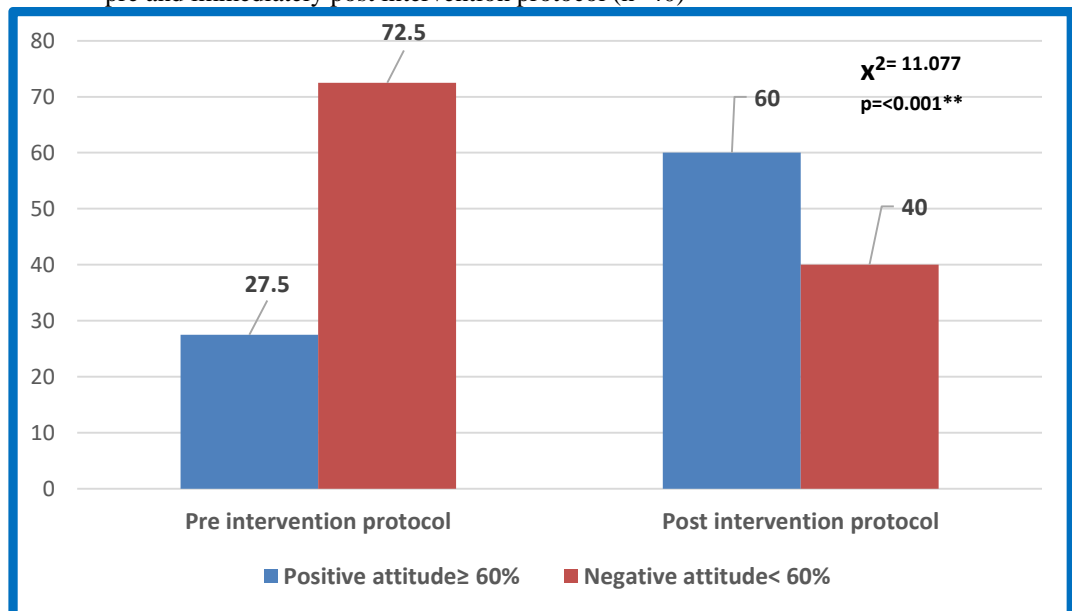
(**) Highly statistically significant at ≤0.001

Table (6): Difference between total attitude among the studied nurses toward patients’ safety pre and immediately post intervention protocol (n=40)

Nurses’ attitude toward patients’ safety	Attitude level	Practice (pre intervention protocol) n= 40		Practice (immediately post intervention protocol) n= 40		X ² test P value
		(No.)	%	(No.)	%	
Team work	Positive attitude ≥ 60%	11	27.5	27	67.5	9.375 0.002*
	Negative attitude < 60%	29	72.5	13	32.5	
Safety Climate	Positive attitude ≥ 60%	10	25.0	32	80.0	18.375 <0.001**
	Negative attitude < 60%	30	75.0	8	20.0	
Job Satisfaction	Positive attitude ≥ 60%	14	35.0	28	70.0	9.389 0.001**
	Negative attitude < 60%	26	65.0	12	30.0	
Management Perception	Positive attitude ≥ 60%	14	35.0	26	65.0	8.643 0.002*
	Negative attitude < 60%	26	65.0	14	35.0	
Work Conditions	Positive attitude ≥ 60%	16	40.0	26	65.0	5.786 0.013*
	Negative attitude < 60%	24	60.0	14	35.0	

(*) Statistically Significant at ≤0.05 (**) Highly statistically significant at ≤0.001

Figure (3): Difference between total attitude level among the studied nurses toward patients’ safety pre and immediately post intervention protocol (n=40)



(**) Highly statistically significant at ≤0.001

Table (7): Relationship between nurses’ personal data and their total knowledge, practice and attitude toward patients’ safety immediately post intervention protocol (n=40)

Nurses’ Personal data	variables	Immediately post intervention protocol								X ² Test P value
		Total knowledge level		X ² Test P value	Total practice level		X ² Test P value	Total attitude level		
		Satisfactory (n=32)	Un Satisfactory (n=8)		Satisfactory (n=28)	Un Satisfactory (n=12)		Positive (n=24)	Negative (n=16)	
		No. (%)	No. (%)		No. (%)	No. (%)		No. (%)	No. (%)	
Age	<25	6(18.8)	0(0.0)	4.540 0.033*	6(21.4)	0(0.0)	3.810 0.283 ^{n.s.}	6(25.0)	0(0.0)	16.458 0.001**
	25 - < 35	17(53.1)	3(37.5)		41(50.1)	6(50.0)		15(62.5)	5(31.3)	
	35- <45	7(21.9)	3(37.5)		6(21.4)	4(33.3)		1(4.2)	9(56.3)	
	≥ 45	2(6.2)	2(25.0)		2(7.1)	2(16.7)		2(8.3)	2(12.5)	
Sex	Male	13(40.6)	2(25.0)	0.667 FEp 0.686 ^{n.s.}	13(46.4)	2(16.7)	3.175 FEp 0.152 ^{n.s.}	12(50.0)	3(18.8)	4.000 FEp 0.056 ^{n.s.}
	Female	19(59.4)	6(75.0)		15(53.6)	10(83.3)		12(50.0)	13(81.3)	
Marital status	Single	2(6.2)	8(100.0)	30.000 <0.001**	1(3.6)	9(75.0)	23.377 <0.001**	8(33.3)	2(12.5)	9.343 0.025*
	Married	22(68.8)	0(0.0)		19(67.9)	3(25.0)		14(58.4)	8(50.0)	
	Divorced	5(15.6)	0(0.0)		5(17.9)	0(0.0)		0(0.0)	5(31.3)	
	Widowed	3(9.4)	0(0.0)		3(10.6)	0(0.0)		2(8.3)	1(6.3)	
Educational level	Nursing Diploma	2(6.2)	8(100.0)	30.024 <0.001**	1(3.6)	9(75.0)	24.286 <0.001**	8(33.3)	2(12.5)	19.514 <0.001**
	Technical institute of Nursing	15(46.9)	0(0.0)		12(42.9)	3(25.0)		13(54.2)	2(12.5)	
	Bachelor degree of Nursing	12(37.5)	0(0.0)		12(42.9)	0(0.0)		1(4.2)	11(68.8)	
	Post graduate	3(9.4)	0(0.0)		3(10.6)	0(0.0)		2(8.3)	1(6.2)	
Years of experience	< 5	2(6.2)	4(50.0)	11.667 0.009*	1(3.6)	5(41.7)	14.365 0.002*	6(25.0)	0(0.0)	16.458 0.001**
	5-< 10	16(50.0)	4(50.0)		13(46.4)	7(58.3)		15(62.5)	5(31.3)	
	10-< 15	10(31.3)	0(0.0)		10(35.7)	0(0.0)		1(4.2)	9(56.3)	
	≥ 15	4(12.5)	0(0.0)		4(14.3)	0(0.0)		2(8.3)	2(12.4)	
Attending previous training courses related to safety measures in the cardiac catheterization unit	Yes	15(46.9)	4(50.0)	0.025 FEp 1.000 ^{n.s.}	14(50.0)	5(41.7)	0.234 FEp 0.736 ^{n.s.}	10(41.7)	9(56.2)	0.819 FEp 0.520 ^{n.s.}
	No	17(53.1)	4(50.0)		14(50.0)	7(58.3)		14(58.3)	7(43.8)	

(FEp) p value for Fisher exact for chi square

(n.s) Not Statistically Significant at >0.05

(*) Statistically Significant at ≤0.05

(**) Highly statistically significant at ≤0.001

Table (8) Correlation between total knowledge, practice and attitude among the studied nurses immediately post intervention protocol implementation (n=40)

Variable	r-\ p values	Periods	Total knowledge		Total attitude	
			r	p	r	p
Total practice		Immediately post intervention	0.379	0.016*	0.309	0.050*
Total attitude			0.866	<0.001**	-	-

(*) Statistically Significant at ≤0.05

(**) Highly statistically significant at ≤0.001

Discussion

Nurses are indispensable in the cardiac catheterization unit, as they deliver essential high-quality nursing care, significantly enhancing patient safety. A key aspect of this is the concept of safety culture, reflecting an individual or organization's ability to manage

risks and prevent harm to achieve their objectives (Fekry & El Wahab, 2020). The primary objective of this study was to assess the impact of a safety measures intervention protocol on the knowledge, practices, and attitudes of nurses responsible for the care of cardiac catheterization patients.

The study's findings concerning the age of the nurses indicate that approximately half of the participants fell within the age range of 25 to 35 years, with a mean age of 34.30 ± 0.85 . The researcher suggests that this distribution might be attributed to the presence of recently graduated nurses in the cardiac catheterization units. This outcome aligns with a previous study conducted by Bayan in 2018, which investigated "Nurses' Knowledge Regarding Cardiac Catheterization at a General Hospital in Rania City." Bayan's study revealed that a significant portion of the studied nurses were young adults, primarily falling within the age range of 26-30 years, with a mean age of 31.5 ± 7.58 . This agreement in age distribution between the current study and Bayan's work reinforces the notion that many cardiac catheterization units have a significant number of younger nurses, likely due to recent graduates entering the field.

This result is in line with **Mamdouh et al., 2020** whose study about "Assessment of Nurses' Performance regarding the Implementation of Patient Safety Measures in Intensive Care Units" and stated that nearly three quarters of the respondents' age ranged between 20-30 years.

As regards to marital status and gender, the current study results revealed that about two thirds of studied nurses were females and more than half of them were married. **From researcher point of view**, this may be due to lack of male nursing staff at Benha University Hospital because the faculty of nursing was accepted females only in last few years.

This result agrees with **Sharif et al., 2018** who showed that the highest percentage of the studied nurses was married. But **Feroze et al., 2017** disagree with the current result as they found that most of nurses were unmarried.

The specific institutions where the studies were conducted and their respective nursing education policies. The variation in educational backgrounds among the studied nurses may stem from the different recruitment and training strategies employed by these institutions.

The current study and Renato's study in 2018 both found that around one-third of the nurses had a technical institute of nursing background. This consistency in findings suggests a potential pattern in the composition of nursing staff with this type of educational background, which could be due to factors such as the availability of technical nursing institutes, the specific geographic region, or other factors influencing the choice of educational pathways for nurses in that area.

In contrast, the results from the study by Fekry and Abd el Wahab in 2020 indicated that a significant majority of the nurses had a secondary school diploma. This finding contradicts the observations made in the current study and Renato's study. The researcher speculates that this discrepancy could be attributed to differences in the policies and practices of the institutions or the specific populations under study. For instance, Fekry and Abd el Wahab's study might have included nurses from a broader range of settings or regions with distinct nursing education norms.

The variation in educational backgrounds among nurses in these studies underscores the importance of considering the context and local factors when interpreting and comparing research findings. Institutional policies, geographic locations, and the availability of educational options can all contribute to the diverse profiles of nurses in different studies. Researchers should be cautious when generalizing findings to broader populations, as the specific characteristics of the studied samples may not be representative of the entire **nursing profession**.

University hospital at Qaluobiya governorate is placing high quality nurses at intensive care units and special units.

Concerning to years of experience, the study findings revealed that half of studied nurses had experience ranged from 5-< 10 years. This finding disagree with **Bayan, 2018** who approved that more than two third of studied subject had 1-4 years' experience

Regarding to previous attendance of training courses related to safety measures, the study findings clarified that more than half

of studied nurses didn't attend any previous training courses related to safety measures. This is in agreement with **Ali & Ali 2019** who stated that all of nurses were not taking in service educational program. **From researcher point of view**; this may be due to lack of relevant training chances provided by nursing authorities.

The findings of the current study concerning nurses' knowledge about cardiac catheterization and safety measures indicate a highly statistically significant improvement ($p \leq 0.001$) in the total knowledge level among the studied nurses when comparing the period before and immediately after the intervention protocol. This significant improvement in knowledge supports the first hypothesis, suggesting that the intervention had a positive impact on the participants' understanding of cardiac catheterization and safety measures.

However, it's worth noting that while the overall knowledge level improved significantly, there was a slightly different pattern for knowledge about infection control measures. The improvement in knowledge about infection control measures was still statistically significant, but the level of significance was slightly lower ($p \leq 0.05$) compared to the broader improvement in knowledge. This suggests that the intervention had a positive effect on infection control knowledge, although it may have been slightly less pronounced compared to the overall knowledge improvement.

The researcher's perspective sheds light on potential reasons for the unsatisfactory knowledge level observed before the intervention protocol. According to the researcher, the majority of nurses faced challenges in updating their knowledge, possibly due to time constraints. Additionally, more than half of the nurses did not attend training courses specifically related to safety measures. These factors likely contributed to the initial knowledge gap. The intervention appears to have addressed this gap, leading to a marked improvement in overall knowledge.

This insight from the researcher underscores the importance of continuous education and training for nurses. Ensuring that nurses have access to updated information

and relevant training courses is crucial for maintaining high-quality care and patient safety. The study's results support the notion that targeted interventions can be effective in enhancing nurses' knowledge, particularly in areas where gaps exist.

Overall, the study highlights the positive impact of the intervention on nurses' knowledge about cardiac catheterization and safety measures, while also shedding light on the specific aspect of infection control knowledge that could benefit from further attention. These findings have implications for nursing education and training strategies, emphasizing the need for ongoing professional development to ensure that nurses stay informed and competent in providing safe and effective care.

This finding supported by **Pandit et al., 2019** who conducted a study to assess the knowledge and practice among cardiac nurses about patient safety after cardiac catheterization and found that, more than half of studied nurses had unsatisfactory level of knowledge regarding to nursing management during cardiac catheterization.

Moreover, the satisfactory level post intervention protocol indicates the effectiveness of the intervention protocol.

This is reinforced by a study conducted by **Abdelmoaty et al., 2020** to assess the impact of training on nurses' knowledge and skills, which found a highly statistically significant difference between levels of acquired nurses' practices before and after the interactive training..

Regarding to nurses' practices throughout cardiac catheterization phases, the results of the current study reveals that, there was a highly statistically significant at $p \leq 0.001$ between total practice level among the studied nurses throughout cardiac catheterization phases pre and immediately post intervention protocol. There was a highly statistically significant at $p \leq 0.001$ between total safety measure practices among the studied nurses involving infection control pre and immediately post intervention protocol. There was marked improvement of total practice level among the studied nurses about cardiac catheterization and safety measures

pre and immediately post intervention protocol. This result supports the second hypothesis.

This result supported by **Ali and Ali, 2019** who conducted a study on "Effect of Designed Teaching Protocol Regarding Patients' Safety after Cardiac Catheterization on Nurses' Performance and Patients' Incidence of Vascular Complications" and indicated that there was a significant differences between nurse's practice during, pre and post program implementation, showing that all of the nurses in the study had insufficient levels of practice before the program.

This study supported by **El-Sol & Badawy, 2017** who conducted a study on "The Effect of a Designed Teaching Module Regarding Prevention of Cardiac Catheter Associated Blood Stream Infection on Nurses' Knowledge and Practice." who found that more than half of studied nurses had inadequate and unsatisfactory practice regarding infection control measures.

Regarding to nurses practice related to environmental safety measures ,the study revealed that there was a statistically significant at $p \leq 0.05$ between environmental safety measure practices among the studied nurses pre and immediately post intervention protocol including thermal, electrical, bacteriological and chemical safety measure practices except mechanical safety measure practices, there was a highly Statistically Significant at $p \leq 0.001$. **From researcher point of view**, this result related to nurses' perception that environmental safety measures doesn't from their duties but it is health and safety workers duties.

This view is supported by a study done by **National Institute for Occupational Safety and Health, (2018)** to evaluate work place risk factors and prevention strategies for nurses in hospitals and this study showed that the majority of nurses don't follow precautions of environmental safety measures.

The current study revealed that, there was a statistically significant at $p \leq 0.05$ between total attitude among the studied nurses toward patients' safety pre and immediately post intervention protocol including team work, management perception and work conditions. While, there was a highly statistically significant at $p \leq 0.001$ regarding safety climate and job satisfaction. There was marked improvement of

total attitude level among the studied nurses toward patients' safety pre and immediately post intervention protocol. This result supports the third hypothesis. This indicates the effectiveness of the intervention protocol.

These findings are corroborated by research conducted in 2019 by **Kaynar et al.**, titled "Attitudes of Respiratory and Cardiac Therapists and Nurses about Measures to Prevent Post Cardiac Catheterization Complication," which discovered that more than half of cardiac nurses had a positive attitude toward safety culture to maintain patient safety following cardiac catheterizations.

Regarding relation between nurses' personal data and their total knowledge, practice and attitude toward patients' safety immediately post intervention protocol, the results of the current study indicated that, there was a highly statistically significant at $p \leq 0.001$ between age of the studied nurses and their total attitude level. There was a highly statistically significant at $p \leq 0.001$ between marital status and studied nurses' total level of knowledge and practice.

Also, there was a highly statistically significant at $p \leq 0.001$ between educational level and studied nurses' total level of knowledge, practice and attitude. There was a highly statistically significant at $p \leq 0.001$ between years of experience and studied nurses' total attitude level. This finding demonstrated the importance of education in influencing a nurse's knowledge, and it was corroborated by **Feroze et al. 2017** who discovered a significant relation between knowledge and practice, knowledge and education.

This also supported by **El-Sol and Badawy, 2017** who found that there were a highly statistical significant relation between nurse's knowledge, practice and their socio demographic data such as level of education and previous training and declared that continuing education regardless of age can significantly get better infection control practices and decrease rate of infection .

Concerning the correlation coefficient between total knowledge, attitude and practice scores, the current study revealed that there was a highly statistically significant correlation between total knowledge and

attitude among the studied nurses immediately post intervention protocol implementation at $p \leq 0.001$. while, there was a statistically significant correlation between total practice and total knowledge and attitude among the studied nurses immediately post intervention protocol implementation at $p \leq 0.05$. This result supports the fourth hypothesis. In the same line according to **El-Sol and Badawy's 2017** research, instructional programs regarding infection control precaution have a substantial impact on the participants' performance.

Conclusions

According to the results of this study, study hypotheses are approved as it can be concluded that there was marked improvement of total knowledge, practice and attitude among the studied nurses about cardiac catheterization and safety measures immediately post intervention protocol. There was a highly statistically significant correlation between total knowledge and attitude among the studied nurses immediately post intervention protocol implementation while, there was a statistically significant correlation between total practice and total knowledge and attitude among the studied nurses immediately post intervention protocol implementation.

Recommendations

These suggestions can be made based on the findings of the current study:

- Patient safety-related standard nursing procedure booklets should be created and made available in both Arabic and English language
- There should be posters clarifying patient safety precautions in every critical care unit.
- Strict supervision of nurses during their work and ongoing performance evaluation.
- Nurses working in the cardiac catheterization unit should have access to ongoing educational and training programmes to keep up with the latest safety measures concepts.
- Reapply this research to a wider probability sample collected from various Egypt-based regions for the purpose of generalization.

Limitations of the study

The study findings could not be generalized because of the following reasons:

- The study was restricted to a certain geographic region, which prevents any further generalization.
- The sample size was relatively small, thus restricting the statistical inferences of results.
- Not all studied nurses were available together at the same time, so that the researchers had to work in morning and afternoon shifts in order to interview all of the study nurses.

Credit authorship contribution statement

Doaa Mohamed Mahmoud: Conceptualization, methodology, data curation, formal analysis & writing **Safaa H. Mohamed** methodology, resources, formal analysis & writing **Ashgan T.Fathy** methodology, writing & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

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