Effect of Implementing Intravenous Infusion Therapy Protocol on Nurses' Knowledge and Performance at Specialized Medical Hospital

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Abstract: Infusion therapy is one of the major responsibilities of nurses. In dealing with intravenous infusion, nurses must have knowledge about what is ordered, why it is indicated, its intended impact on the patient, and any possible side effects that may occur. They also must understand the rationale for intravenous fluid administration and the type of intravenous solution ordered. Education and training are two components of nursing staff development that occur after an employee's orientation. Thereby, this study aimed to evaluate the effect of implementing intravenous infusion therapy protocol on nurses' knowledge and performance at Specialized Medical Hospital. **Methodology:** a quasi experimental research design was utilized. This study was conducted on convenience sample of 50 female nurses who provide direct care for patients during the study period and willing to participate voluntarily in the study in all units; cardiology, hepatology, and diabetes & endocrinology unit at Specialized Medical Hospital. Data were collected using two tools; socio-demographic data & nurses' knowledge about intravenous infusion therapy questionnaire sheet and nurses' performance of the intravenous infusion therapy checklist. **Results:** The present study revealed that the total mean knowledge and performance score of nurses was increased immediately after implementation of the protocol with statistically significant difference. This increased level slightly decreased following one month of protocol implementation but still higher than before protocol implementation. **Conclusion:** implementing the designed nursing protocol about intravenous infusion therapy shows a significant improvement in nurses' knowledge and performance. **Recommendation:** continued nursing education about intravenous infusion therapy for nurses recommended to be organized regularly.
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Key words: intravenous infusion therapy protocol, nurses´ knowledge, nurses´ performance.

1. Introduction:

Intravenous therapy is the infusion of a substance directly into the patient's vein for therapeutic purposes. Intravenous therapy is an essential component of medical and nursing care because it is considered as a direct route for the administration of medications, fluids, and blood products [(1)]. The intravenous route is also a dangerous route of medication administration because the drug is entered directly into the bloodstream, it cannot be recalled, and its actions cannot be slowed [(2)].

Intravenous (IV) fluid therapy is one of the most common treatments provided in hospitals each year. Despite this, there is often lack of training for nurses in administering and managing this therapy. This makes nurses considering IV fluids as a routine therapy and often being unaware of its benefits, importance and associated risks. Nurses are needed to increase their knowledge and performance regarding IV fluid therapy to manage its possible complications and improve patient safety [(3)].

Intravenous solutions include two general categories: colloids and crystalloids. Colloids contain large molecules that don't pass through semipermeable membranes. Crystalloid solutions contain small molecules that flow easily across semipermeable membranes, allowing for transfer from the bloodstream into the cells and body tissues [(4).] Crystalloid solutions are classified according to their tonicity into isotonic, hypotonic, and hypertonic solutions [(5)].

Any nurse administering intravenous fluids and drugs must be competent in all aspects of intravenous therapy. Assessment and training should include both theoretical as well as practical components regarding intravenous fluid therapy, drug administration, local and systemic complications, infection control issues, use of equipment and risk management [(6,7)].

2. Aim of the study:

The aim of the study was to evaluate the effect of implementing intravenous infusion therapy protocol on nurses' knowledge and performance at Specialized Medical Hospital through three folds aims: 1- assess nurses' knowledge and performance regarding intravenous infusion therapy. 2- Design intravenous infusion therapy protocol. 3- Implement and evaluate the effect of intravenous infusion

therapy protocol on nurses' knowledge and performance.

3. Hypothesis:

There will be an improvement of nurses' knowledge and performance after implementing the intravenous infusion therapy protocol.

4. Subjects & Method:

Subjects and method of this study were discussed under the following four main designs; technical, administrative, operational, and statistical design.

4.1- Technical design:

4.1.1-Study Design:

Quasi experimental research design was utilized in this study.

4.1.2-Setting:

This Study was conducted at specialized medical hospital in the following; Cardiology, Hepatology, and Diabetes & Endocrinology unit.

4.1.3-Subjects:

All available (50) female nurses who provide direct care for patients during the study period, willing to participate voluntarily in the study, and accepted to give consents were included in the study.

4.1.4-Tool: two tools were used in this study.

Tool 1: Nurses' Knowledge about intravenous infusion therapy questionnaire: This tool was developed by the researcher after reviewing the related recent literature to assess nurses' knowledge about intravenous infusion therapy. It was in Arabic form and divided into two main parts:

Part 1: This part is concerned with socio demographic characteristics of the study subjects; it included questions related to personal characteristics of the studied nurses such as (age, educational level, and years of experience) in addition to questions regarding their previous attendance to any training courses, workshops, or conferences about intravenous infusion therapy.

Part II: This part is concerned with nurses' knowledge questionnaire about intravenous infusion therapy. It included 40 questions which divided into four main headings; nurses' general knowledge about intravenous infusion therapy, nurses' knowledge about intravenous fluids, nurses' knowledge about how to administer the intravenous infusion therapy, and nurses' knowledge about complications of intravenous infusion therapy.

Scoring of nurses´ knowledge: one degree was given for the correct answer to each question, while zero for incorrect, unknown, or missed answer. The answers were evaluated through using a model answer prepared by the researcher.

The rating scale for nurses´ knowledge was distributed as follow:

Rating scale	Percentage (%)	Score
Poor	< 50%	< 20
Fair	50 - 75%	20 – 30
Good	≥ 75%	≥ 30

Tool II: Nurses' performance of intravenous infusion therapy checklist:

This tool was developed by the researcher after reviewing the related recent literature to assess nurses' performance about intravenous infusion therapy. It included three main headings: preparation, administration, and discontinuation of intravenous infusion therapy.

Scoring of nurses´ performance checklist: one degree was given for each correct step performance and zero for each incorrect step performance. The total number of steps was 73. The total performance score ranged from (0-73) points.

The rating scale for nurses´ performance was distributed as follows:

Rating scale	Percentage (%)	Score
Poor	< 50%	< 37
Fair	50 - 75%	37 – 55
Good	≥ 75%	≥ 55

4.2- Administrative design:

To carry out the study, an official approval was obtained from Faculty of Nursing, as well as the Ethical Committee of Faculty of Nursing, Mansoura University. Tool of the study was developed and constructed by the researcher after reviewing recent related literature. Validity of the tool was ascertained by a panel of experts in medical and nursing fields for relevance, comprehensiveness, clarity, and applicability. Official approval for conducting the study was obtained from the responsible administrative personnel of the Specialized Medical Hospital based on an official letter from the Faculty of Nursing.

4.3- Operational design:

4.3.1- Pilot study:

A pilot study was carried out in order to test the clarity, feasibility, correctness, and the applicability of the study tool. In this study, ten nurses were included randomly to participate in the pilot testing of the questionnaire sheet. It also, provided an estimate of the time needed for answering the questionnaire sheet and they were excluded from total studied subjects.

4.3.2- Reliability test:

The reliability of the developed tools was estimated using Chronbach´s alpha test to measure

the internal consistency of the tools. It was found that the reliability for nurses´ knowledge questionnaire sheet using Chronbach´s alpha equation was (r = 0.815). Also, reliability was measured using the test retest method by using SPSS program version 16.0 which showed that reliability of nurses´s knowledge questionnaire was (r = 0.920). **4.3.3- Data collection:**

Data collected through 3 phases; preparation, implementation, and evaluation phase.

Preparatory phase: a review of the current and past, national and international literature related to the various aspects of the research was done using books, articles, periodicals, internet, and magazines. Preparation was included developing tools and protocol for nurses about intravenous infusion therapy.

Implementation phase: during this phase, the researcher introduced herself to the study group and gave them an idea about the aim of the study. Consent approval was obtained from each nurse included in the study. The researcher with nurses arranged session times and dates. Tool I was used to collect data relevant to nurses´ knowledge before implementation of the protocol (pretest). Observation of nurses´ performance was done at first (pretest) and indirectly to avoid nurses´ anxiety by using Tool II. The researcher provided all lectures in nurses´ room in each unit and implemented all portions of the protocol. There were two sessions; the first session related to knowledge part which lasted from 45- 75 minutes and the second session regarding performance part which lasted from 30-45minutes. Because it was difficult to teach the whole number of nurses at the same time, the researcher classified nurses in each unit into small groups (2-5) nurses considering their schedule of working hours. A post test was done immediately after implementing the protocol through the same knowledge questionnaire sheet and performance checklist which used in the pre test.

Evaluation phase: This phase focused on determining the effect of the protocol through using the same knowledge questionnaire sheet and performance checklist which used in pre and post tests after one month from implementing the protocol for follow up of nurses' knowledge.

4.3.4- Ethical consideration:

The researcher took into consideration all relevant ethical issues, including the following: the research approval was obtained; the aim of the study was explained to each nurse then verbal consent was obtained from each nurse participated in the study, ensuring nurses' privacy and confidentiality of the collected data during the study period, and they were assured that their information would be used only for research purposes. Voluntary participation as they were given an opportunity to refuse participation in the study.

4.4- Statistical analysis:

After collection of the data, it was analyzed using the statistical package of social science "SPSS" software. Results were presented as frequencies, percentage, chi square, paired t-test, Pearson correlation analysis to test the statistical significance of some variables. The p value of < 0.05 indicate a significant result while, P value > 0.05 indicates a non significant result.

5- Results:

This part represents the current study findings regarding the effect of implementing intravenous infusion therapy protocol on nurses' knowledge and performance at Specialized Medical Hospital. Findings of the present study revealed that, nurse's ages ranged from 21-32 years with mean age 25.1 ± 2.873 years. Nearly two third of nurses (60%) graduated from technical institute and 40 % of them graduated from nursing school. More than half of nurses (52%) had less than five years of experience, slightly more than one quarter of them (26%) had experience ranged from five to ten years, and 22 % of them had more than ten years of experience. No one of nurses had attended training courses/ workshops/ conferences in specialty field.

Table (1) shows mean scores of nurses' knowledge about intravenous infusion therapy pre, immediately, and one month after implementation of the protocol: there was a statistically significant increase in the mean scores of nurses´ general knowledge about intravenous infusion therapy, nurses´ Knowledge about intravenous fluids, nurses´ Knowledge about how to administer the intravenous infusion therapy, and nurses´ Knowledge about complications of intravenous infusion therapy immediately and one month after protocol implementation compared to before protocol implementation, while there was a slightly significant decrease in nurses' knowledge one month after protocol implementation compared to immediately after protocol implementation.

Table (2) shows mean scores of nurses' performance regarding intravenous infusion therapy pre, immediately, and one month after implementation of the protocol: there was a statistically significant increase in the mean scores of nurses´ performance regarding preparation, administration, and discontinuation of intravenous infusion therapy immediately and one month after protocol implementation compared to before protocol implementation, while there was a slightly significant decrease in nurses' performance one month after

protocol implementation compared to immediately after protocol implementation.

Table (3) shows total mean scores of nurses' knowledge and performance pre, immediately, and one month after implementation of the protocol about intravenous infusion therapy: there was a statistically significant increase in the mean scores of nurses' knowledge and performance regarding intravenous infusion therapy immediately and after one month from implementing the protocol compared to before implementing the protocol, while there was a statistically significant decrease in the mean scores of nurses' knowledge and performance regarding intravenous infusion therapy one month after implementing the protocol compared to immediately after implementing the protocol.

Table (4) shows total nurses' knowledge pre, immediately, and one month after implementation of the protocol about intravenous infusion therapy: most of studied nurses (90%) gained good knowledge score regarding intravenous infusion therapy immediately post implementing the protocol compared to 4% before implementing the protocol. This good knowledge score decreased to 46% after one month from implementing the protocol.

Table (5) shows total nurses' performance score pre, immediately, and one month after implementation of the protocol about intravenous infusion therapy: the majority of studied nurses (82%) gained good performance score regarding intravenous infusion therapy immediately post implementing the protocol compared to 2% before implementing the protocol. This good performance score decreased to 24% after one month from implementing the protocol.

Table (6) shows relationship between total nurses' knowledge score about intravenous infusion therapy and sociodemographic characteristics of nurses: there was no statistically significant difference between total nurses' knowledge score about intravenous infusion therapy and age, educational level, as well as years of experience of studied nurses in pre test, immediately post test, and after one month post test.

Table (7) shows relationship between total nurses' performance score regarding intravenous infusion therapy and sociodemographic characteristics of nurses: there was no statistically significant difference between total nurses' performance score regarding intravenous infusion therapy and age, educational level, as well as years of experience of studied nurses in pre test, immediately post test, and after one month post test.

Table (8) shows correlation between nurse's knowledge and performance regarding intravenous infusion therapy in pre, immediately after, and one month after post test: there was a mild positive significant correlation in between nurses´ knowledge and performance score before implementing the protocol. There was a negligible positive non-significant correlation in between nurses´ knowledge and performance score after implementing the protocol. Also, there was a negligible positive non-significant correlation in between nurses´ knowledge and performance score one month after implementing the protocol.

Table (1): Mean scores of nurses' knowledge about intravenous infusion therapy pre, immediately, and one month after implementation of the protocol (n=50).

Knowledge	Number of items	Pre-test Mean ±SD	Immediately post-test Mean ±SD	1month after post-test Mean ±SD	Significance test		
					T1	T2	T3
General Knowledge about intravenous infusion therapy	3	2.34±0.688	2.80±0.404	2.64±0.525	t = 5.039 p = 0.000	t = 3.90 p = 0.000	t = 2.682 p = 0.01
Knowledge about intravenous fluids	7	2.10 ± 2.09	6.10 ± 1.35	4.40 ± 1.44	t = 13.49 p = 0.000	t = 9.280 p = 0.000	t = 7.958 p = 0.000
Knowledge about how to administer the intravenous infusion therapy	3	2.54 ± 0.579	3.0 ± 0.0	2.92 ± 0.274	t = 5.619 p = 0.000	t = 5.067 p = 0.000	t = 2.064 p = 0.044
Knowledge about complications of intravenous infusion therapy	27	13.92 ± 3.54	23.34 ± 3.48	18.76 ± 3.37	t =17.878 p =0.000	t =10.904 p =0.000	t =10.781 p =0.000

(T1) test = Paired Samples T-test between pre-test and immediately post-test
(T3) test = Paired Samples T-test between immediately and 1month post-test
(T2) test=Paired Samples T-test between pre-test and one month post-test P = Significance

Table (2): Mean scores of nurses' performance regarding intravenous infusion therapy pre, immediately, and one month after implementation of the protocol (n=50).

Performance	Number of items	Pre-test Mean ±SD	Immediately post-test Mean ±SD	1month after post-test Mean ±SD	Significance test		
					T1	T2	T3
Preparation for intravenous infusion therapy administration	30	18.84 ± 1.799	23.96 ± 1.308	21.68 ± 2.004	t =23.603 p = 0.000	t =11.405 p = 0.000	t = 9.895 p = 0.000
Administration of intravenous infusion therapy	35	21.34 ± 2.723	28.44 ± 1.618	25.68 ± 2.171	t =19.817 p = 0.000	t = 14.563 p = 0.000	t = 10. 774 p = 0.000
Discontinuation of intravenous infusion therapy	8	4.28 ± 1.031	5.50 ± 1.111	4.98 ± 1.039	t = 8.328 p = 0.000	t = 5.584 p = 0.000	t = 3.157 p = 0.000

(T1) test= Paired Samples T-test between pre-test and immediately post-test
(T3) test =Paired Samples T-test between immediately and 1month post-test
(T2) test = Paired Samples T-test between pre-test and one month post-test P= Significance

Table (3): Total mean scores of nurses' knowledge and performance pre, immediately, and one month after implementation of the protocol about intravenous infusion therapy (n=50).

Item	Pre-test Mean ±SD	Immediately post-test Mean ±SD	1month after post-test Mean ±SD	Significance test		
				T1	T2	T3
Total mean knowledge score	20.88 ± 5.359	35.24 ± 4.452	28.86 ± 4.189	t =19.193 p = 0.000	t =14.472 p = 0.000	t =10.950 p = 0.000
Total mean performance score	44.46 ± 4.072	57.58 ± 2.949	51.82 ± 3.330	t =23.724 p = 0.000	t = 21.560 p = 0.000	t =11.667 p = 0.000

(T1) test =Paired Samples T-test between pre-test and immediately post-test
(T3) test = Paired Samples T-test between immediately and 1month post-test
(T2) test =Paired Samples T-test between pre-test and one month post-test P=Significance

Table (4): Total nurses' knowledge pre, immediately, and one month after implementation of the protocol about intravenous infusion therapy (n=50).

Score	Pre test		Immediately post test		After one month post test		Significance test		
	No	%	No	%	No	%	X^2_1	X^2_2	X^2_3
Poor < 50%	20	40.0	1	2.0	1	2.0	X^2 =74.53 p = 0.000	X^2 =34.90 p = 0.000	X^2 = 23.25 P = 0.000
Fair 50 - 75%	28	56.0	4	8.0	26	52.0			
Good ≥ 75%	2	4.0	45	90.0	23	46.0			

(X^2_1)=Chi square (significance) between pre test and immediately post test
(X^2_3)=Chi square (significance) between immediately and one month post
(X^2_2)= Chi square (significance) between pre test and one month post test P Significance

Table (5): Total nurses' performance score pre, immediately, and one month after implementation of the protocol about intravenous infusion therapy.

Score	Pre test		Immediately post test		After one month post test		Significance test		
	No	%	No	%	No	%	X^2_1	X^2_2	X^2_3
Poor < 50%	1	2.0	0	0.0	0	0.0	X^2 = 65.78 p = 0.000	X^2 = 11.47 p = 0.000	X^2 = 33.76 p = 0.000
Fair 50 - 75%	48	96.0	9	18.0	38	76.0			
Good ≥ 75%	1	2.0	41	82.0	12	24.0			

(X^2_1)=Chi square (significance) between pre test and immediately post test
(X^2_3)=Chi square (significance) between immediately and one month post
(X^2_2)= Chi square (significance) between pre test and one month post test P Significance

Table (6): Relationship between total nurses' knowledge score about intravenous infusion therapy and sociodemographic characteristics of nurses (n=50).

Socio-demographic characteristic	Pre test						Immediately post test						One month post test						Significance test		
	Poor		Fair		Good		Poor		Fair		Good		Poor		Fair		Good				
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	X^2_1	X^2_2	X^2_3
Age																					
< 25 years	9	36.0	14	56.0	2	8.0	0	0.0	1	4.0	24	96.0	0	0.0	11	44.0	14	56.0	X^2=6.15 p=0.188	X^2=3.57 p=0.466	X^2=3.41 p=0.490
25 – 29 years	11	52.4	10	47.6	0	0.0	1	4.8	3	14.3	17	81.0	1	4.8	12	57.1	8	38.1			
≥ 30 years	0	0.0	4	100.0	0	0.0	0	0.0	0	0.0	4	00.0	0	0.0	3	75.0	1	25.0			
Education level																					
Graduated from nursing school	8	40.0	12	60.0	0	0.0	1	5.0	3	15.0	16	80.0	1	5.0	12	60.0	7	35.0	X^2=1.43 p=0.489	X^2=3.91 p=0.141	X^2=3.9 p=0.141
Technical institute	12	40.0	16	53.3	2	6.7	0	0.0	1	3.3	29	96.7	0	0.0	14	46.7	16	53.3			
Years of experience																					
< 5 years	10	38.5	14	53.8	2	7.7	0	0.0	1	3.8	25	96.2	0	0.0	11	42.3	15	57.7	X^2=6.72 p=0.151	X^2=2.79 p=0.248	X^2=6.33 p=0.175
5 – 10 years	8	61.5	5	38.5	0	0.0	1	7.7	2	15.4	10	76.9	1	7.7	9	69.2	3	23.1			
> 10 years	2	18.2	9	81.8	0	0.0	0	0.0	1	9.1	10	90.9	0	0.0	6	54.5	5	45.5			

(X^2_1)=Chi square (significance) between pre test and immediately post test
(X^2_3)=Chi square (significance) between immediately and one month post
(X^2_2)= Chi square (significance) between pre test and one month post test P Significance

Table (7): Relationship between total nurses' performance score of intravenous infusion therapy and sociodemographic characteristics of nurses (n=50).

Socio-demographic characteristic	Pre test						Immediately post test						One month post test						Significance test		
	Poor		Fair		Good		Poor		Fair		Good		Poor		Fair		Good				
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	X21	X22	X23
Age																					
< 25 years	1	4.0	23	92.0	1	4.0	0	0.0	5	20.0	20	80.0	0	0.0	19	76.0	6	24.0	X^2=2.08 p=0.720	X^2=0.96 p=0.618	X^2=1.76 p=0.413
25 – 29 years	0	0.0	21	100.0	0	0.0	0	0.0	4	19.0	17	81.0	0	0.0	17	81.0	4	19.0			
≥ 30 years	0	0.0	4	100.0	0	0.0	0	0.0	0	0.0	4	100.0	0	0.0	2	50.0	2	50.0			
Education level																					
Graduated from nursing school	0	0.0	20	100.0	0	0.0	0	0.0	3	15.0	17	85.0	0	0.0	14	70.0	6	30.0	X^2=1.39 p=0.499	X^2=0.20 p=0.652	X^2=0.66 p=0.417
Technical institute	1	3.3	28	93.3	1	3.3	0	0.0	6	20.0	24	80.0	0	0.0	24	80.0	6	20.0			
Years of experience																					
< 5 years	1	3.8	24	92.3	1	26.0	0	0.0	5	19.2	21	80.8	0	0.0	20	76.9	6	23.1	X^2=1.92 p=0.750	X^2=0.85 p=0.655	X^2=0.08 p=0.959
5 – 10 years	0	0.0	13	100.0	0	0.0	0	0.0	3	23.1	10	76.9	0	0.0	10	76.9	3	23.1			
> 10 years	0	0.0	11	100.0	0	0.0	0	0.0	1	9.1	10	90.9	0	0.0	8	72.7	3	27.3			

(X^2_1)=Chi square (significance) between pre test and immediately post test
(X^2_3)=Chi square (significance) between immediately and one month post
(X^2_2)= Chi square (significance) between pre test and one month post test P Significance

Table (8): Correlation between nurse's knowledge and performance regarding intravenous infusion therapy in pre, immediately after, and one month after post test (n=50).

Variable	r value	P value
Pre test	0.299	0.035
Immediately post test	0.235	0.101
After one month post test	0.244	0.088

r =Correlation
P= Significance

6- Discussion:

Nurses' knowledge and skills in administering intravenous infusion therapy for patients can minimize infusion-related complications and affect patient safety; satisfaction, health care costs, and length of hospital stay [8].

The discussion of this study will cover four main areas; socio demographic characteristics of the studied nurses, the effect of implementing intravenous infusion therapy protocol on nurses' knowledge, the effect of implementing intravenous infusion therapy protocol on nurses' performance, and correlation between variables of the study.

Concerning socio-demographic characteristics of the studied nurses: The present study showed that, the majority of studied nurses were young with mean age (25.1 ± 2.873) years. It was in the line with **Mohamed (2015)** who reported that most of participants were less than 30 years with a mean age (24.5±3.5) years. In contrast, **Khalil (2013)** reported

that the mean age of nurses was (32.95±6.99) years. The present study also revealed that all of the studied nurses were female. It was in the line with **Mohamed (2011)** who also reported that the entire sample was females. In contrast, **Fashafsheh *et al.* (2013)** reported that more than half of the studied sample (54.3%) was male.

Regarding the educational level, the present study showed that more than half of nurses (60%) graduated from a technical institute. In contrast**, Seliman (2014)** reported that only 6% of the study subjects were technical nursing institute, while the majority of them (94%) had a diploma degree. Also **Khalil (2013)** reported that the majority of nurses (76.4%) graduated from nursing school. This may be related to distinction of setting which had an effect on findings of educational level.

As regard to years of experience, the present study showed that more than half of studied nurses (52%) had less than five years of experience. In the same line, **Ahmed (2007)** reported that 70.3% of nurses had less than five years of experience. Also **Mohamad (2014)** reported that 43.3% of the studied nurses had below 5 years of experience. In contrast, **Khalil (2013)** [10] reported that 60% of nurses had an experience more than 10 years. Also, **Seliman (2014)** found that, more than half of the study subjects (56%) had 15 or more years of experience, while 44% had less than 15 years of experience.

Concerning the attendance of previous training courses, the present study showed that all of the studied nurses didn't attend training courses in specialty field. This may be due to ignorance of nurses about the importance of continuous training courses, and this may be one of the causative factors that sharing into the lowest level of nurses' knowledge about intravenous infusion therapy. These findings were in accordance with the study of **Mahmoud (2009)** who reported that all nurses (100%) didn't participate in training programs. Also, **Khalil (2013)** found that 92.7% of the studied nurses did not attend any training program in speciality field. In contrast, **Emad (2011)** reported that 77.5% of the studied nurses participated in continuous nursing education program.

Effect of implementing intravenous infusion therapy protocol on nurses' knowledge:

Concerning nurses' knowledge about how to administer the intravenous infusion therapy, the present study showed that there was a significant increase in the mean score of nurses' knowledge about how to administer the intravenous infusion therapy immediately and one month after implementing the protocol compared to before implementing the protocol. In the same line, **Al Yousef (2014)** reported that there was a significant improvement in knowledge of the studied subject regarding specific measures of infection control when giving intravenous infusion.

Concerning nurses' knowledge about intravenous fluids, the present study showed that more than half of the studied nurses (58%, 56%, and 54%) didn't know the definition of isotonic, hypertonic, and hyoptonic fluids, which improved after sessions to be 8%. This finding was supported by **Mohamed (2011)** who reported that 40% of nurses didn't know definition of HCV, which improved after sessions to be 8%.

The present study showed that there was a statistically significant increase in the mean score of nurses' knowledge about complications of intravenous infusion therapy immediately and one month after protocol implementation compared to before protocol implementation. This finding was supported by **Shahin (2012)** who reported that there was a statistically significant increase in the mean score of nurses' knowledge about complications of enteral nutrition after program implementation and one month following program implementation compared to before program implementation. Also, **Khalil (2013)** reported that there was a statistically significant difference in level of nurses' knowledge about complications of blood transfusion on pre and post test.

The present study showed that there was a statistically significant increase in the mean score of nurses' knowledge about intravenous infusion therapy immediately and one month after protocol implementation compared to before protocol implementation. This finding was supported by **Refaey (2012)** who reported that there was a statistically significant increase in the mean knowledge scores of nurses about advanced cardiac life support immediately and three month after implementation of the program compared to before implementation of the program. Also, **Smith &Waugh (2009)** found that nurse's knowledge were significantly higher when exposed to educational material.

Similar findings reported by **Seliman (2014)** who reported that there was a statistically significant increase in the mean knowledge scores of nurses about management of traumatic head injury patients immediately after implementation of the protocol and two month following protocol implementation compared to before implementation of the protocol. Also, **Mohamed (2015)** reported that nurses' knowledge regarding pressure ulcer were improved after implementing the program as there was a statistically significant difference between pre, post test and follow up (2 months) of nurses' knowledge regarding pressure ulcer at (p-value <.05).

Regarding total nurses' knowledge score, the present study showed that most of the studied nurses (90%) had good level of knowledge about intravenous infusion therapy immediately after implementing the protocol which partially decreased to 46% one month after protocol implementation compared to 4% before implementing the protocol. This finding was supported by **Mohamed (2015)** who reported that 29.5% of the studied nurses had satisfactory knowledge regarding pressure ulcer pretest, while the majority of participants (87.5%) had satisfactory knowledge regarding pressure ulcer after application of the program. This improvement was partially lost to 80% during follow up assessment. Also, **Al Yousef (2014)** reported that 12.1% of the studied nurses had a good knowledge score regarding infection control before guidelines implementation which improved to be 84.8% after guidelines implementation.

Similar findings reported by **Mahmoud (2009)** who reported that 20% of the studied nurses had a good knowledge score before program implementation which improved to be 94% after program implementation. Also, **Khalil (2013)** reported that no one of the studied nurses (0%) had good knowledge score about blood, blood transfusion and complication before implementing the protocol which become 87.3% after protocol implementation.

The present study showed that there was no statistically significant difference between total nurses' knowledge and their age group, years of experience, and level of education.. This may be attributed to transfer of inappropriate knowledge from old to new nurses that in turn lead to following the same mistakes in caring for patients. In the same line **Khalil (2013)** showed that there was no significant difference between nurses' knowledge and their age group and years of experience in medical surgical nursing. Also, **Sheta (2006); Shalby (2005); and Osman (2001)** reported that the relationship between knowledge and years of experience, was found to be not significantly changing in pre-, immediate post- and follow- up of the program implementation.

In contrast, **Abdulla & Abdulla (2014)** reported that there was a positive significant statistical correlation between age and knowledge of nurses' staff (increase knowledge with increase age of nurses). Also, **Eskander (2013)** reported that there was a statistically significant difference between total nurses' knowledge and their age, years of experience, and work shift.

Effect of implementing intravenous infusion therapy protocol on nurses' performance:

The present study showed that there was a significant improvement in nurses´ performance regarding insertion of the cannula in between before and after implementing the protocol. This was supported by **El said (2015)** who found that there was a significant improvement in nurses´ performance regarding peripheral venous cannulation in between before and after implementing the strategies.

The present study showed that there was a statistically significant increase in the mean score of nurses' performance regarding intravenous infusion therapy immediately and one month after protocol implementation compared to before protocol implementation. This finding was supported by **Seliman (2014)** who reported that there was a statistically significant increase in the mean score of nurses' practice immediately post implementing the protocol and two months following the protocol implementation compared to before protocol implementation. Also, **Khalil (2013)** revealed that there was a great improvement in the practice score levels obtained by nurses after implementation of the nursing intervention program.

Regarding total nurses' performance score, the present study showed that the majority of nurses (82%) had a good level of performance regarding intravenous infusion therapy immediately after implementing the protocol, which partially decreased to (24%) one month after implementation of the protocol compared to (2%) before implementing the protocol. This finding was supported by **Al Yousef (2014)** who reported that 27.3% of the studied nurses had a good performance score regarding infection control before guidelines implementation which improved to be 84.8% after guidelines implementation.

Regarding the relationship between total nurses' performance score and socio-demographic characteristic of studied nurses, the present study showed that there was no statistically significant difference between total nurses' performance and their age group, years of experience, and level of education. In the same line, **Mohamed & Wafa (2011)** reported that there were no significant statistically differences between practice score and age of participants. In contrast, **Ragab (2013)** showed that significant relation was found between level of education and practice regarding total practice's scores through all the study periods.

Correlation between nurses' knowledge and performance:

The present study showed that there was a mild positive significant correlation in between nurses´ knowledge and performance score before sessions. This was in line with **Seliman (2014)** who reported that there was a statistically significant correlation between knowledge scores and total practice scores of the study subjects before sessions.

The present study showed that there was a negligible positive, non significant correlation in between nurses´ knowledge and performance score after sessions. In the same line, **Abd El-Aziz (2003)** found that there was no statistically significant correlation between the nurse's level of knowledge and practices. In contrast, **Ragab (2013)** showed that there was a highly significant relation between nurse's knowledge and practice as regards immediate post and 3months following the program implementation.

Conclusion:

In the light of the present study findings, it can be concluded that:

- Nurses' knowledge and performance regarding intravenous infusion therapy was inadequate. Nurses are potentially capable of improving their knowledge and performance after exposure to intravenous infusion therapy protocol.
- Implementing the intravenous infusion therapy protocol was effective and improved nurses´ knowledge and performance regarding intravenous infusion therapy.

Recommendation:

Based upon findings of the present study, the following suggestions are recommended:

For nurses:

- Continued nursing education in Specialized Medical Hospital should be well organized and equipped with adequate educational facilities and materials necessary to upgrade the knowledge and performannce of nurses, which will be reflected on better outcome and service for the inpatients.
- Nurses should add to their routine obligations the regular reading of up-to-date references (periodicals, textbooks, etc.). They should always be encouraged to attend scientific meetings and conferences to keep pace with the rapidly growing wealth of knowledge and performance necessary for proper nursing service.
- Newly employed nurses are required to successfully complete a test of basic knowledge and performance before assuming independent responsibility for patient care.

For administration:

- Adequate supplies and facilities should be available in each unit.
- Orientation program for all newly employed nurses and in service training program for experienced nurses about intravenous infusion therapy.
- Availability of manual procedures for nurses to be aware of handling any problems that may arise.
- Periodically and continuously, evaluation of nurse's performance should be done to improve quality of their performance.

For further research:

- Replication of the study on a larger probability sample acquired from different geographical areas in Egypt to figure out the main aspects of this problem.

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