

Effect of Educational Program on Nurses' Performance Regarding Prevention and Management of Intravenous Extravasation Chemotherapy

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ABSTRACT

Context: Systemic chemotherapy plays a pivotal role in curative therapy for patients with hematological neoplasms and several types of advanced solid tumors. Extravasation describes an anticancer agent's accidental leakage from a vessel into the surrounding tissues, leading to irreversible local injuries and severe disability. Despite its considerable clinical importance, evidence-based information on extravasation in chemotherapy is lacking.

Aim: This study aimed to evaluate the effect of an educational program on nurses' performance regarding the prevention and management of intravenous extravasation chemotherapy.

Methods: The following hypotheses were formulated to achieve the study aim. H1: Nurses' performance related to the prevention and management of intravenous extravasation chemotherapy will be improved after implementing the educational program compared to the pre-program. H2: There will be a significant correlation between nurses' knowledge and practice post-program implementation. A quasi-experimental research design was utilized to conduct the current study in the oncology unit at Benha University Hospital. A convenience sample consisted of all available nurses (n=40) working in the oncology unit were recruited to achieve the aim of this study. Two tools were used, the nurses' knowledge assessment questionnaire and the nurses' practice observational checklist regarding the prevention and management of intravenous extravasation chemotherapy.

Results: This study shows that most nurses had an unsatisfactory level of total knowledge and inadequate total practice regarding the prevention and management of intravenous extravasation chemotherapy pre-program implementation (85% and 56%). This result improved significantly regarding all knowledge and practice elements immediately post-program implementation, where the majority of the nurses had a satisfactory level of their total knowledge and adequate total practice (95% and 94%) that was slightly decreased three months after program implementation (75%) for both knowledge and practice.

Conclusion: The majority of the nurses surveyed had an unsatisfactory performance level (knowledge and practice) concerning the prevention and management of intravenous extravasation chemotherapy pre-program implementation. In contrast, most of the studied nurses had statistically significant improvement in their performance immediately and after three months from program implementation, which supported the current study hypotheses. The study recommended continuous in-service training programs and establishing guidelines to help the oncology nurses revise, acquire, and develop their knowledge and practice regarding preventing and managing intravenous extravasation chemotherapy.

Keywords: Educational program, Intravenous extravasation chemotherapy, Nurses' performance, Prevention and management.

1. Introduction

Cancer is a broad term. It characterizes the illness that occurs when cellular changes trigger the uncontrolled growth and division of cells. Certain forms of cancer cause rapid growth of cells, while other types cause slow cell division and growth. Some cancer types lead to visible tumor formation, while others, such as leukemia, do not. In one region, cancerous cells can appear and then spread through the lymph nodes and form tumors, damage the immune system and lead to other changes preventing the body from functioning correctly (Ranchod & Nall, 2020).

Cancer is the second leading cause of death globally and is responsible for an estimated 9.6 million deaths in 2018. Globally, about 1 in 6 deaths is due to cancer. Approximately 70% of deaths from cancer occur in low- and middle-income countries. Around one-third of cancer

deaths are due to the five leading behavioral and dietary risks: high body mass index, low fruit and vegetable intake, lack of physical activity, tobacco use, and alcohol use (World Health Organization, 2018).

Chemotherapy is usually used to treat cancer since cancer cells grow and multiply much more quickly than most cells in the body. It is possible to use chemotherapy drugs alone or in conjunction with radiotherapy to treat a wide variety of cancers. However, chemotherapy is an efficient way to treat many types of cancer. Treatment with chemotherapy also has a chance of side effects. Some side effects of chemotherapy are mild and treatable, while others can cause severe complications (Creagan & Giridhar, 2020).

Extravasation is defined as the leakage of a drug into the extravascular space, leakage from a vessel, or direct infiltration. Many drugs are irritating when introduced into extravascular tissues, and extravasation of an irritant drug, especially one classified as a vesicant, can cause tissue damage with a severe and lasting injury. Although the most well-known vesicants are cytotoxic chemotherapy

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drugs, many other non-antineoplastic drugs also have the potential for local toxicity if extravasation occurs (Buter et al., 2019).

Extravasation is not limited, as many people think, and it may occur even in the most strictly controlled situations. The incidence of extravasation in adults is estimated to range from 0.01 to 6.9%, but few studies report the incidence based on firm data with the total number of patients who received chemotherapy (Sakaida et al., 2014). Extravasation has a wide range of manifestations and early effects, including swelling at the infusion site, redness, and changes that may appear as burning, cold sensation, pain, or stinging. On the other hand, late results include marked induration, dystrophy, and possible loss of the affected limb function that may contribute to blister formation and necrosis, leading to amputation (Al-Benna et al., 2013; Schulmeister, 2014).

The nurse has a significant role in assessing and managing many of the problems expressed by patients undergoing chemotherapy because of the systemic effects on normal cells and malignant cells. Moreover, the nurse must apply all safety precautions in the prevention of extravasation, including identification of potential risk factors of extravasations, assessment of patients who need a central access device and refer them to the appropriate service for placement, ongoing vein assessments to determine if administration of chemotherapy is causing veins to become fragile, and close monitoring throughout chemotherapy infusion (Kreidie et al., 2016).

2. Significance of the study

Cancer and blood disorders are becoming the most common problems in Egypt. Egypt's cancer rate is growing as 100-120 new cases raise the number of incidents from 114,985 in 2013 to 331,169 is expected in 2050 (Ibrahim et al., 2014). The number of cases treated by chemotherapy at Benha university hospital in 2018 was about 50 cases, and nearly 1300 cases were treated by radiotherapy (Statistical Office in Benha University Hospital, 2018).

However, extravasation injuries remain rare, with an approximate incidence of patients undergoing chemotherapy reported in the literature of between 0.1% and 6%. (Al-Benna et al., 2013). Complications from chemotherapy directly affect patients' quality of life, so assessing nurses' performance regarding the prevention and management of intravenous extravasation chemotherapy is very important.

3. Aim of the study

The study aimed to evaluate the effect of an educational program on nurses' performance regarding the prevention and management of intravenous extravasation chemotherapy.

3.1. Operational definition

Nurses' performance means nurses' knowledge and practice.

3.2. Research Hypotheses

The following hypotheses were formulated to fulfill the aim of the study

H 1: Nurses exposed to the educational program will exhibit better performance regarding preventing and managing intravenous extravasation chemotherapy immediately and after three months from program implementation than pre-program.

H 2: There will be a significant correlation between nurses' knowledge and practice post and after three months from program implementation.

4. Subjects & Methods

4.1. Research design

A quasi-experimental (pre/post/follow-up test) design was utilized to achieve the study's aim. Quasi-experimental designs investigated whether there is a causal correlation between independent and dependent variables. Also, the typical experimental design or randomized controlled trial is identical, but the aspect of random assignment to treatment or control is absent (Loewen & Plonsky, 2016).

4.2. Research Setting

The study was conducted in the oncology unit at Benha university hospital; it consisted of 10 rooms, including 50 beds. A nursing station and physician's office.

4.3. Subjects

A convenient sample of all available nurses worked at the oncology unit at Benha University Hospital and willing to participate in the study. They were 44 nurses. Four nurses were excluded from the primary sample for the pilot testing.

4.4. Tools of the study

Two tools were used to collect data for this study. Nurses' knowledge assessment questionnaire and the nurses' practice observational checklist. The researcher developed them after reviewing recent related literature.

4.4.1. Nurses' knowledge Assessment questionnaire

It involved the following two parts:

Part 1 is concerned with assessing nurses' demographic characteristics related to their age, gender, marital status, educational level, years of experience in the oncology unit, and attendance of training courses regarding chemotherapy precautions in oncology units.

Part 2 aimed to assess nurses' knowledge about chemotherapy extravasation. It was adapted from Binner (2010); Margulies et al. (2012). It consisted of the following sections:

Section I covered nurses' knowledge about chemotherapy administration. It included (6) items related to the definition, action, classification, side effects, and precautions during administration and documentation.

Section II covered the studied nurses' knowledge about chemotherapy extravasation. It included (5) main items and (3) sub-items related to the definition of chemotherapy extravasation, causes, signs, and symptoms of extravasation, and nurses' role in the prevention and management of extravasation.

The questionnaire tool contained (14) questions about chemotherapy. All knowledge items were multiple-choice questions. The nurses were asked to reply to these questions with only one correct response for each question pre, post, and follow-up program implementation.

Scoring system

Two scoring levels for questions were used. The correct answer was scored (1), the incorrect answer, and not known was scored (0). The total score was (14) resulting from adding the total number of questions. Then the result is divided by 100 to be converted into a percentage. Total knowledge score converted into percentage and categorized into:

- $\geq 70\%$ was considered a satisfactory level of knowledge (10 degrees or more).
- $< 70\%$ was considered as an unsatisfactory level of knowledge (Less than 10 degrees).

4.4.2. Nurses' Practice Observational Checklist

It aimed to assess nurses' practice before, during, and after implementing the educational program. It was adapted from *Hadaway et al. (2009)*. The researcher filled it. The observational checklist has consisted of (16) items for extravasation prevention, including preparing insertion site, handling chemotherapy, preparing chemotherapy, disposal of chemotherapy, and (7) items for extravasation management.

Scoring system

Two scoring levels were used: done was scored (1), and not done step was scored (0). The total score was (23), resulting from multiplying the total number of scores, and then the result was divided by 100 to be converted into a percentage. Total practice score converted into percentage and categorized into:

- $\geq 75\%$ was considered an adequate level of practice (17 scores or more).
- $< 75\%$ was considered as an inadequate level of practice (Less than 17 scores).

4.5. Procedures

A pilot study was conducted on four nurses (10%) of all nurses at the oncology unit to test the feasibility of the research process, clarity and applicability of the study tools and the educational program, to estimate the time needed for filling the questionnaire, checklist, and to identify any possible obstacles that may hinder data collection. Some improvements were made to the developed instruments. The study omitted nurses

participating in the pilot study.

The content validity was done through a panel of five experts in the medical and nursing specialty for face and content validity. Their opinions were requested via an assessment form. The experts were asked to grade each item as "essential," "useful but inadequate," or "unnecessary." According to the panel's judgment on the clarity of sentences and appropriateness of the content, minor modifications were carried out. The consensus among experts regarding the structured interviewing questionnaire was 97%, and the observational checklist was 98% for most items. The same experts revised the developed educational program that covered all items related to the prevention and management of extravasation chemotherapy based on the current literature, and all recommended modifications were made. The reliability of the tools has, therefore, been checked using the method of internal consistency. The Cronbach alpha reliability coefficient (0.985) for the knowledge questionnaire and (0.807) for the observational checklist proved high.

The researcher developed the educational program after reviewing the related literature. It covered the following information: definition, classification, action, and preparation of chemotherapeutic agents. It also included a definition and risk factors of extravasation, signs, and symptoms of extravasation; specific measures followed by the nurse to prevent the risk of chemotherapy extravasation; the contents of extravasation kit and general procedures for the management of extravasation cases.

Ethical considerations: After explaining the study's aim, official permission for data collection was obtained from the Oncology Unit director at Benha University Hospital. Verbal consent was obtained from nurses to participate in this study after explaining the aim of the study.

Nurses were informed about the confidentiality of the obtained information and the nature of the study. They were reassured that the obtained information was used only for the study. They have the right at any time to withdraw from the research without providing any reason.

The study was conducted through three phases:

Assessment Phase: It was carried out for all studied subjects by the researcher to collect baseline data regarding nurses' knowledge and chemotherapy practice. The researcher attended the clinical setting two days per week to assess the actual nurses' performance before, immediately, and after three months from applying to the educational program. All the studied nurses were observed during chemotherapy administration during morning shifts (Tool II).

The implementation phase included the following steps:

- Setting general and specific objectives.
- Preparation of material covering the reasons behind the session's implementation.
- The researcher divided the studied nurses into five groups, and each group consisted of eight nurses.

- The program implementation was carried out for each group separately through the conduction of sessions according to the studied nurses' actual needs assessment.
- The program implementation was conducted in 6 sessions, two sessions per week. Each session lasted about 30 minutes, including periods of discussion according to the nurses' progress and feedback.
- Different teaching tools and media were used, including seminars, group discussions, and presentations.
- The data collection continued over one year, from February 2019 to February 2020.
- Each group attended the following sessions:

The first session covered the definition, classification, action, and preparation of chemotherapeutic agents. The Second session started with reviewing the previously presented principles and advancement to the next step, which centered on precautions during administration and nurses' role in chemotherapeutic agent administration. Discussions and presentations were used to demonstrate the role of nurses. The third session concentrated on potential complications and documentation of chemotherapeutic agents.

The fourth session began by reviewing the points that were previously instructed and demonstrating about chemotherapy. It focused on the definition, risk factors, and clinical signs and symptoms of extravasation. The fifth session concentrated on showing practical precautions taken by the nurse to avoid the possibility of extravasation by chemotherapy and the contents of the extravasation package. The content presented and demonstration of how to apply extravasation prevention was done through simulation on some patients. The sixth session demonstrated general procedures for the management of extravasation cases and the documentation of chemotherapy extravasation.

Evaluation Phase: The evaluation had been made immediately and after three months from implementing the program.

4.6. Data Analysis

The data collected was structured, tabulated, and statistically analyzed using SPSS (Version 20 of the statistical computer software package). Average and standard deviations were determined for the spectrum of quantitative variables. The number and percentage distribution were computed for qualitative variables. A Chi-square test was used to analyze the relationship between qualitative variables. Significance was adopted at $p \leq 0.05$ and highly statistically significant at $p \leq 0.001$.

5. Results

Table 1 represents the studied nurses' demographic characteristics. 40% of the studied nurses' age ranged from 20 to less than 30 years, with a mean age of 30.87 ± 5.59 years, and all of them (100%) were females. Concerning marital status, 92.5% were married. Regarding their education, the table reveals that 62.5% of nurses had a technical nursing institute certification. Regarding their

years of experience inside the oncology unit, 40% of the studied nurses had years of experience ranged from 1 year to less than five years, with mean \pm SD equal 13.3 ± 3.33 years. The table also indicates that 75% of the studied nurses did not attend any training courses regarding chemotherapy precautions in oncology units.

Table 2 compares the studied nurses' knowledge regarding chemotherapy pre, immediately, and after three months from program implementation. There were highly statistically significant differences in the studied nurses' knowledge regarding definition, action, and chemotherapy precautions ($p < 0.001$) between pre, immediately, and after three months of the educational intervention while statistically significant differences were presented regarding nurses' knowledge of classification, side effects, and chemotherapy documentation ($p < 0.05$) pre, immediately, and after three months from program implementation.

Table 3 compares nurses' knowledge regarding chemotherapy extravasation pre, immediately, and after three months from program implementation. High statistically significant differences were revealed in the studied nurses' knowledge regarding the definition and prevention of chemotherapy extravasation ($p < 0.001$). A statistically significant difference was revealed in the studied nurses' knowledge regarding causes, signs & symptoms, and management of chemotherapy extravasation ($P < 0.05$) pre, immediately, and after three months from program implementation.

Figure 1 illustrates that 85% of the studied nurses had unsatisfactory knowledge level pre-program implementation, while 95% had satisfactory knowledge immediately post-program implementation, and 75% had satisfactory knowledge after three months from program implementation.

Table 4 compares the studied nurses' practice regarding preventive strategies and extravasation management. There were highly statistically significant differences in the studied nurses' practice regarding preparing the insertion site and preparing chemotherapy ($P < 0.001$) pre, immediately, and after three months from program implementation. Statistically significant differences were revealed in the studied nurses' practice regarding the handling of chemotherapy, disposal of chemotherapy, and management of chemotherapy extravasation ($p < 0.05$) pre, immediately, and after three months from program implementation.

Figure 2 shows that 56% of the studied nurses had an inadequate level of practice pre-program implementation, while 94% had an adequate level of practice immediately post-program implementation, and 75% had an adequate level of practice after three months from the program implementation.

Table 5 reveals the relation between total nurses' knowledge and demographic characteristics pre, immediately, and after three months of program implementation. There were statistically significant relationships between satisfactory knowledge of the studied nurses' and their demographic characteristics

($p < 0.05$) immediately and after three months from program implementation.

Table 6 reveals the relation between adequate nurses' practice and demographic characteristics pre, immediately, and after three months of program implementation. There were statistically significant differences between the studied nurses' adequate practice and their demographic characteristics ($p < 0.05$) immediately and after three months from program implementation.

Table 7 demonstrates the correlation between total nurses' knowledge and total nurses' practice pre, immediately, and after three months of program implementation. There was a high statistically significant positive correlation between the total practice of the studied nurses' and their total knowledge ($p < 0.001$) pre, immediately, and after three months from program implementation.

Table (1): Frequency and percentage distribution of the studied nurses' demographic characteristics (N=40).

Demographic characteristics	N	%
Age (In years)		
20-<30	16	40.0
31-<40	13	32.5
> 40 years	11	27.5
Mean ± SD	30.87±5.59	
Gender		
Male	0	0.0
Female	40	100.0
Marital status		
Single	3	7.5
Married	37	92.5
Educational Level		
Secondary nursing school diploma	4	10.0
Technical institute of nursing diploma	25	62.5
Baccalaureate degree	11	27.5
Years of Experience in Oncology Unit		
1- <5 years	16	40.0
5- <10 years	14	35.0
> 10 years	10	25.0
Mean ± SD	13.3±3.33	
Attendance of training courses regarding chemotherapy precautions in oncology units		
Yes	10	25.0
No	30	75.0

Table (2): Comparison of the studied nurses' knowledge regarding chemotherapy pre, immediately post, and after three months of program implementation (N=40).

Items of knowledge	Preprogram implementation		Immediately post-program implementation				Three months post-program implementation				X ² P-value (1)	X ² P-value (2)	X ² P-value (3)		
	Correct		Incorrect		Correct		Incorrect		Correct					Incorrect	
	N	%	N	%	N	%	N	%	N	%				N	%
Definition of chemotherapy	36	90	4	10	40	100	0	0	40	100	0	0	36.190	15.824	8.485
Action of chemotherapy	25	62.5	15	37.5	39	97.5	1	2.5	39	97.5	1	2.5	24.000	12.130	4.444
Classification of chemotherapy	9	22.5	31	77.5	38	95	2	5	38	95	2	5	5.714	6.465	8.82
Side effects of chemotherapy	13	32.5	27	67.5	38	95	2	5	35	87.5	5	12.5	5.714	6.465	5.714
Precautions during chemotherapy administration	12	30	28	70	39	97.5	1	2.5	34	85	6	15	17.143	19.259	7.059
Documentation of chemotherapy	5	12.5	35	87.5	36	90	4	10	34	85	6	15	5.714	6.465	5.714

X² (1) between pre and immediately after program implementation, X² (2) between pre and three months after program implementation, X² (3) between immediately and three months after program implementation.

Table (3): Comparison of the studied nurses' knowledge regarding chemotherapy extravasation pre, immediately post, and after three months of program implementation (N=40).

Items of knowledge	Preprogram implementation				Immediately post-program Implementation				Three months post-program implementation				X2 P-value (1)	X2 P-value (2)	X2 P-value (3)
	Correct		Incorrect		Correct		Incorrect		Correct		Incorrect				
	N	%	N	%	N	%	N	%	N	%	N	%			
Definition of chemotherapy extravasation	25	62.5	15	37.5	39	97.5	1	2.5	39	97.5	1	2.5	24.000 <0.001	12.130 <0.001	14.444 <0.001
Causes of chemotherapy extravasation	13	32.5	27	67.5	38	95	2	5	35	87.5	5	12.5	8.81 <0.05	6.465 <0.05	5.714 <0.05
Signs and symptoms of chemotherapy extravasation	9	22.5	31	77.5	38	95	2	5	38	95	2	5	5.714 <0.05	6.465 <0.05	8.82 <0.05
Prevention of chemotherapy extravasation	12	30	28	70	39	97.5	1	2.5	34	85	6	15	17.143 <0.001	19.259 <0.001	7.059 <0.001
Management of chemotherapy extravasation	5	12.5	35	87.5	36	90	4	10	34	85	6	15	5.714 <0.05	6.465 <0.05	5.714 <0.05

X² (1) between pre and immediately after program implementation, X² (2) between pre and three months after program implementation, X² (3) between immediately and three months after program implementation.

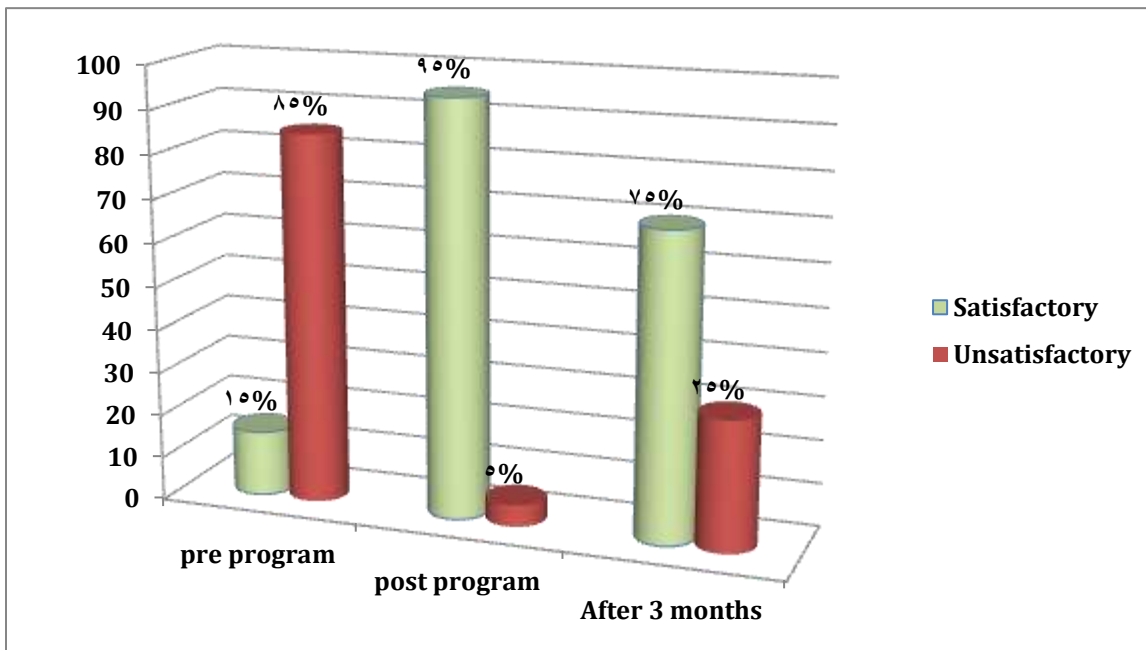


Figure (1): Percentages distribution of total nurses' knowledge pre, immediately post, and after three months of program implementation (N=40).

Table (4): Comparison of the studied nurses' practice regarding preventive strategies and extravasation management pre, immediately post, and after three months of program implementation (N=40).

Items of practice	Preprogram implementation				Immediately post-program implementation				Three months post-program implementation				X ² P-value (1)	X ² P-value (2)	X ² P-value (3)
	Done		Not done		Done		Not done		Done		Not done				
	N	%	N	%	N	%	N	%	N	%	N	%			
Preparing insertion site	28	70	28	70	39	97.5	1	2.5	34	85	6	15	24.000	12.130	14.444
Handling of chemotherapy	13	32.5	27	67.5	38	95	2	5	35	87.5	5	12.5	<0.001	<0.001	<0.001
Preparation of chemotherapy	28	70	28	70	39	97.5	1	2.5	34	85	6	15	6.04	6.465	8.83
Disposal of chemotherapy	9	22.5	31	77.5	38	95	2	5	38	95	2	5	<0.05	<0.05	<0.05
Management of Extravasation	5	12.5	35	87.5	36	90	4	10	34	85	6	15	17.143	19.259	7.059
													<0.001	<0.001	<0.001
													5.714	6.465	8.82
													<0.05	<0.05	<0.05
													5.714	7.03	6.04
													<0.05	<0.05	<0.05

X² (1) between pre and immediately after program implementation, X² (2) between pre and three months after program implementation, X² (3) between immediately and three months after program implementation.

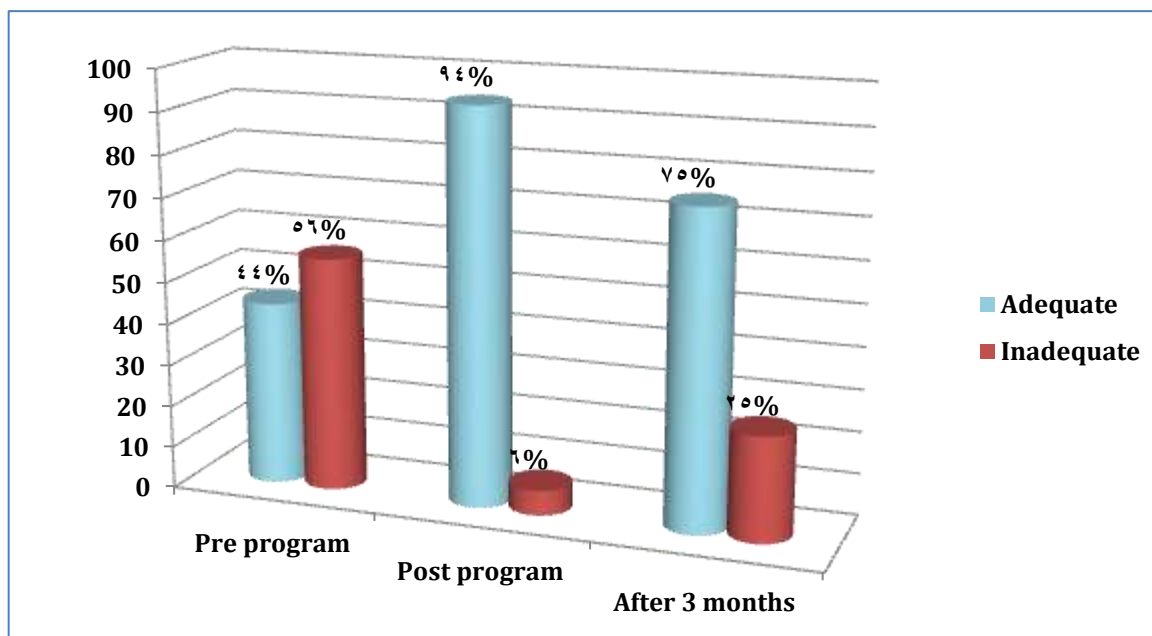


Figure (2): Percentage distribution of total nurses' practice pre, immediately post, and after three months of program implementation (N=40)

Table (5): Relation between satisfactory nurses' knowledge and sociodemographic characteristics pre, immediately post, and after three months of program implementation (N=40).

Variables	Satisfactory nurses' knowledge						X2 P-value (1)	X2 P-value (2)	X2 P-value (3)
	Preprogram implementation		Immediately post- program Implementation		Three months post- program implementation				
	No	%	No	%	No	%			
Age (in years)									
20-<30	0	0	16	40	16	40			
31-<40	0	0	10	25	10	25	-	6.64	
> 40 years	0	0	10	25	9	22.5	-	<0.05	
Total	0	0	36	90	35	87.5		<0.05	
Education level									
Nursing school	0	0	22	55	21	52.5			
Technical institute	0	0	3	7.5	3	7.5	-	8.86	
Bachelor	0	0	11	27.5	11	27.5	-	<0.05	
Total	0	0	36	90	35	87.5		<0.05	
Years of experience									
1- <5 years	0	0	10	25	10	25			
5- <10 years	0	0	7	17.5	7	17.5	-	7.22	
> 10 years	0	0	19	47.5	18	45	-	<0.05	
Total	0	0	36	90	35	87.5		<0.05	
Training courses									
Yes	0	0	17	42.5	16	40			
No	0	0	19	47.5	19	47.5	-	12.87	
Total	0	0	36	90	35	87.5		<0.05	

P1 between demographic and satisfactory knowledge pre, P2 between demographic and satisfactory knowledge immediately after implementation, P3 between demographic and satisfactory knowledge after three months of implementation.

Table (6): Relation between adequate nurses' practice and sociodemographic characteristics pre, immediately post, and after three months of program implementation (N=40).

Variables	Adequate nurses' practice						X2 P-value (1)	X2 P-value (2)	X2 P-value (3)
	Preprogram implementation		Immediately post- program implementation		Three months post- program implementation				
	No	%	No	%	No	%			
Age (in years)									
20-<30	0	0	14	35	11	27.5			
31-<40	0	0	7	17.5	3	7.5	-	0.478	
> 40 years	0	0	8	20	4	10	-	<0.05	
Total	0	0	29	72.5	18	45		<0.05	
Education level									
Nursing school	0	0	16	40	7	17.5			
Technical institute	0	0	2	5	1	2.5	-	0.048	
Bachelor	0	0	11	27.5	10	25	-	<0.05	
Total	0	0	29	72.5	18	45		<0.05	
Years of experience									
1- <5 years	0	0	9	22.5	9	22.5			
5- <10 years	0	0	6	15	3	7.5	-	0.478	
> 10 years	0	0	14	35	6	15	-	<0.05	
Total	0	0	29	72.5	18	45		<0.05	
Training courses									
Yes	0	0	17	42.5	12	30			
No	0	0	12	30	6	15	-	0.048	
Total	0	0	29	72.5	18	45.5		<0.05	

P1 between demographic and adequate practice pre, P2 between demographic and adequate practice immediately after implementation, P3 between demographic and adequate practice after three months of implementation.

Table (7): Correlation between total nurses' knowledge and total nurses' practice pre, immediately post, and after three months of program implementation (N=40).

Total Nurses' knowledge	Total nurses' practice		
	Preprogram implementation	Immediately post program implementation	Three months post program implementation
r	0.526	0.870	0.735
P-value	<0.001	<0.001	<0.001

6. Discussion

Extravasation results from the accidental escape of any liquid (fluid or drug) into the surrounding tissues. In terms of cancer therapy, extravasation identifies the unintended leakage of chemotherapy into the subcutaneous or subdermal tissues surrounding the intravenous or intra-arterial administration site (Pérez Fidalgo et al., 2012). Pressure, sting, burning, induration, erythema, swelling at the injection site, increased resistance to administration, and changes in the rate of infusion are signs and symptoms of potential extravasation (Schulmeister, 2011a).

The nurses develop the standard of practice in the field and improve the patient's safety in the long term so that a highly trained nursing workforce is needed to provide safe and efficient patient care. Besides, patients experienced lower mortality and better performance in hospitals with higher proportions of nurses qualified at the baccalaureate standard (Aiken et al., 2012).

The present study aimed to evaluate the effect of an educational program on nurses' performance regarding the prevention and management of intravenous extravasation chemotherapy. The study hypothesized that nurses' performance related to the prevention and management of intravenous extravasation chemotherapy would be improved after implementing the educational program compared to the pre-program. Also, there will be a significant correlation between nurses' knowledge and practice post-program implementation. The study findings are supporting the current research hypotheses.

Concerning the studied nurses' demographic characteristics, the present study revealed that more than two-fifths of the studied nurses were within the age group of 20-<30 years with a mean age of 30.87±5.59 years, all of them were females, and the majority of them were married.

These results were in the same line with Polovich (2010), who mentioned in his study entitled "Nurses' use of hazardous drug safe handling precautions." The majority of nurses were females in the middle-age. These results were incongruent with Sharour (2020), who reported in his study entitled "Oncology nurses' knowledge about exploring chemotherapy-related extravasation care" that nearly two-thirds of participants were males with a mean age of 26.4 years.

The present study illustrated that less than two-thirds of the studied nurse had the technical institute of nursing. This finding may be due to a shortage in the number of baccalaureate nurses working in oncology units. A study supported this result carried out by Corner and Barnett (2009), entitled "The newly registered nurse and the cancer

patient: An educational evaluation." They discovered that nurses graduating from the university were more competent than nurses with good experience. This result was incongruent with Sharour (2020), who reported that most participants held a bachelor's degree in nursing.

The current study revealed that two-fifths of the studied nurses had years of experience between (1-<5 years), and three-quarters of them did not attend any training courses about chemotherapy. This finding might be due to the lack of a hospital in-service training department, lack of training motivation, and an increased workload. These results were in the same line with Al-Attar et al. (2015), as they reported in their study entitled "Effectiveness of the nursing educational program upon nurses' knowledge and practices concerning chemotherapy precautions" that half of the nurses in the study group had (1-5) years of experience, and nearly half of the control group are in the same range. Most of the nurses in both groups did not attend any training sessions regarding chemotherapy precautions in oncology units. This result was also in agreement with Mohsen and Fareed (2013), who found in their study entitled "Safety protocol for oncology nurses" that most of the studied nurses did not receive any training program related to chemotherapy.

Concerning nurses' knowledge regarding chemotherapy, the present study showed statistically significant differences in the studied nurses' knowledge regarding definition, action, classification, side effects, precautions, and documentation of chemotherapy pre-program implementation, which improved immediately and after three months from program implementation. These results could be related to the inadequate preparation of the nurses in their undergraduate studies. Moreover, the lack of staff development and continuing education could be the reasons for these results. Furthermore, improvement immediately after implementing the program was related to the educational program's effectiveness in increasing nurses' level of knowledge.

This result was in agreement with Gozzo et al. (2017), who reported in his study entitled "Knowledge of the nursing team on the prevention and management of extravasation of chemotherapy drugs," concerning risk factors for extravasation, nurses displayed a lack of awareness. This result is incongruent with Sharour (2020), who reported that nurses had adequate knowledge of the concept of extravasation; fifty percent had proper knowledge of signs and symptoms. Many of the risk factors were identified as alarmingly unsatisfactory. The standard of nursing care may be impaired by failure to recognize risk

factors, increasing the extravasation of chemotherapy, and affecting the treatment plan.

This study revealed statistically significant differences in the studied nurses' knowledge regarding chemotherapy extravasation pre, immediately, and after three months from program implementation. As nurses' knowledge had increased significantly, immediately post-program implementation and after three months from program implementation than pre-program. This finding could be explained in light of increased nurses' knowledge, awareness about chemotherapy extravasation prevention, and nurses' desire to become competent in caring for their patients. Furthermore, nurses could change by themselves, but they need continuous training, supervision, and evaluation.

The present study's findings agreed with *El Sherif (2014)*, who mentioned in his study entitled "Nursing management for prevention of peripheral chemotherapeutic extravasation" that the educational program had improved nurses' knowledge and performance, particularly in minimizing chemotherapy extravasation. This result was incongruent with *Schulmeister (2011b)*, who stated in his article entitled "extravasation management: Clinical update" that extravasation was also happening despite healthcare professionals taking every measure and education to avoid extravasation and regardless of the expertise of the workers who administered the chemotherapy.

Regarding nurses' level of total knowledge about chemotherapy and its extravasation, the current study revealed that total scores of knowledge for more than three-quarters of nurses before program implementation were unsatisfactory. This finding was consistent with *ALmagid (2012)*, in his study entitled "Nursing care standards for cancer patients undergoing chemotherapy," who discovered that before applying nursing care standards for cancer patients undergoing chemotherapy, over half of the nurses had low knowledge scores.

On the opposite immediately, after implementing the educational program, most nurses' knowledge's total scores were satisfactory. This finding could be attributed to the program content developed based on nurses' needs, clarity, simplicity, and frequent repetition to reinforce nurses' knowledge. This result was in line with *Aziz et al. (2019)*, who reported in their study entitled "Audit on incidents and knowledge of nurses regarding chemotherapy extravasations at daycare oncology of a tertiary care hospital in Karachi, Pakistan" that there was a significant improvement in nurses' knowledge regarding prevention, prompt identification, and management of chemotherapy extravasation by continuous teaching sessions.

Moreover, three months after the program implementation, this percentage was slightly reduced as three-fourths of the nurses still had a satisfactory level in their total knowledge. This finding indicates that the improvement in knowledge was partially lost three months after the program implementation, reflecting the continuous need for educational enforcement. This result was in the same line with *Dawoud et al. (2017)*, as they mentioned in

their study entitled "Effect of intervention guidelines on nurses' performance regarding prevention and management of intravenous extravasation chemotherapy for children" that knowledge retention is usually affected by time.

The study revealed high statistically significant differences in the studied nurses' practice pre, immediately, and after three months from program implementation about nurses' practice regarding preventive strategies and extravasation management. This finding might be referred to the nurses gained new knowledge and skills that enabled them to be competent during their practice.

This result was in agreement with *Dawood et al. (2018)*, as they reported a significant improvement in nursing staff knowledge and performance concerning prevention and management of chemotherapy extravasation.

Regarding nurses' level of total practice related to chemotherapy administration, the present study results revealed that the total score of more than half of nurses' practice was inadequate before program implementation. This finding may be attributed to the lack of proper equipment needed to improve nursing care and the shortage of the oncology unit nursing staff, lack of supervision, and continuous evaluation regarding identified standards of patient care. This result was in agreement with *Mohamed (2015)*, who stated in his study entitled "Effect of a designed nursing protocol on nurses' knowledge and practice regarding chemotherapy," that most nurses had poor practice scores regarding chemotherapy administration.

On the contrary, immediately and three months after program implementation, it was evident that the program had effectively achieved its expected objectives. Nursing staff had significantly higher performance scores than before program implementation. This finding could be referred to as the new knowledge and skills that the nurses acquired made them more able to apply them during their daily practice. The present study agreed with *Mohsen and Fareed (2013)*, who mentioned an improvement in the nursing staff's overall practice score since the introduction of the chemotherapy safety protocol for oncology nurses.

Regarding the relation between total nurses' knowledge, practice, and demographic characteristics pre, immediately, and after three months of program implementation. The present study illustrated statistically significant differences between satisfactory knowledge, the adequate practice of the studied nurses' and their sociodemographic characteristics immediately and after three months from program implementation.

This result disagreed with *Al-Atiyyat and Banifawaz (2018)*, who reported in their study entitled "Oncology nurses' knowledge, practice, and confidence toward chemotherapy-induced peripheral neuropathy in Jordan" there was a positive relationship between higher education and nurses' knowledge. However, the relationship between nursing experience and knowledge was insignificant.

Regarding the correlation between total nurses' knowledge and practice, the present study indicated a statistically significant positive correlation between the

total practice of the studied nurses and their total knowledge pre, immediately, and after three months from program implementation. From the researcher's point of view, this might be due to knowledge being a prerequisite to practice, reflecting the need for continued supportive education.

This result was in the same line with *Qalawa et al. (2017)*, as they reported in their study entitled "the relation between oncology nurses' practice behaviors, knowledge, and confidence regarding chemotherapy-induced peripheral neuropathy" that there was a statistically significant positive correlation between nurses' knowledge and practice.

7. Conclusion

Based on the findings of the current study, it can be inferred that nurses' performance has been greatly improved concerning the prevention and management of intravenous chemotherapy extravasation that supports the first research hypothesis. Also, there was a significant correlation between nurses' knowledge and practice immediate post and after three months from program implementation that supports the second research hypothesis.

8. Recommendations

- In-service training programs should be conducted periodically and regularly to teach nurses the necessary clinical skills.
- Repeating the study on a high probability sample to achieve generalization of the findings.
- Stressing on the importance of documenting extravasation to decrease risks and complications.
- Special awards, accreditation, and qualification scheme should be taken into account to motivate nurses' involvement and registration in the training and education programs to be conducted in the workplace.

9. References

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