

## Nurses' Performance Regarding Infusion Pumps' Medication Administration among Critically Ill Patients

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### Abstract

**Background:** An infusion pump is a medical device that delivers fluids, such as nutrients and medications, into a patient's body in controlled amounts. Nurses have an important role in ensuring safety in the infusion pumps' medication administration process. This study **aimed** to assess the nurses' performance regarding the infusion pumps' medication administration among critically ill patients. The study **design** was a descriptive exploratory design. It was **conducted** at the cardiac intensive care units at The Center of Cardiac and Digestive System at Sohag. The **study subjects** included a convenience sample of 30 nurses. Two **tools** were used for data collection, tool I: A designed infusion pumps' questionnaire; it included two parts; part 1 is concerned with the assessment of the demographic characteristics of nurses, part 2, nurses' knowledge questionnaire regarding intravenous medication administration using infusion pumps, and tool II: An infusion pumps' medication administration observational checklist. The main study **results** showed that near three quarter of the studied nurses had an unsatisfactory level of total knowledge regarding infusion pumps' medication administration among critically ill patients, more than half of them had unsatisfactory level of total practice regarding infusion pumps' medication administration among critically ill patients and there was a statistical significant correlation between the total nurses' knowledge and their total practice level regarding infusion pumps' medication administration among critically ill patients. It was **concluded** that the studied nurses' knowledge and practice were inadequate and there was statistical significant correlation between the total nurses' knowledge and their total practice. It was **recommended** that health care settings should provide in-service educational programs and upgrading courses based on evidence based guidelines to improve the nurses' knowledge and practice regarding the administration of intravenous medications using infusion pumps.

**Key words:** Nurses' performance, Infusion pump, critically ill patients.

### Introduction

Acutely ill patients with life-threatening conditions require constant care, monitoring and a number of life-sustaining medications. The administration of medication and fluids into a patient's veins is referred to as intravenous (IV) administration, and about 90% of

hospitalized patients receive medications this way (Fan et al., 2014).

An infusion pump electronically regulates the flow of intravenous solutions and drugs. They are used when a precise flow rate is required for instance, when administering total parenteral nutrition solutions and chemotherapeutic or cardiovascular agents (Abramovitz, 2015).

## Nurses' Performance Regarding Infusion Pumps' Medication Administration Among Critically Ill Patients

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Programmable syringe pumps deliver solutions such as fluids, medications, or blood products to patients. They are capable of delivering at low infusion rates in increments as small as tenths or hundredths of a milliliter per hour, and programming capabilities can include intermittent, fixed-volume, constant-rate infusions, and, particularly with critically-ill patients, continuous infusions subject to frequent adjustment or titration, as needed. They are commonly used in settings where patients may need highly concentrated medication doses because of fluid restriction or fluid intolerance (Food and drug administration, 2016).

Infusion pumps are in widespread use in clinical settings such as hospitals, nursing homes, and in the home. They are operated by a trained user, who programs the rate and duration of fluid delivery through a built-in software interface. The application of infusion pump is helpful for lightening nurses' work strength, improving the accuracy and efficiency(Xuemei et al., 2017).

A review of the United States Food and Drug Administration records over a 4-year period revealed that there were 87 infusion pump recalls and 56,000 adverse events (including 710 deaths) associated with infusion pump use. Since 2010, organizations such as the Association for the Advancement of Medical Instrumentation and the Food and Drug Administration have made improving the safety of infusion pumps a priority (Fan et al., 2014).

An Analysis of high alert medication administration observational checklist that covered Pre-administration, administration and post-administration of selected intravenous high alert medications by using infusion pump revealed that 98.6% of the studied nurses have got unsatisfactory level of practice before administration, during administration and after administration. several factors may have relevance to this

finding are inadequate nurses' knowledge, increased number of patients, inadequate staffing, nurses' work load, inadequate communication between nurses and physicians, and absence of updating courses regarding high alert medications (Samy et al., 2014).

Nurses have an important role in ensuring safety in the medication administration process; the role of the nurse in safely managing this ever-changing technology should not be underestimated, the nurses have to keep up to speed with the technology as it develops. Administering drugs is one of the most critical nursing responsibilities. It highlights the importance of fully integrating infusion pumps into intravenous therapy training and assessment. Nurses have to identify the breadth of practices, education associated with administering of infusions in critical care units and potential patient safety issues related to IV pump infusions(Pinkney et al., 2014 and Abramovitz, 2015).

### Aim of study:

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The aim of the study was to assess the nurses' performance regarding infusion pumps' medication administration among critically ill patients through the following:

1. Assess the nurses' level of knowledge regarding the infusion pumps' medication administration among critically ill patients.
2. Measure the nurses' level of practice regarding the infusion pumps' medication administration among critically ill patients.

### Research questions:

1. What is the nurses' knowledge regarding infusion pumps' medication administration among critically ill patients?
2. What is the nurses' practice regarding infusion pumps' medication

administration among critically ill patients?

3. Is there a relation between the nurses' knowledge and their practice regarding infusion pumps' medication administration among critically ill patients?

**The study was portrayed under the four designs as follows:-**

- I. Technical design
- II. Operational design
- III. Administrative design
- IV. Statistical design

**I-The technical design**

The technical design included research design, setting, subjects, and tools of data collections

**Research design:**

Descriptive exploratory design was used to achieve the aim of this study.

**Setting:**

This study was conducted at the cardiac intensive care units at **The Center of Cardiac and Digestive System** at Sohag Governorate, affiliated to the Ministry of Health. The cardiac intensive care units in the center include two units; the post operative cardiothoracic surgery intensive care unit and the cardiac care unit.

**Subjects:**

A convenience sample of 30 female nurses were working at the previously mentioned setting were recruited to participate in the study, 16 nurses at the cardiac care unit and 14 nurses at postoperative cardiothoracic surgery intensive care unit.

**Tools of data collection:**

Data collection was obtained using two tools, they were developed by the

investigator based on the relevant and most recent literatures (**Pinkney et al., 2014 and Mukoreka & Sisay, 2015**) and reviewed by a panel of experts in critical care nursing; they consisted of the following:

**I. A designed Infusion pumps' Questionnaire tool:**

It was written in English language and translated into simple Arabic language to suit all the educational levels of the studied nurses; it was closed ended questions and filled by the studied nurses themselves. It included two parts:

**Part 1:** It was concerned with the assessment of the demographic characteristics of the nurses such as age, educational level, years of experience, patient / nurse ratio, working unit, attending training programs and presence of nursing procedures' manual (7 items).

**Part 2:** It was concerned with the assessment of nurses' knowledge regarding intravenous medication administration using a selected type of infusion pumps among critically ill patients; it was translated into simple Arabic language. The questionnaire consisted of 25 questions in the form of multiple choice questions (MCQ) and true/false questions. It covered 8 main parts about the syringe pumps' medication administration, which were:

1. Definition of the syringe pumps (1 item)
2. Preparing and setting up an intravenous infusion (7 items)
3. Infusion calculations (3 items)
4. Managing the dead volume in intravenous lines (7 items)
5. Identifying an infusion from multiple intravenous infusions (2 items)
6. Disadvantage of the syringe pump (1 item)

## Nurses' Performance Regarding Infusion Pumps' Medication Administration Among Critically Ill Patients

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7. Labeling (2 items)

8. Infusion observation & patient monitoring (2 items)

### ❖ Scoring system

The total score was 25 marks, one mark for correct & zero for incorrect response. The results of scoring system were classified as followed:

- Satisfactory knowledge level: Equal to or more than 80%.
- Unsatisfactory knowledge level: Less than 80%.

### II. An infusion pumps' medication administration observational checklist:

It was developed by the researcher using the most recent and relevant literatures (Pinkney et al., 2014 and Mukoreka & Sisay, 2015). This tool was written in English language. It was used to assess the nurses' level of practice regarding infusion pumps' medication administration among critically ill patients. It included 81 steps which composed of 91 items after the not applicable items were excluded. The tool was divided into four main parts and their sub- items as follows:

1. Preparing phase (19 items)

2. Priming and setting up phase(22 items)

3. Administration phase (35 items)

- General administration steps (8 items)
- Identifying an infusion from multiple IV infusions (15 items)
- Administering medication by intravenous push through an intravenous infusion (12 items)

4. Post administration phase (15 items)

### ❖ Scoring system:

One mark for correctly done and the incorrectly done or not done take zero. The not applicable items were not included in total score and removed from the table.

The results of scoring system are classified as follows:

- Satisfactory practice level: Equal to or more than 80%.
- Unsatisfactory practice level: Less than 80%.

### II-Operational design

The operational design included preparatory phase, content validity and reliability, pilot study and field work.

#### Preparatory phase

It included reviewing the current and past local and international related literature and the theoretical knowledge of various aspects of the study using books, articles, internet, periodicals and magazines to develop tools of data collection.

#### Content validity and reliability

After the construction of data collection tools, face and content validity of the tools was assessed by a jury group consisted of 9 experts in medical surgical nursing department, Ain Shams University. The tools were distributed to the jury to judge its comprehensiveness, clarity and accuracy. The tools were rephrased based on the jury opinions. Based on their recommendation, addition, correction and modifications of some items were done.

Internal consistency reliability was assessed in the present study tools via Cronbach's Alpha reliability analysis to indicate how well the items in an instrument fit together conceptually, (Alpha

Cronbach's test scores were 0.88 and 0.92 for the questionnaire about nurses' performance and the observational checklist respectively).

### **Ethical consideration**

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Approval was obtained from the scientific research ethical committee of the faculty of Nursing, Ain Shams University. Participation in this study was voluntary; nurses were informed about the purpose, procedure, benefits, and the nature of the study. Nurses were informed about their rights to withdraw from the study without any cause; and the obtained data will not be used in any research. Confidentiality and anonymity of each nurse was assured through coding of all data.

#### **Pilot study**

A pilot study was carried out on 3 nurses (10%) to test feasibility, objectivity, and applicability of the study tools. Based on the results of the pilot study, needed refinements and modifications were done and pilot study subjects were excluded from the actual study subjects.

#### **Fieldwork**

Nurses who agreed to participate in the study were informed by the researcher about the nature and purpose of the study. Data were collected in three months from beginning of August 2017 to the end of October 2017. The researcher visited the two cardiac intensive care units during the actual work at the long day shift from 8 am to 8 pm or the night shift from 8 pm to 8 am two days weekly. First, each nurse was observed separately three times (for each phase) during infusion pumps' medication administration procedures using the observational checklist (tool II) and it took about 30-40 minutes, the mean of the three observations was calculated and recorded by the researcher; then, the designed infusion pumps' questionnaire (tool I) was filled by the nurses themselves, it took about 20-30 minutes. The answers were recorded by the

nurses regarding demographic characteristics in 10 minutes and knowledge in 20 minutes. The researcher clarified and answered any related questions.

### **III-Administrative design**

An official permission was taken from the nursing and medical directors of the center of cardiac and digestive system in Sohag Governorate after explaining the aim of the study to gain their approval.

### **IV-Statistical design**

All data were collected, tabulated and subjected to statistical analysis. Statistical analysis is performed by Statistical Package for the Social Sciences (SPSS) in general (version 17), also Microsoft Office Excel is used for data handling and graphical presentation. Quantitative variables are described by the Mean, Standard Deviation (SD). Qualitative categorical variables are described by proportions and percentages.

Chi squared test is applied for categorical variables and Pearsons' correlation coefficient for quantitative variables. Significance level is considered at  $P < 0.05(S)$ ; while for  $P > 0.001$  is considered highly significant (HS). Two tailed tests are assumed throughout the analysis for all statistical tests.

### **Result:**

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**Table(1):**demonstrates that, the mean age of the studied nurses was  $23.03 \pm 2.17$ , the mean years of experience was  $3.33 \pm 1$ , as well as all (100%) of nurses had no manual of nursing procedures and policies about the patient safety regarding infusion pumps' medication administration in their working place. Also, 66.6% of the patient / nurse ratio exceeded one patient for every one nurses and 46.7% of the studied nurses didn't attend a training work shop or programs about infusion pumps' medication administration.

## Nurses' Performance Regarding Infusion Pumps' Medication Administration Among Critically Ill Patients

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**Figure (1):** Shows that, 66.70% of studied staff nurses had a technical institute diploma.

**Table (2):** Shows that 86.7% of the studied nurses had satisfactory knowledge level regarding defining the syringe pump, while the nurses' knowledge level was unsatisfactory regarding intravenous infusion calculations, managing the dead volume in intravenous lines, labeling and infusion monitoring & patient observation (93.3%, 56.7%, 56.7% and 56.7%) respectively.

**Figure (2):** shows that 70% of the studied nurses had unsatisfactory total knowledge regarding infusion pumps' medication administration among critically ill patients, while only 30% of the studied nurses had satisfactory total knowledge.

**Table (3):** illustrates that 63.3% of the studied nurses had an unsatisfactory level of total practice regarding the infusion pumps' medication administration among critically ill patients. In relation to the practice subtotal items; the studied subjects had a satisfactory level of practice regarding the administration phase (56.7%) and the post administration phase (50%). While they had an unsatisfactory level of practice regarding the preparing, priming and setting up phase (66.7 & 66.7%). The sub items of the administration phase revealed that 76.7% of the studied nurses had satisfactory level of practice regarding the administering medication by intravenous push through an intravenous infusion.

**Figure (3):** shows that 63.3% of the studied nurses had unsatisfactory total practice regarding infusion pumps' medication administration among critically ill patients, while only 36.7% of the studied nurses had satisfactory total practice.

**Table (4):** describes the critical items mostly neglected by the studied nurses. The studied nurses neglected the important steps of completing a drug additive label with the name and signature of the person starting the infusion, applying an adhesive label to the IV tubing, placing a label on tubing with the appropriate date, completing a drug additive label with patient's name, standardizing infusion system communication by using adhesive labels and using an antiseptic swab to clean the access port or stopcock (96.7%, 96.7%, 93.3%, 93.3%, 93.3% & 90%) respectively.

**Table (5):** describes that there was no statistically significant relation between total nurses' knowledge level and their qualifications ( $P = 0.258$ ), while there was a statistically significant relation between the total nurses' knowledge and their years of experience, the patient /nurse ratio, their working place and training ( $P = 0.007$ ,  $P = 0.040$ ,  $P = 0.025$  &  $P = 0.010$ ) respectively.

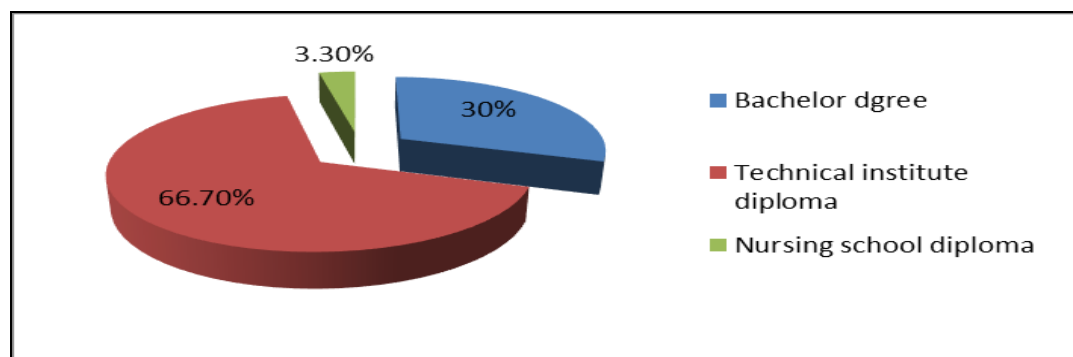
**Table (6):** describes that there was no statistically significant relation between the total nurses' practice level and their qualifications, the patient /nurse ratio and their working place ( $P = 0.282$ ,  $P = 0.309$  &  $P = 0.510$ ), whereas there was a statistically significant relation between the total nurses' practice level and their years of experience and training ( $P = 0.0012$  &  $P = 0.0017$ ) respectively.

**Table (7):** displays that there was statistically significant relation ( $\chi^2 = 4.983$ ;  $P = 0.256$ ) and correlation ( $r = 0.54$ ;  $P = 0.002$ ) between the total nurses' knowledge and their total practice level regarding infusion pumps' medication administration among critically ill patients.

**Table (1):** Number and percentage distribution of the demographic characteristics among the studied nurses (n=30).

Item	Study sample	
	N	%
<b>Age</b>		
20- < 30 years old	30	100%
30 - <40 years old	0	0%
More than 40 years	0	0%
Mean ± SD	23.03 ± 2.17	
<b>years of experience</b>		
1-<5 years	25	83.3%
5 - <10 years	5	16.7%
Mean ± SD	3.33 ± 1.9	
<b>Patient / nurse ratio in the unit</b>		
One patient /nurse.	10	33.3%
Two patients /nurse.	13	43.3%
Three patients /nurse.	7	23.3%
<b>Working place</b>		
Cardiothoracic surgery ICU	14	46.7%
Cardiac care unit CCU	16	53.3%
<b>Attending training work shop/ programs</b>		
No	14	46.7%
Yes	16	53.3%
<b>Presence of nursing procedures' manual and policies</b>		
No	30	100%
Yes	0	0%

**Figure (1):** The percentage distribution of the staff nurses' qualification degree (n=30).

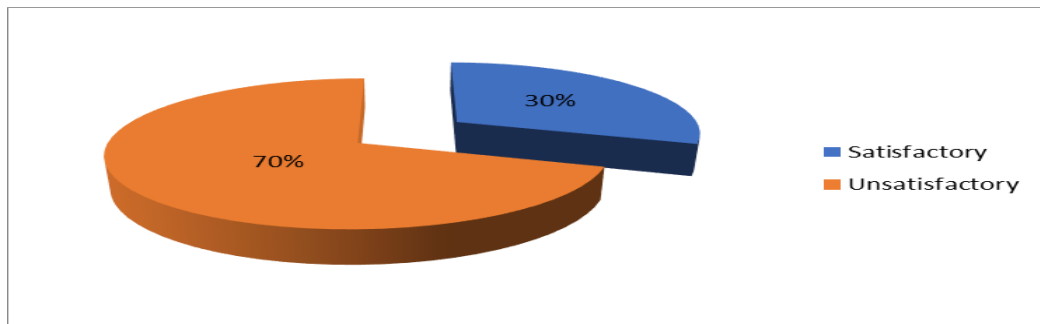


## Nurses' Performance Regarding Infusion Pumps' Medication Administration Among Critically Ill Patients

**Table (2):** Number and percentage distribution of the total and subtotal nurses' knowledge level regarding infusion pumps' medication administration among critically ill patients (n=30).

Knowledge items	Satisfactory		Unsatisfactory		Mean	± SD
	N	%	N	%		
Definition of the syringe pumps	26	<b>86.7%</b>	4	13.3%	86.67	± 34.57
Preparing & setting up an intravenous infusion	18	60%	12	40%	81.89	± 12.42
Intravenous infusion calculations	2	6.7%	28	<b>93.3%</b>	33.33	± 30.33
Managing the dead volume in intravenous lines	13	43.3%	17	56.7%	75.69	± 16.85
Identifying infusion from multiple intravenous infusions	19	63.3%	11	36.7%	81.67	± 24.51
Disadvantages of the syringe pump	16	53.3	14	46.7%	53.33	± 50.74
Labeling	13	43.3%	17	56.7%	71.67	± 25.20
Infusion observation & patient monitoring	13	43.3%	17	56.7%	68.33	± 30.75
<b>Level of total knowledge</b>	<b>9</b>	<b>30%</b>	<b>21</b>	<b>70%</b>	<b>71.47</b>	<b>± 14.39</b>

**Figure (2):** The percentage distribution of the staff nurses' total knowledge level regarding infusion pumps' medication administration among critically ill patients (n=30).

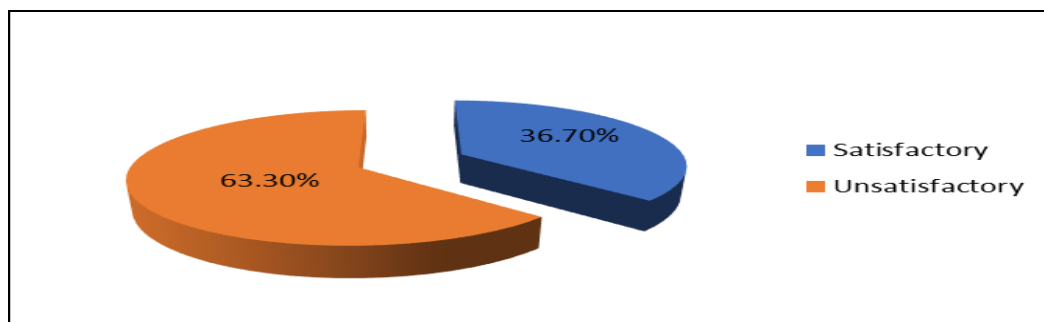


**Table (3):** Number and percentage distribution of the total and subtotal nurses' practice level regarding infusion pumps' medication administration among critically ill patients (n=30)

Practice items	Satisfactory		Unsatisfactory		Mean	± SD
	N	%	N	%		
<b>Preparing phase</b>	10	33.3%	20	<b>66.7%</b>	66.49	± 23.96
<b>Priming and setting up phase</b>	10	33.3%	20	<b>66.7%</b>	70.87	± 12.62
<b>Administration phase</b>						
a) General administration steps	11	36.7%	19	<b>63.3%</b>	70.42	± 25.95
b) Identifying an infusion from multiple IV infusion	13	43.3%	17	56.7%	65.33	± 23.84
c) Administering medication by intravenous push through an intravenous infusion	23	<b>76.7%</b>	7	23.3%	87.78	± 18.14
<b>Total Administration phase</b>	<b>17</b>	<b>56.7%</b>	<b>13</b>	<b>43.3%</b>	<b>74.19</b>	<b>± 21.06</b>
<b>Post administration phase</b>	15	<b>50%</b>	15	50%	73.78	± 17.93
<b>Total Practice</b>	<b>11</b>	<b>36.7%</b>	<b>19</b>	<b>63.3%</b>	<b>71.70</b>	<b>± 17.96</b>



**Figure (3):** The percentage distribution of the staff nurses' total practice level regarding infusion pumps' medication administration among critically ill patients (n=30).



**Table (4):** A Descriptive analysis of Critical items mostly neglected during practice (n=30).

Critical items mostly neglected during practice	Incorrectly/ not done	
	N	%
<b>I. Preparing phase (for all procedures)</b>		
- Check the patient's chart for allergies.	21	70%
- Hand washing.	20	66.7%
- Check expiration dates of the medication and diluents.	21	70%
- Explain the procedure, purpose and action of the medication to the patient.	19	63.3%
- Complete necessary assessment before administering medication infusion: - Ask the patient about allergies.	24	80%
<b>II. Priming and setting up phase</b>		
- Use aseptic technique.	18	60%
- Place label on tubing with appropriate date.	28	<b>93.3%</b>
- Complete a drug additive label according to local policy and attach to the syringe with:-		
• Time and date the infusion started.	19	63.3%
• Patient's name.	28	<b>93.3%</b>
• Name and signature of the person starting the infusion.	29	<b>96.7%</b>
- Use antiseptic swab to clean the access port or stopcock.	27	<b>90%</b>
<b>III. Administration phase</b>		
<b>A</b>	<b>General administration steps</b>	
- Do an independent double-check of high alert drugs infusion.	21	70%
- Observe the patient for allergy lead to observed hemodynamic changes.	19	63.3%
<b>B</b>	<b>Identify an infusion from multiple IV infusions :-</b>	
- Apply adhesive label to the IV tubing.	29	<b>96.7%</b>
- Standardize infusion system communication by using adhesive labels to distinguish high alert medication lines from other infusions	28	<b>93.3%</b>
- Clearly communicate the architecture of infusion setups during transitions of care (handover) between providers.	21	70%
<b>IV. Post administration phase</b>		
- Document the following:		
• The status of the IV insertion site.	24	80%
• Any adverse responses of the patient.	23	76.7%

## Nurses' Performance Regarding Infusion Pumps' Medication Administration Among Critically Ill Patients

**Table (5):** The relationship between the demographic characteristics and nurses' Knowledge level regarding infusion pumps' medication administration among critically ill patients(n=30).

Item	Total Knowledge		Total	Chi Square $\chi^2$	P Value		
	Unsatisfactory	Satisfactory					
<b>Qualifications</b>							
Bachelor in nursing	5	4	9	1.277	0.25838		
	55.6%	44.4%	100%				
Diploma of technical health institute	16	5	21				
	76.2%	23.8%	100%				
<b>Years of Experience</b>							
1 - < 5 years	20	5	25			7.143	0.00753*
	80%	20%	100%				
5 - <10 years	1	4	5				
	20%	80%	100%				
<b>Patient / nurse ratio</b>							
One patient /nurse	4	6	10	6.431	0.04013*		
	40%	60%	100.0%				
Two patients / nurse	11	2	13				
	84.6%	15.4%	100%				
Three patients /nurse	6	1	7				
	85.7%	14.3%	100%				
<b>Working place</b>							
cardiothoracic surgery ICU	7	7	14	5.000	0.02535*		
	50%	50%	100%				
Cardiac care unit	14	2	16				
	87.5%	12.5%	100%				
<b>Training</b>							
NO	13	1	14			6.531	0.01060*
	92.9%	7.1%	100%				
Yes	8	8	16				
	50%	50%	100%				

(\*) statistically significant (p <0.05)

(\*\*) highly statistically significant (p<0.001)

**Table (6):** The relationship between the demographic characteristics and the nurses' practice level regarding infusion pumps' medication administration among critically ill patients (n=30).

Item	Total Practice		Total	Chi Square $\chi^2$	P Value
	Unsatisfactory	Satisfactory			
<b>Qualification</b>					
Bachelor in nursing.	7	2	9	1.155	0.28247
	77.8%	22.2%	100%		
Diploma of technical health institute.	12	9	21		
	57.1%	42.9%	100%		
<b>Years of Experience</b>					
1 - < 5 years	19	6	25	10.364	0.00129*
	76%	24%	100%		
5 - <10 years	0	5	5		
	0%	100%	100%		
<b>Patient / nurse ratio</b>					
One patient /nurse.	6	4	10	2.346	0.30951
	60%	40%	100%		
Two patients / nurse.	10	3	13		
	76.9%	23.1%	100%		
Three patients /nurse.	3	4	7		
	42.9%	57.1%	100%		
<b>Working place</b>					
cardiothoracic surgery ICU	8	6	14	0.433	0.51043
	57.1%	42.9%	100%		
Cardiac care unit	11	5	16		
	68.8%	31.3%	100%		
<b>Training</b>					
No	13	1	14	9.853	0.00170*
	92.9%	7.1%	100%		
Yes	6	10	16		
	37.5%	62.5%	100%		

(\*) statistically significant (p <0.05)

(\*\*) highly statistically significant (p<0.001)

**Table (7):** The relationship and correlation between total nurses' knowledge and their total practice level regarding infusion pumps' medication administration among critically ill patients(n=30).

Total Knowledge	Total Practice		Total	Chi Square $\chi^2$	P Value
	Unsatisfactory	Satisfactory			
Unsatisfactory	16	5	21	4.983	0.02560*
	76.2%	23.8%	100%		
Satisfactory	3	6	9		
	33.3%	66.7%	100%		
<b>Total</b>	19	11	30		
	63.3%	36.7%	100%		
<b>Correlation of Total Knowledge and Total Practice</b>					
Pearsons' correlation coefficient r =				0.54	
P value =				0.002*	

(\*) Statistically significant (p <0.05)(\*\*) highly statistically significant (p<0.001)



## Nurses' Performance Regarding Infusion Pumps' Medication Administration Among Critically Ill Patients

### Discussion:

As regards the demographic characteristics of the studied nurses, the study demonstrated that all of the studied subjects were females. This finding could be interpreted in the light of the fact that the majority of nurses in Egypt are females and their number is still greater than males in the nursing fields over the past ten years. They were less than thirty years old, besides all of nurses had no manual of nursing procedures and policies about the patient safety regarding infusion pumps' medication administration in their working place, and the majority of them had less than five years of experience.

Also, two thirds of the studied nurses had a technical institute diploma, as well as two thirds of the patient/ nurse ratio exceeded one patient for every one nurse in their working place, and almost half of them were working at the cardiac care unit. In addition, almost half of studied nurses didn't attend training programs.

These findings showed the contributing factors to the inadequate performance and persistence of infusion pumps' medication administration errors which could be related to the fact of the inadequate experience of the young studied nurses and the work load caused by shortage of the staffing evidenced by exceeding the patient / nurse ratio more than one patient for every one nurse.

This findings agreed with **Al-Youssif et al., (2013)**; a study performed to assess nurses' experiences toward perception of medication administration errors reporting which was carried out in all departments of King Khalid Public Governorate Hospital in Hafer El-Batin at Kingdom of Saudi Arabia; it revealed that more than three quarters of the nursing staff were females, and more than half of them aged between 26-30 in addition, half of

them had a diploma degree, and most of them had less than 5 years of experiences.

As regards the total nurses' knowledge regarding infusion pumps' medication administration among critically ill patients, the study findings showed that less than three quarters of the studied nurses had unsatisfactory total knowledge regarding infusion pumps' medication administration among critically ill patients. These results could be because the training programs about infusion pumps' safe using were not offered in the nursing in-service training programs or in the educational curriculums. In addition, the studied nurses' units didn't include a manual of nursing procedures and policies about safe using of infusion pumps.

This study findings agreed with **Shamsuddin&Shafie (2012)**; a study conducted to assess "knowledge of nurses in the preparation and administration of intravenous medications" found that the studied subjects had a limited knowledge on the preparation and administration of high alert medication infusion. This is supported by **Westbrook et al., (2011)**; a study titled "errors in the administration of intravenous medications in hospital and the role of correct procedures and nurse experience" demonstrated that while infusion pumps have the potential to reduce errors, their effectiveness in everyday practice is often seriously compromised by a knowledge deficit and failure to use the devices as intended due to the lack of nurses' knowledge, experience and training.

As regards the subtotal nurses' knowledge regarding infusion pumps' medication administration among critically ill patients, the study demonstrated that the majority of the studied nurses had unsatisfactory knowledge regarding intravenous infusion calculations, and more than half of them had unsatisfactory knowledge regarding managing the dead volume in intravenous lines, labeling & infusion observation and patient monitoring.

These results could be related to the fact that the studied nurses had received little to no training on how to manage dead volume and medication dilution calculations from either their formal nursing education or their hospital unit orientation. The studied nurses reported that dead volume was a concept they became more familiar through direct experience, or through observing more experienced nurses in the cardiac intensive care units.

In the same line, **Pinkney et al., (2014)**; a study titled “Multiple Intravenous Infusions Phase 2B: Laboratory Study” who demonstrated that errors were observed in completing common tasks associated with the administration of multiple IV infusions, including managing dead volume e.g., 96% flush rate errors following IV syringe dose administration .

These study findings agreed with **Shamsuddin &Shafie (2012)**; a study conducted to assess “knowledge of nurses in the preparation and administration of intravenous medications” found that the majority of the studied nurses had limited knowledge about how to calculate the dilution of intravenous high alert medication.

The researcher findings were consistent with **Cassano-Piché et al., (2012)**; a study of “Multiple Intravenous Infusions Phase 1B” emphasized that two issues associated with the proper management of dead volume that impact infusion accuracy were identified from the field study data, they were inadequate training of nurses about the management of dead volume, and IV tubing and connector design. Dead volume management issues garnered a high hazard score because delays and unintended boluses of IV medication resulting from dead volume are hard to detect.

As regards the total nurses’ practice regarding infusion pumps’ medication administration among critically ill patients, the study findings revealed that about two

thirds of the studied nurses had an unsatisfactory level of total practice regarding infusion pumps’ medication administration among critically ill patients. In relation to the practice subtotal items; almost half of the studied subjects had a satisfactory level of practice regarding the administration phase and post administration phase. While two thirds of them had an unsatisfactory level of practice regarding the preparing, priming and setting up phase.

It seems reasonable to conclude on the basis of these findings that the studied nurses’ knowledge and practice level regarding infusion pumps’ medication administration among critically ill patients are inadequate. These findings could be due to the fact that the studied nurses had no manuals of nursing procedures and policies about the patient safety regarding infusion pumps’ medication administration in their working place, the majority of them had less than five years of experience, besides inadequate training and staffing.

These results were supported by **Kumaret al., (2011)**; a study conducted to assess medication administration errors in a tertiary care hospital, which revealed that the predominant human factors responsible for medication administration errors were identified as performance deficit .

Moreover, the result is consistent with **Ohashi et al., (2013)**; a study conducted to evaluate the intravenous medication errors with smart infusion pumps in an academic medical center found that almost all the nursing staff had an unsatisfactory level of practice regarding the preparation of intravenous medication and the most frequent errors during the medication administration by the smart infusion pump were due to violations of hospital policies regarding labeling and tubing practices during the preparation of the intravenous medication.

The study revealed the critical items mostly neglected by the studied subjects.

## Nurses' Performance Regarding Infusion Pumps' Medication Administration Among Critically Ill Patients

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The majority of the studied nurses neglected the important steps such as completing a drug additive label with the name and signature of the person starting the infusion, applying an adhesive label to the IV tubing, placing a label on tubing with the appropriate date, completing a drug additive label with the patients' name, standardizing infusion system communication by using adhesive labels and use an antiseptic swab to clean the access port or stopcock.

In the light of these findings it is reasonable to confirm that the inadequate knowledge and practice regarding infusion pumps' medication administration (evidenced by lack of experience) and shortage of nurses staffing (evidenced by the exceeding patient/ nurse ratio); were the contributing factors of the cognitive and physical workload, work around and improper management of clinical situation in the working place, leading to fatigue of nurses, lack of attention, acts of omission and violations of the safety measures regarding labeling and disinfection.

This result agreed with **Kivekäs et al., (2014)**; a study conducted for evaluation of intravenous medication errors with infusion pumps mentioned that issues and several types of errors regarding intravenous infusion pumps were observed; the most common error was the lack of information on the label of a the IV infusion dose. This may increase the risk of administering wrong intravenous medications for a patient.

These results were inconsistent with, **Cassano-Piché et al., (2012)**; a study of "Multiple Intravenous Infusions Phase 1B" demonstrated that the health care system becomes more able to manage patients with increasingly more complex conditions due to the improvements in medications, the medical device technology and the increasing number of infusions; so when managing multiple IV infusions, nurses must be able to quickly identify the

contents, location, and infusion pump parameters for each IV line.

The study revealed that there was no statistically significant relation between the total nurses' knowledge and their qualifications; while there was a statistically significant relation between the total nurses' knowledge and their years of experience, the patient /nurse ratio, work place and their training. These findings could be due to the fact that the information technology of the different types of infusion pumps and topics about the administration of intravenous medications by infusion pumps are not integrated in the nursing training programs and the educational curriculums for different categories of educational levels (diploma - technical institute - bachelor).

The result is inconsistent with **Samy et al., (2014)**; the study findings revealed that there were significant statistical differences among nurses by their educational categories regarding knowledge and practice regarding the administration of selected high alert medications by infusion pumps. The current study findings disagreed with **John et al., (2012)**; a study about reporting of adverse drug reactions: an exploratory study among nurses in a teaching hospital, Ajman, United Arab Emirates; revealed that the nurses with a bachelor degree had slightly higher median knowledge score than the diploma nurses.

The study findings are supported with **Hassan & Ahmed (2012)**; a study entitled "Patient Safety: Assessing Nurses' Compliance" revealed that there was a statistical significant correlation between attending training programs and the total scores of nurses' compliance to the safety practices regarding administration of high alert medications.

The study revealed that there was no statistically significant relation between the total nurses' practice level and their qualifications, the patient /nurse ratio and the working place; while there was a

statistically significant relation between the total nurses' practice level and the years of experience, and their training.

In the light of these findings it is reasonable to confirm that the inadequate nurses' practice level is related to the lack of experience and effective training programs. In addition, a proportion of infusion pumps' medication administration errors are also associated with routine violations which are likely to be learned workplace behaviors which persist regardless of the increased clinical knowledge; the majority of nurses develop their own individual approaches and strategies on their units to address clinical needs.

These study findings disagreed with **Al-Youssif et al., (2013)**; a study conducted to assess the nurses' experiences towards the perception of medication administration errors reporting illustrated that there was no statistically significant correlation between the participants' age and experience with practice.

As regards the relationship and correlation between the total nurses' knowledge and their total practice level, there was a statistical significant relation and correlation between the total nurses' knowledge and their total practice level regarding infusion pumps' medication administration among critically ill patients. It seems reasonable to conclude on the basis of the study findings that the total studied nurses' knowledge and practice levels are inadequate.

In the light of these findings, this could be due to their poor compliance with the correct procedures and infusion pumps' medication administration protocols, the omission of patients' safety measures due to cognitive and physical workload, staffing inadequacies, workarounds and the lack of training.

The current study findings agreed with **Westbrook et al., (2011)**; a study

conducted to assess the errors in the administration of intravenous medications in a hospital and the role of correct procedures and nurse experience. Their findings showed that there were a significant proportion of IV administration errors that reflect knowledge and/or skill deficit.

This was supported by **Pinkney et al., (2014)**; a study about administering multiple intravenous infusions via infusion pumps revealed that the studied subjects' lack of knowledge with intravenous medications and infusion pumps has been identified as a key contributing factor to 79% of intravenous medication administration errors; and some omission errors were partly attributable to a lack of knowledge about infusion principles.

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### **Conclusion**

**Based on the findings of the study, the researchers concluded that:**

- The study demonstrated that less than three quarters of the studied subjects had unsatisfactory total knowledge regarding infusion pumps' medication administration among critically ill patients.
- The study revealed that about two thirds of the studied subjects had unsatisfactory level of total practice regarding infusion pumps' medication administration among critically ill patients.
- The study demonstrated that there was a statistical significant relation and correlation between the total nurses' knowledge and their total practice level regarding infusion pumps' medication administration among critically ill patients.

**Based on the study findings the researchers suggested the following recommendation:**

- Provide in-service educational programs and upgrading courses based



## Nurses' Performance Regarding Infusion Pumps' Medication Administration Among Critically Ill Patients

on nurses' needs and evidence based guidelines to improve their knowledge and practice related to administration intravenous medications using infusion pump.

- Resources and time should be allocated to training in order to ensure patient safety and minimize adverse incidents.
- The integration of topics about infusion pumps' medication administration in the nursing curriculums for different categories (diploma - technical institutes-bachelor).
- The study should be replicated on large sample in different hospitals settings in Egypt to generalize the results and figure out the main aspects of the infusion pumps' medication administration among critically ill patients.

### References:

- Abramovitz, J. (2015):** Lippincott's nursing procedures (7th edition), Wolters Kluwer health, Lippincott Williams & Wilkins, Philadelphia, United States of America, p. (438).
- Al-Youssif, A. S., Mohamed, K. L. & Mohamed, S.N., (2013):** "Nurses' Experiences toward Perception of Medication Administration Errors Reporting". *Journal of Nursing and Health Science*, 4(1), 56-70.
- Cassano-Piché, Fan M., Sabovitch S., Masino C. & Easty A.C. (2012):** "Multiple Intravenous Infusions Phase 1b", institute for Safe Medication Practices Canada, Ont Health Technol Assess Ser. 2012; 12(16): 1-132. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3377572/>. Last accessed in August 2018.
- Fan, M., Koczmara, C., Masino, C., Cassano-Piché, A., Trbovich, P., and Easty, A. (2014):** "Multiple Intravenous Infusions Phase 2a". Ontario Survey. available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4522693/>. Last accessed in June 2018. *Ont Health Technol Assess Ser.* 2014; 14(4): 1-141.
- Food & Drug Administration (FDA) (2016):** "Medical Devices: infusion pumps". Available at: <https://www.fda.gov/medicaldevices/productsandmedicalprocedures/generalhospitaldevicesandsupplies/infusionpumps/default.htm>. Last accessed in April 2108.
- Hassan, M.R. & Ahmed, S. (2012):** "Assessing Nurses' Compliance: Patient Safety". *Journal of American Science*. 8 (1):748- 755]. (ISSN: 1545-1003).
- John, L.J., Arifulla, M., Cheriathu, J.J., & Sreedharan, J. (2012):** "Reporting of adverse drug reactions: an exploratory study among nurses in a teaching hospital, Ajman, United Arab Emirates". *DARU Journal of Pharmaceutical Sciences*, 20, 1- 6. doi:10.1186/2008-2231-20-44. Available at: <https://link.springer.com/article/10.1186/2008-2231-20-44>. Last accessed in June 2018.
- Kivekäs, E., Haatainen, K., Kokki, H. & Saranto, K. (2014):** "Evaluation of Intravenous Medication Errors with Infusion Pumps". *WIS 2014, CCIS 450*, pp. 78-87, 2014. Available at: [https://link.springer.com/content/pdf/10.1007%2F978-3-319-10211-5\\_8.pdf](https://link.springer.com/content/pdf/10.1007%2F978-3-319-10211-5_8.pdf). Last accessed in June 2018.
- Kumar, A. K. S., Venkateswarlu, K. & Ramesh, A. (2011):** "Medication administration errors in a tertiary care hospital". *Indian Journal of Pharmacy Practice*, 4(2), 37-42. Available at: <https://www.ijpbs.com/>

- ijpbadmin/upload/ijpbs\_5a8c382900adb.pdf. Last accessed in July 2018.
- Mukoreka, J.&Sisay, I. (2015):**“Safe practices in syringe pump management”. *Nursing Times*; 111; 14: 19-21. Available at: [https://www.nursingtimes.net/Journals/2015/03/30/tr/n/010415\\_Safe-practice-in-syringe-pump-management.pdf](https://www.nursingtimes.net/Journals/2015/03/30/tr/n/010415_Safe-practice-in-syringe-pump-management.pdf). Last accessed in January 2018.
- Ohashi, K., Dykes, P., McIntosh, K., Buckley, E., Wien, M. & Bates, D. (2013):**Evaluation of intravenous Medication Errors with Smart Infusion Pumps in an Academic Medical Center. AMIA Symposium; American Medical Informatics Association, Annual Symposium, Washington, DC, US, November 16-20. 2013:1089-98. Available at: [https://www.researchgate.net/publication/260254189\\_Evaluation\\_of\\_Intravenous\\_Medication\\_Errors\\_with\\_Smart\\_Infusion\\_Pumps\\_in\\_an\\_Academic\\_Medical\\_Center](https://www.researchgate.net/publication/260254189_Evaluation_of_Intravenous_Medication_Errors_with_Smart_Infusion_Pumps_in_an_Academic_Medical_Center). Last accessed in May 2018.
- Pinkney, S., Fan, M., Chan, K., Koczmara, C., Colvin, C., Sasangohar, F., Masino, C., Easty, A. &Trbovich, P.(2014):** “Multiple Intravenous Infusions Phase 2b: Laboratory Study”, *Ont Health Technol Assessment Ser.* 2014 May 1; 14(5):1-163. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4549602/>. Last accessed in April 2018.
- Samy, R., Youssef,W., Ali,N.(2014):**“High alert medication Critical Care Nurses' Knowledge and Practice Regarding Administration of Selected Positive Inotropics at Cairo University Hospitals”. Available at: <http://www.iiiste.org/Journals/index.php/JNSR/article/view/10613>. Last accessed in April 2018.
- Shamsuddin, A. F. &Shafie, S. D. (2012):**“Knowledge of nurses in the preparation and administration of intravenous medications”, *Quality Use of Medicines Research Group, Faculty of Pharmacy. University Kebangsaan, Malaysia. Procedia - Social and Behavioral Sciences* 60 (2012) 602 – 609. Available at: [www.sciencedirect.com](http://www.sciencedirect.com). Last accessed in August 2018.
- Westbrook, J. I., Rob, M. I., Woods, A., & Parry, D. (2011):**“Errors in the administration of intravenous medications in hospital and the role of correct procedures and nurse experience”. *BMJ quality & safety*, 20(12), 1027-1034. Available at: <https://qualitysafety.bmj.com/content/qhc/20/12/1027.full.pdf>. Last accessed in March 2018.
- Xuemei, G., Qiang, W., Duan, X., Weil, J., Xiaohong, T., Ling, Z., Shitao, X., Hailing, F. and Daidi, Z. (2017):**“A Hazard Analysis Of Class I Recalls of Infusion Pump”. Available at: <https://pdfs.semanticscholar.org/5c3c/0fb441945452654ed8a9eed282a351a2326.pdf>. Last accessed in August 2018.